Backward Transfer of Glaswegian English on Indian English and Hindi:
A Case of Simultaneous Bilingual and Bidialectal Contact and Interaction in Indian Immigrants in Glasgow

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Abstract

In the wider context of Second Language Acquisition, much evidence has been found for phonological backward transfer across languages, but there are still various facets of it that remain unknown. This thesis investigates three such aspects: (1) the role of systemic similarity between linguistic varieties in affecting backward transfer, (2) differences between backward transfer across languages and backward transfer across dialects, and (3) the role of multiple sociolinguistic and psycholinguistic factors in affecting backward transfer. To this end, this study examined the first-generation bilingual adult Indian immigrant community in Glasgow 'Glaswasians' (n = 38), who were bilingual in Hindi and Indian English prior to arriving in Glasgow and are now in contact with the dominant host variety in Glasgow, Glaswegian English. In addition to Glaswasians, two control groups were recruited: 'Glaswegians' (n = 34), native speakers of Glaswegian English who reside in Glasgow, and 'Indians', (n = 31), native speakers of Indian English and Hindi, who reside in India and have never been in contact with Glaswegian English.

To investigate the first aspect, an XAB similarity judgement task was carried out to determine if in addition to typological similarity, Indian English is also perceptually more similar to Glaswegian English as compared to Hindi, and therefore more vulnerable to transfer from Glaswegian English. The two control groups participated in this task and the results did not indicate a pattern of consistent similarity between Indian English and Glaswegian English phones, as compared to Hindi phones.

To examine phonological backward transfer across languages versus dialects, the three speaker groups participated in a speech production task. Multiple phone categories were examined for various phonetic cues: (1) /l/ for F2-F1 difference, (2) GOOSE vowel for F1, F2, F3, (3) /t/ for Voice Onset Time (VOT), (4) Voiced stops /b d g/ for VOT, Voicing During Closure (VCD) and Relative Burst Intensity (RBI). The results, which were mixed, were interpreted with respect to Flege's Speech Learning Model (1995b; Flege & Bohn, 2021) and its predictions of assimilation and dissimilation. Out of the three occasions of differences in the amount of transfer exhibited by Hindi and English, English underwent quantitatively more assimilation than Hindi on two occasions (VOT in /t/ and /d/), whereas Hindi underwent quantitatively more dissimilation than English on one occasion (F2-F1 difference in /l/).

Finally, to examine the role of sociolinguistic and psycholinguistic factors in affecting backward transfer, data was collected from Glaswasians. A questionnaire task was used to collect data on gender, age of entry and length of residence in Glasgow, language proficiency and dominance, contact and identity, perceived discrimination. Multiple psychometric tasks were used to collect data on language switching ability and inhibitory skills. The results indicated that most of these factors influenced backward transfer and had a general effect across phones and corresponding features. For instance, higher Age of Entry and Length of Residence in Glasgow, Indian Identity, Indian Contact and higher inhibition were generally associated with more native-like or exaggeratedly native like shifts, whereas higher Glaswegian Contact and Glaswegian Identity were related to shifts towards Glaswegian English. There were, however, exceptions to the general effects of these predictors, such as for the phone categories /t/ and /g/. This finding is discussed in relation to the salience of these categories in the respective native and host linguistic varieties.

The results of this study are discussed with reference to patterns of transfer and influence of factors found in previous research. Additionally, their implications about the nature of the adult bilingual-bidialectal system, its flexibility and the apparent lack of strong correspondence between perceptual similarity and backward transfer effects, are discussed. These findings also contribute to the knowledge on transfer effects across languages versus dialects and add to what was previously known about Indian English, Hindi and Glaswegian English. A model of backward transfer, the 'Proximity Modulated Transfer Hypothesis', is proposed to understand the manner of interaction between Glaswegian English and Hindi and Indian English in this situation of simultaneous bilingual and bidialectal interaction in relation to backward effects discovered across the various phones and corresponding features.

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Declaration

With the exception of the introductory material contained in Chapters 1, 2, 3 and 4, all work in this thesis was carried out by the author unless otherwise explicitly stated.

Chapter 1

Introduction and Research Context

1.1 Introduction

Migration has close ties with linguistics. This is because migrants not only bring their own identity, language, and culture with them, but also acquire and interact with the languages of the host country. In the 20th century, research on bilingualism and second language acquisition (SLA) gained speed due to increasing migration and language contact across the world. One extensively studied avenue within this was the influence of a native language, the L1, on the acquired language, the L2. Much early research specifically examined how the L1 'interfered' with the learning or acquisition of an L2: a process referred to by Lado (1957) as 'transfer'. Around the same time, Weinreich (1953) argued that 'interference' is bidirectional and either language can cause a rearrangement of patterns in the other. Due to extensive research in both these areas over the years, it is now accepted that either of the languages of the bilingual can influence the other (Barlow, 2014; Flege, 1995b; Pavlenko & Jarvis, 2002). The present study, however, is concerned with the unidirectional influence or 'backward transfer' of a second or new language on the native language (L1) and native dialect (D1) of bilingual speakers. With respect to this, it adds to the existing literature in three ways: first, by studying an interesting but understudied situation of language contact, that of SLA proceeding in tandem with Second Dialect Acquisition (SDA); second, by asking how sociolinguistic and psycholinguistic factors jointly affect backward transfer; and third, by focusing on a combination of languages and dialects that have not yet been explored in this respect.

1.1.1 Significance of this dissertation

1.1.1.1 An interesting but understudied situation of language contact

In previous research, among other approaches, changes in the phonology of the L1 due to the influence of another linguistic variety have been examined from two perspectives that are relevant to the present study. The first is phonetic backward transfer (Cook, 2003; Kartushina, Frauenfelder, & Golestani, 2016) or L1 phonetic attrition (Ahn, Chang, Dekeyser, & Lee-Ellis, 2017; Cherciov, 2011; E. de Leeuw, 2009, 2020; E. de Leeuw, Mennen, & Scobbie, 2012, 2013; E. de Leeuw, Schmid, & Mennen, 2007; Gürel, 2004, 2007; Hopp & Schmid, 2011; Köpke, 2007; Paradis, 2007; Riehl, 2019; Schmid, 2007, 2013; Yılmaz, 2019) or drift (Chang, 2010, 2012, 2013), where the new language is learned and acquired by the previously monolingual speaker as an L2, and influences the speakers' L1. The second perspective is L1 phonetic accommodation (Babel, 2009, 2012; M. Kim, 2012; M. Kim, Horton, & Bradlow, 2011; Olmstead, Viswanathan, Cowan, & Yang, 2021; Pardo, 2006; Wagner, Broersma, McQueen, Dhaene, & Lemhöfer, 2021), where the new linguistic variety acts as an ambient language, not necessarily learned by the speaker. This is usually the case when a monolingual speaker is in contact with another dialect (or accent; D2), which influences their L1 (D1).

The research under both these approaches has generated plenty of evidence to show that L2 phonology can induce changes in the phonology of the speakers' L1 (Bergmann, Nota, Sprenger, & Schmid, 2016; Chang, 2012, 2013; E. de Leeuw, Schmid, & Mennen, 2010; Kartushina, Frauenfelder, & Golestani, 2016; Lev-Ari & Peperkamp, 2013; Major, 1992; Mayr, Price, & Mennen, 2012; Mora & Nadeu, 2012), and the D2 can also induce phonetic changes in the D1 by being in short-term or long-term contact with it (Alshangiti & Evans, 2011; Babel, 2009, 2010; Chambers, 1992; Coupland, 1984; Enzinna, 2018; Evans & Iverson, 2007; Goldinger, 1998; Soquet & Delvaux, 2007; Trudgill, 1986).

So, the effect of L2 on L1 and the effect of D2 on D1 have been examined separately under the frameworks of backward transfer (also L1 phonetic attrition/drift) and L1 phonetic accommodation (or imitation) respectively. However, a situation of language contact (and its implications for phonetic backward transfer) that has not been examined before is when a speaker is native in two languages (simultaneous bilingualism) and is exposed to a new linguistic variety that simultaneously acts not only as a new language, but also as a new dialect with respect to the bilinguals' previously and simultaneously acquired native languages.

The above situation is illustrated in Figure 1.1 with the help of the experimental group examined in this study, which presents an interesting yet somewhat neglected linguistic scenario. The term 'Glaswasian' was introduced by Alam (2006, 2015) to refer to the diverse South-Asian population that migrated from India, Pakistan, Bangladesh, Sri Lanka and other South-Asian countries, and settled in Glasgow. In this study, however, I shall extend the term 'Glaswasian' to refer to a group of first-generation Indian migrants in Glasgow (Scotland). These Glaswasians are native speakers of Hindi and a variety of English spoken in India 'Indian English' (Gargesh, 2008). Both these native linguistic forms were acquired by these speakers prior to their migration to Glasgow, often simultaneously. Thus, they were bilinguals prior to migrating to the new country and have also been in continued contact with the host dominant language in Glasgow 'Glaswegian English'.

These Glaswasians present a situation of contact between their native language Hindi, native dialect Indian English, and the dominant host language *and* dialect Glaswegian English that they are exposed to on a long-term and continued basis. Thus, the primary focus of the present study is how would a host dominant language (Glaswegian English), which is both a new dialect (with respect to Indian English) and a new language (with respect to Hindi) influence these native varieties. This situation provides a valuable and unique opportunity to examine the effects of SLA and SDA on the native varieties in the same individuals. As mentioned earlier, the effects of L2 on L1 and D2 on D1 have been studied separately under the respective frameworks (as shown in Figure in 1.1), but never simultaneously in the same speaker group. Importantly, I approach this contact situation from the perspective of second language and dialect acquisition, because it is clearly not a case of third language or dialect acquisition (explained by the Typological Primacy Model; Rothman, 2010, 2013, 2015) even though it involves three linguistic varieties.

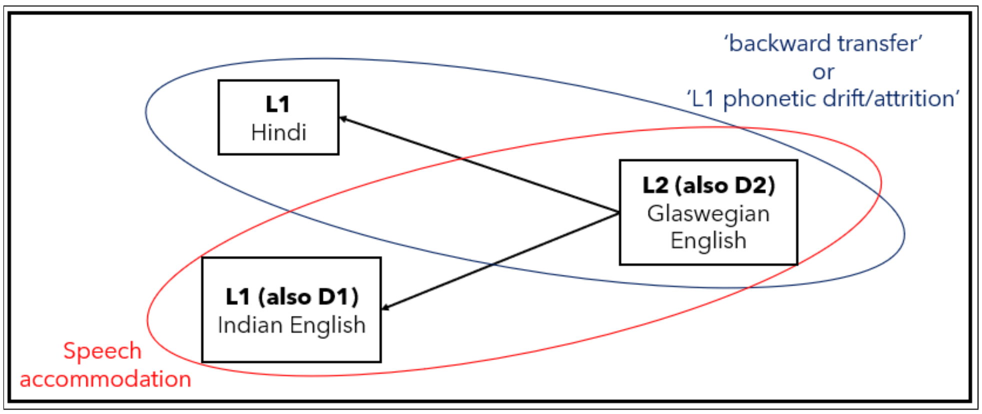


Figure 1.1: D1 phonetic accommodation to D2 studied under the 'Speech Accommodation Framework' and L1 phonetic shift towards L2 studied under the 'backward transfer' or 'L1 drift or attrition' framework

Furthermore, this situation of linguistic contact offers an opportunity to examine if and how transfer processes between languages differ from transfer processes between dialects. Previous research indicates that one can expect higher transfer between linguistic varieties that are mutually intelligible as compared to those that are not (Trudgill, 1986), and also that in situations of third language acquisition, forward transfer to L3 would come from the more structurally similar L1 or L2 (Typological Primacy Model; Rothman, 2010, 2013, 2015). Based on this, the present study argues that because Indian English and Glaswegian English are dialects of the same language, Indian English may exhibit more transfer from Glaswegian English as compared to Hindi which is a separate language and exhibits higher familial distance from Glaswegian English.

The present study makes another contribution in relation to the organisation and interaction between multiple linguistic varieties in the mind. Various models have been proposed to explain the organisation of languages in a bilingual mind (Cook, 2003; Flege, 1995b; Flege & Bohn, 2021; Kroll & Stewart, 1994; Laeufer, 1996; Paradis, 2001; Weinreich, 1953), but less so for the organisation of dialects in a bidialectal mind (J. Siegel, 2010). So, an interaction between these linguistic varieties will offer an insight into how these linguistic varieties may interact and be organised at the phonological level in minds that are both bilingual and bidialectal at the same time.

1.1.1.2 Integrating psycholinguistic and sociolinguistic phenomena

The present study acknowledges that from the perspective of ethnolinguistic minorities in a new country, bilingualism (synonymous to multilingualism in the present study) is both a psycholinguistic and sociolinguistic phenomenon. As a sociolinguistic phenomenon, bilingualism is the result of contact between different languages when communities from different cultural/linguistic backgrounds interact with each other (Deumert, 2012; Mackey & Ornstein-Galicia, 1979; Matras, 2009), and multiple languages are used in a society. As a psycholinguistic phenomenon, bilingualism (synonymous to multilingualism in this study) is a situation where two or more languages that are used alternately by the same bilingual speaker come into contact with each other and interact in the bilingual mind (Deumert, 2012; Weinreich, 1953). As Weinreich (1953) puts it, “from the point of view of the individual, the two languages are two types of activity in which the same organs are employed" (71). And since “multilingual speakers do not exist in a sociolinguistic vacuum" (Hickey, 2010:267), this study approaches Glaswasians not only as individual bilinguals but also as members of an immigrant community. This is reflected in the choice of factors chosen to examine backward transfer.

The studies on backward transfer approach the effect of learning a second language on the first mainly from a psycholinguistic perspective. In doing so, several of these studies have identified the role of factors like age of acquisition of L2 (Ahn et al., 2017; Barlow, 2014; Flege & Eefting, 1987a; Guion, 2003; Harada, 2003; Kang & Guion, 2006; Oh et al., 2011), length of residence in the host country (Lev-Ari & Peperkamp, 2013), L1 and L2 proficiency and dominance (Flege & Eefting, 1987b; Lord, 2008; Major, 1992; Mayr et al., 2012; Sancier & Fowler, 1997), similarity between L1 and L2 (Flege, 1995b; Flege & Bohn, 2021; Flege & Eefting, 1987b; Flege, Yeni-Komshian, & Liu, 1999) in modulating backward transfer effects.

However, especially when examining migrants in such a situation of language contact, it is important to also approach language contact from their perspective and include other factors that may be more reflective of their experience as an ethnolinguistic minority assimilating in a new host country, which is culturally, economically, linguistically very different from their country of origin, especially with respect to the migrants’ position in this host community. Studies under the accommodation framework take this into account and acknowledge that adaptation to the ambient linguistic variety is modulated by various social and psychological motivations, as well the individuals’ experiences with the host community (Accommodation Theory; Giles & Powesland, 1997; Ogay & Giles, 2007).

Based on the above, the present study examines the influence of Glaswegian English on Indian English and Hindi as a function of various social and psychometric factors. These are age of arrival in Glasgow, length of residence in Glasgow, proficiency and dominance in English and Hindi, gender, individual inhibitory skill and language switching ability, as well as contact with the Glaswegian and Indian community, the perception of their own identity, and perceived discrimination in Glasgow.

1.1.1.3 A unique combination of languages

In examining Glaswasians, the present study allows to study a combination of languages that has never been examined before by either transfer or accommodation studies. Previous research on transfer and accommodation has been quite diverse in terms of bilingual groups and languages involved. There has been much research on L1 German in relation to English (American and Canadian) as well as Dutch (Bergmann et al., 2016; E. de Leeuw, Mennen, & Scobbie, 2013; E. de Leeuw et al., 2007), L1 American English in relation to Korean (Chang, 2012, 2013), L1 English in relation to French (Lev-Ari & Peperkamp, 2013), L1 Catalan in relation to L2 Spanish (Mora & Nadeu, 2012), L1 Spanish and L2 American English (Barlow, 2014), L1 American English and L2 Brazilian Portuguese (Major, 1992), L1 French in relation to L2 Dutch and Russian (Kartushina, Hervais-Adelman, Frauenfelder, & Golestani, 2016), L1 Dutch and L2 English (Mayr et al., 2012). Accommodation studies have examined several pairs of dialects including across dialects of Belgian French (Soquet & Delvaux, 2007), L1 New Zealand English accommodating to Australian English (Babel, 2010) and North-East British English accommodating to Standard Southern British English (Alshangiti & Evans, 2011; Evans & Iverson, 2007).

Thus, it can be concluded that backward transfer and accommodation have been found for languages that are typologically close and similar like Dutch-German and Catalan-Spanish, as well as for languages that are typologically more distant like English and Korean. The combination of linguistic forms in the present study (Glaswegian English, Indian English, Hindi) has never been examined before and should be very insightful as it examines a combination of typologically similar (Glaswegian English and Indian English) and comparatively distant (Glaswegian English and Hindi) varieties. In addition to this, this study will also contribute to the existing knowledge on the acoustic and phonetic makeup of categories in Hindi and Indian English, especially when not much current research is accessible for both of these linguistic varieties (Awan & Stine, 2011; Cowie & Elliott, 2019; Davis, 1994, 1995; Gargesh, 2008; Kachru, 1976; Maxwell & Fletcher, 2009, 2010; Ohala, 2014a; Pandey, 1981; Phull & Kumar, 2016; Sailaja, 2012; Samudravijaya, 2003; Sirsa & Redford, 2013; Wiltshire & Harnsberger, 2006).

1.1.2 Outline of this dissertation

Based on the above discussion, three general research questions can be identified:

1. **Is there a backward transfer of Glaswegian English on Indian English and Hindi in production?**

The present study examines the phonetic backward transfer of the host dominant language (and dialect) Glaswegian English to the native language (Hindi) and native dialect (Indian English) of bilingual Indian immigrants in Glasgow (Glaswasians). These processes will be approached from two theoretical standpoints: the Speech Learning Model (SLM, Flege, 1995b; SLM-r, Flege & Bohn, 2021), Accommodation Theory (Giles & Powesland, 1997; Ogay & Giles, 2007). According to Flege's SLM (Flege, 1995b) and SLM-r (Flege & Bohn, 2021), all sounds of the bilinguals' languages exist in the same phonetic space which reorganises in response to acquisition of a new language. This reorganization leads to changes by two processes: *assimilation* and *dissimilation*. Assimilation takes place when similar L1-L2 categories are merged, which leads to the L1 category becoming more like the L2 category; dissimilation takes place when an L1 category is deflected from the similar L2 category to maintain a contrast between them. A detailed explanation of the circumstances of these processes is presented in §1.2.1.2. Parallel to this, accommodation theory identifies two functionally similar phenomena: *Convergence*, which bears similarity to assimilation; and *divergence*, which bears similarities to dissimilation (§1.2.2.1).

To investigate this first research question, the present study employed a speech production task. Speech tokens were elicited from the experimental group, Glaswasians, and two control groups, Indians and Glaswegians. Four phone categories were examined for various acoustic-phonetic cues: (1) word-initial lateral /l/ for F2-F1 difference, (2) word-medial GOOSE vowel for F1, F2, F3, (3) word-initial voiced stops /b d g/ for Voice Onset Time (VOT), Voicing During Closure (VDC) and Relative Burst Intensity (RBI), and (4) word-initial voiceless stop /t/ for VOT. Data from this task were compared across groups and predictions regarding L1 phonetic changes were based on SLM and SLM-r's outcomes of assimilation, dissimilation and no change.

2. **Is backward transfer greater for dialect acquisition than language acquisition?**

   This is to ask whether Indian English will exhibit greater transfer from Glaswegian English, than Hindi from Glaswegian English. This is because Indian English and Glaswegian English are dialects of the same language, whereas Hindi and Glaswegian English are different languages. Based on various sources (Rothman, 2010, 2013, 2015; Trudgill, 1986), the present study assumes that because of its typological proximity to Glaswegian English, Indian English will exhibit more transfer than Hindi, which is comparatively typologically distant from Glaswegian English. Yet, because of the context in which it exists, the phonology of Indian English is highly influenced by the Indic languages. Consequently, it is possible that both Indian English and Hindi are at a similar distance from Glaswegian English phonologically. Due to this, Indian English may, after all, not exhibit higher transfer from Glaswegian English than Hindi. At the same time, models of L2 learning (Best, 1995; Best & Tyler, 2007; Bohn, 2018; Flege, 1995b; Flege & Bohn, 2021;

Pierrehumbert, 2001) claim that categories that are highly similar are more prone to transfer effects. This gives rise to a secondary research question under this second research question. Instead of assuming proximity and similarity between Glaswegian English and Indian English of sound categories in comparison to Hindi, I ask:

Is there higher perceptual similarity between Indian English and Glaswegian English as compared to Hindi and Glaswegian English?

The aim of this question is to investigate whether Indian English sound categories are perceptually more similar to Glaswegian English categories than Hindi categories. This was tested using an XAB similarity judgement task. On each trial, Glaswegian English, Indian English and Hindi stimuli were presented to listeners who were instructed to indicate which language – Hindi or Indian English – was more similar to Glaswegian English. The results of the speech production task were interpreted with respect to the results of this XAB similarity judgement task to determine if the backward transfer effects in production are in line with the similarity judgements found in perception in this XAB task.

3. **Which of the following factors play a role in affecting L1 phonetic changes (in relation to assimilation or dissimilation):**

    (a) Language use/dominance

    (b) Language proficiency

    (c) Gender

    (d) Age at which they arrived in Glasgow (Age of Entry)

    (e) Length of residence in Glasgow

    (f) Interaction with the host Glaswegian community (contact, identity, perceived discrimination)

    (g) Inhibitory skills

    (h) Language switching ability

Previous research has been quite selective about the examination of factors influencing L1 phonetic changes. Especially under the transfer framework there has been a comparative neglect of the involvement of sociolinguistic factors in studying L2 effects on L1 in first-generation migrants. This could be expected since modifying L1 representations in response to L2 acquisition “changes nothing about the social distance between them and native speakers of the L2, given that L1 is not a shared language" (Chang, 2010:3). However, it makes sense to examine them here because Glaswasians are not only bilinguals but also bidialectals after coming in contact with Glaswegian English. Thus, these

Glaswasians offer a unique opportunity to examine all of these factors together in the same speaker group, and also examine the effect of language switching ability on backward transfer, which has not been done before. So, the present study aims to investigate the effects of these psycholinguistic and sociolinguistic factors for phone categories and features that were found to have undergone transfer (assimilation or dissimilation) in the speech production task.

Another interesting aspect to this third research question is whether these factors will affect transfer effects in Hindi and Indian English differently, which, again, is something that has not been addressed in previous research. Data on these factors was collected using questionnaire and multiple psychometric tasks such as the Simon Task (§4.3.2.1.1), Non-linguistic Flanker and Linguistic Flanker Tasks (§4.3.2.1.2), Cued Recall Inhibition Tasks (in Hindi and English) (§4.3.2.1.3) and Language Switching Task (§4.3.2.2.1).

With respect to its structure, this dissertation has been organised into five chapters. The present chapter (Chapter 1) continues the research context for the two phenomena that address L1 and D1 (native dialect) phonetic changes in face of L2 or D2: backward transfer and speech accommodation. Various theoretical models and approaches to these phenomena are discussed in their relevant sections. These are followed by an introduction and discussion of the various models of L3 acquisition (Typological Proximity Model, Rothman, 2010, 2013, 2015; L2 Status Factor, Bardel & Falk, 2007; Cumulative Enhancement Model, Flynn, Foley, & Vinnitskaya, 2004; Scalpel Model, Slabakova, 2017; Linguistic Proximity Model, Westergaard, Mitrofanova, Mykhaylyk, & Rodina, 2017; Phonological Permeability Hypothesis, Cabrelli Amaro, 2013, 2017). It is based on these models that I have proposed the Independent and Mediated models of backward transfer, that present various configurations of simultaneous bilingual and bidialectal interaction between Glaswegian English, Indian English and Hindi. Chapter 2 presents the XAB similarity judgement task. This chapters covers the relevant research background, presents a detailed methodology of the task, results as well as a discussion. Chapter 3 does the same for the speech production task: a detailed methodology has been presented along with discussion of the previous research on each phone category and respective cues. The results of this task are then presented along with their discussion. Chapter 4 presents the analysis of backward transfer as a function of the psychometric and sociolinguistic factors. This chapter begins with a discussion of the methodology involved in eliciting the relevant data, with support from various studies informing how the involved factors may affect the process and direction (assimilation or dissimilation) of transfer. This is followed by the results of this analysis as well as their discussion. Chapter 5 presents the general discussion, conclusion, limitations of the study as well as future directions.

1.2 Research Context

The primary aim of this section is to introduce the reader to the phenomena of backward transfer and L1 and D1 phonetic accommodation, with their corresponding theoretical explanations and studies providing evidence for their theoretical predictions. While transfer and accommodation phenomena are very similar to each other in their predicted outcomes (assimilation, dissimilation, no change versus convergence, divergence, maintenance), they are still quite different in several ways. At the same time, an attempt has been made to combine these phenomena of backward transfer and phonetic accommodation to reflect the simultaneous bilingual and bidialectal situation of language contact in the present study. To this end, the reader is introduced to the various models of L3 acquisition, which have aided in the creation of various propositions with respect to the influence of Glaswegian English on Indian English and Hindi.

§1.2.1 presents a discussion on backward transfer. Studies under this phenomenon strictly examine situations of SLA where the speaker is acquiring or has acquired the second language and has been in short or long-term contact with it. Theoretical support for this comes from a model of second language perception and production, the Speech Learning Model (SLM; Flege, 1995b) and revised Speech Learning Model (SLM-r; Flege & Bohn, 2021). The approach of backward transfer studies is mostly psycholinguistic, with focus on interaction between multiple languages in the bilingual mind.

§1.2.2 presents a discussion on L1 phonetic accommodation, which examines the influence of an ambient linguistic variety (usually another dialect of the same language as the speakers' L1) on the speakers' native linguistic variety. Exposure to this new linguistic form may be natural or in laboratory and may not be long-term. More importantly, the theoretical support for the phenomenon of accommodation is heavily sociolinguistic, with support from cognitive and psycholinguistic accounts.

§1.2.3 introduces and discusses the various models of L3 acquisition (Typological Proximity Model, Rothman, 2010, 2013, 2015; L2 Status Factor, Bardel & Falk, 2007; Cumulative Enhancement Model, Flynn et al., 2004; Scalpel Model, Slabakova, 2017; Linguistic Proximity Model, Westergaard et al., 2017; Phonological Permeability Hypothesis, Cabrelli Amaro, 2013, 2017). These models have been crucial in my attempt to combine the separate L2 to L1 and D2 to D1 interaction and transfer scenarios into a combined scenario of bilingual-bidialectal linguistic contact. In doing so, various predictions are proposed with respect to the influence of Glaswegian English on Hindi and Indian English in the form of Independent and Mediated models of backward transfer.

1.2.1 L1 Change due to L2 Acquisition

1.2.1.1 Backward Transfer

The transfer of features from the L2 to L1 is called 'backward transfer'. Some researchers also refer to backward transfer as 'reverse interference' (Chang, 2010) in reference to the reversed direction of transfer with respect to the more commonly known 'forward transfer', where transfer is from the L1 to L2. In current research on bilingualism and SLA, terms like L1 phonetic drift (Chang, 2010, 2012, 2013) and L1 attrition (Bergmann et al., 2016; E. de Leeuw, 2009; Köpke, 2004; Köpke & Schmid, 2004; Mayr et al., 2012; Schmid, 2011) have also been applied to refer to this type of phonetic backward transfer.

According to Chang (2010:2), L1 phonetic drift is the subtle "phonological restructuring in the first language during second language acquisition", where the phonetic properties of the L1 sound get assimilated towards those of the language that is being acquired (Schmid, 2013). Importantly, it is used to describe short-term changes in the L1 due to recent L2 experience. On the other hand, the term L1 attrition has been discussed more extensively over the years and even defined in diverse ways. In early usage, a few definitions of attrition strictly described it as a process which ultimately led to language death (Boyd & Anderson, 1991). This was based on Grosjean (1982), who explained that decreased or even rare use of a language triggers the slow process of language forgetting. Following Boyd and Anderson (1991), Giesbers (1997) also emphasised that attrition was only to be applied to instances of disappearing knowledge, not changing knowledge.

However, more recently, Köpke and Schmid (2004) take up a fundamental question which still remains unanswered and has been problematic in defining attrition: can a speaker lose or forget a language permanently. This can be seen as the difference between competence and performance such that performance in a language does not equate to competence in it (Chomsky, 1965). Schmid (2013) points out that an individual's inability to retrieve a certain item at a given moment (for example, during a particular task) or swapping it with an L2 element should not be taken as an instance of attrition but simply as their inability to retrieve it in that moment and having the L2 choice available (Kenji & D'andrea, 1992). In this light, while current attrition research still maintains the use of 'loss', they also warn that the word is not to be taken at face value. For instance, Köpke (2004:4) defines language attrition as the "loss of the structural aspects of language, i.e. change or reduction in form". Following Köpke's (2004) definition, E. de Leeuw (2009) goes on to clarify the use of the word 'loss' which she defines as "the non-pathological, non-age related, structural change to a first language within a late consecutive bilingual, assuming that acquisition of the first language precedes its change" (p. 11).

More recently in the last decade, Schmid (2013) described attrition as a case of phonetic drift where the increased proficiency and exposure of a second language brings about variability in the phonetic properties of the first language. Furthermore, Bergmann et al. (2016:72) clarified that "attrition must not be understood as permanent 'loss', but rather as a change in L1 performance" caused by reduced usage of L1, increased exposure and even dominance of the L2. However, they describe this 'change in L1 performance' as 'usually a decline', wherein, according to Chang (2012), lies the difference between attrition and phonetic drift. According to Chang (2012:266), "individuals undergoing attrition experience a deterioration in their L1 production as communication is accomplished increasingly in an L2, while individuals undergoing phonetic drift experience a change, but not necessarily a deterioration in their L1 production due to the accumulation of L2 experience". After examining these definitions, I conclude that the term 'attrition' is possibly more inclusive and can be used to refer to structural changes or even decline in L1 due to L2 or bilingualism. E. de Leeuw (2009) emphasises that L1 attrition can and has been defined in many ways and it is wise to clarify one's own use of the term. However, an important aspect to attrition that should remain constant across definitions is complete acquisition and stabilisation of the L1 before attrition effects start to set in it. This is important in order to establish attrition as a type of diachronic, not synchronic process, and also to contrast it from changes experienced by simultaneous or early bilinguals (E. de Leeuw, 2009).

Based on the above discussion, it seems that changes in the L1 due to the influence of the L2 may appear as a simple rearrangement of L1 features for some speakers, while for others they might represent the first stage of a decline, and thus signal the start of attrition. However, in the present study, I use the term 'backward transfer' to refer to the reversed direction of transfer with respect to its more commonly known counterpart 'forward transfer'. And this term spans any or all changes in the L1 - related to deterioration or not, and differences in scope, agency or consciousness[1].

1.2.1.2 Theoretical Approaches to Backward Transfer and Previous Research

1.2.1.2.1 The Speech Learning Model

Flege's Speech Learning Model (SLM; Flege, 1995b) provides an influential explanation of L2 speech perception and production, but more importantly for the present study, it also provides an account of how acquiring an L2 can lead to changes in the production of the pre-existing L1 sound categories. It argues for a shared phonetic space where existing L1 categories reorganise to accommodate new L2 categories. This reorganisation of the common phonetic space may happen in two ways: by forming new L2 categories, via the process of 'dissimilation', or modifying existing L1 categories, via the process of 'assimilation'. A big contributor to determining which of these two processes will happen is the perceived cross-linguistic similarity between L1-L2 categories.

SLM argues that by the automatic and subconscious process of 'interlingual identification', L2 learners perceive the full range of L2 sounds as instances (some better than others) of one

[1] as argued very recently in De Leeuw and Chang (in press)

or more L1 phonetic categories (Bohn, 2018; Flege & Bohn, 2021). In this way, ‘perceptual linkages’ are formed between a specific L2 sound and the corresponding L1 category that it has mapped onto. Importantly, such linkages are formed at a position-sensitive allophonic level, rather than an abstract phonemic level. Furthermore, these linkages do not remain stagnant, but evolve with increasing L2 input and experience, which determines how the common phonetic space will be reorganised.

One way of reorganizing the phonetic space is through a process called *category dissimilation*. This occurs when an L2 learner identifies enough dissimilarity between such perceptually linked L1-L2 categories (‘diaphones’; Weinreich, 1953), leading to a breakage of the link between these categories and the creation of a separate category for the corresponding L2 sound. In doing so, the L1 category, which specifies the language-specific features of that category, may be deflected away from this newly formed L2 category in the common phonetic system to maintain a contrast between them. This deflection can be detected when the features of that category are exaggerated to highlight this contrast from the corresponding L2 category.

Dissimilation can be affected by a variety of factors. For example, the creation of L2 categories requires the learning of how multiple cues are weighted for any given L2 phonetic category, which can come with greater L2 input and experience (Flege & Bohn, 2021). Furthermore, the greater the perceived distance of an L2 sound from the closest L1 sound, the greater the chance that a new category will be established for that L2 sound.

Previous research has reported multiple instances of dissimilation in consonants as well as vowels. For example, while examining VOT in /t/ in Dutch-English bilinguals, Flege and Eefting (1987a) found that bilinguals with high proficiency in English, produced Dutch /t/ with shorter VOT than what is found in Dutch. This means that the bilinguals exaggerated the shorter Dutch VOT characteristic of monolinguals, to contrast it from longer English VOT. This is evident of category dissimilation, which resulted due to the creation of a separate L2 phonetic category. This was also the case in Flege and Eefting (1987b) who examined various groups of childhood Spanish-English bilinguals for VOT in /p t k/. Again, all bilingual groups produced their L1 Spanish VOT with significantly shorter VOT values than age-matched native Spanish monolinguals. This was evidence of dissimilation of L1 Spanish VOT in /p t k/ to maintain a contrast from the similar but longer English VOT patterns. Dissimilation has also been reported in vowels. For instance, Guion (2003) reported that early Quichua-Spanish bilinguals successfully partitioned their vowel space to accommodate their L1 and L2 vowels, but at the cost of a systemic raising of the L1 vowels to maintain an acoustic distinction with the L2 vowels. Furthermore, Flege (2003) reported dissimilation in early Italian-English bilinguals in Canada, who differentiated English /e$^{\text{ɪ}}$/ from Italian /e/ indicating that they had formed a new category for the English vowel, while also dissimilating the native Italian category.

However, it is also possible for L2 learners to be unable to distinguish between highly phonetically similar diaphones, due to a process called *equivalence classification*. When that happens, then instead of creating a new L2 category, the linked L1-L2 categories are merged such that the corresponding L1 category will be appropriated to reflect the characteristics of the linked L2 category. This process is called L1 *category assimilation*. Additionally, in late L2 learners rather than early L2 learners, “the more a bilingual approximates the phonetic norm for an L2 speech sound, the more her production of the corresponding L1 speech sound will tend to diverge from L1 phonetic norms” in direction of the L2 (Flege et al., 2003: 469-470). The SLM proposed an ‘age’ hypothesis which claimed that the ability to discern differences between L1-L2 perceptual pairs is decreased as the age of L2 acquisition increases. The model argues that this is because late learners become so perceptually fine-tuned to important phonetic dimensions in the L1, that they filter out the detailed phonetic information, which is relevant to the L2, but irrelevant in their L1. The findings from Flege (2003), Flege and Eefting (1987b) and Guion (2003) also seem to support this argument for higher likelihood of L2 category formation and dissimilation in early L2 learners, but assimilation in late learners.

Again, support for the process of assimilation comes from multiple studies on consonants as well as vowels for various L1-L2 language pairs. Much research has found evidence of assimilation in relation to long-term immersion in L2 environment. Bergmann et al. (2016) investigated backward transfer in a group of German L1 emigrants in North America who had acquired English (L2) as adults. They examined four German speech sounds– /a:/, /ɛ/, /ɔ/, /l/ in German spontaneous speech and compared their migrants’ speech to that of a monolingual L1 German control group. They observed that formants for German /a:/ and /l/ had shifted towards the corresponding L2 values. In general, the results showed that changes in L1 pronunciation can occur due to the influence of L2. E. de Leeuw, Mennen, & Scobbie, 2013 also examined a group of German-English bilinguals (residing in Anglophone Canada) for production of /l/. Tokens for /l/ were collected and compared across three groups of speakers: ten German-English bilinguals, ten monolingual native German controls and ten monolingual native Canadian English controls. German /l/ is known to have a ‘clear’ realisation with low F1 and higher F2, whereas Canadian /l/ is known to have a dark realisation with higher F1, lower F2. The results showed an influence of the darker Canadian-English /l/ on L1 such that the bilingual German /l/ became darker. Lev-Ari and Peperkamp (2013) also found evidence for assimilation in late English-French bilinguals who were residing in France for at least 3 years. They examined VOT in word-initial voiceless stops and found that the VOT for English had significantly reduced and become like the shorter VOT in French voiceless stops. Mayr et al. (2012) studied attrition in two L1 Dutch monozygotic twin sisters. The sister who had been immersed in an L2 English environment for more than 30 years showed longer VOT values for voiceless stops in L1, influenced by the longer VOT for voiceless stops in English. Another evidence for assimilation comes from one of the two late-bilingual groups examined by Stoehr, Benders, van Hell, and Fikkert (2017). They found that the group of German-Dutch bilinguals underwent assimilation in VOT for all three voiceless stops /p t k/. This was argued to be the result of infrequent and irregular contact with their L1

German.

Another set of studies on phonetic drift inform us that these changes can be experienced not only by long-term immersed bilinguals, but also new learners of an L2. Kartushina, Hervais-Adelman, et al. (2016) showed that in monolinguals, drift can even be brought into effect only after an hour of articulatory training in non-native vowels. Twenty monolingual French speakers were trained to produce two non-native sounds for one hour for three days: Dutch /ɔ/, which is similar to French /o/, and Russian /ɨ/ which ranges from more to less similar with these French vowels in the same order: /ø/, /y/, /i/. By the end of the training their production of some French vowels had drifted towards the non-native productions. The acoustically closest French /ø/ became closer to Russian /ɨ/ along with French /y/. Similarly, Chang (2012) demonstrated short-term L1 phonetic drift in a longitudinal study on L1 English students who were in Korea for a six-week beginners' course in Korean. He found that immersion in the L2 environment caused the VOT of L1 English voiceless stops to become longer– closer to the longer VOT of Korean aspirated stops. There was also a subtle drift in their English vowels towards Korean vowels. This drift was to the effect that their L1 stops and vowels had assimilated to the phonetic properties of Korean indicating that experience with L2 can cause L1 phonetic drift.

Such strong L1 phonetic drift experienced by Chang's (2012) novice learners of Korean in such a short time span, triggered a very important question: Is there a difference between the drift experienced by long-term advanced learners and novice learners? Chang (2013) examined this by dividing a group of native speakers of American English into two. One consisted of eleven experienced learners of Korean (who had significant prior experience with Korean) and the other group consisted of nineteen novice learners of Korean (who had no prior experience with Korean and were functionally monolingual in American English). All participants read out monosyllabic words in English and thus data was collected to examine VOT in /p, b, t, d, k, g/ and f0 at the onset of the following vowel. The results indicated that VOT for voiceless stops lengthened over the course of Korean learning (closer to longer VOT in Korean), but this change was more pronounced for novice learners as compared to experienced learners. Voiced stops, however, showed no such change. This pattern of change for voiceless stops was reproduced for f0 onset following both voiced and voiceless stops but only for female speakers. Therefore, f0 onset following English stops increased less for experienced females as compared to novice females. These results indicate that there is a 'novelty effect' in L1 phonetic drift by which the newer the L2 is, the more the phonetic drift experienced by the L1. By extension, as L2 familiarity increases, as seen in the experienced speakers, the amount of L1 phonetic drift decreased.

Another aspect of L1 phonetic drift that these studies highlight is that it is not necessarily caused by a lack of L1 use. Chang (2012) demonstrated this in the novice Korean learners. He argued that the L1 phonetic drift found for these learners in direction of Korean was not due to lack of L1 use. This is because these bilinguals would thoroughly engage with their L1 each day after the teaching in Korean would end.

This was also demonstrated by Major (1992), who examined the relation between increased L2 proficiency and changes in the L1 due to L2 influence. His study included five L1 American English immigrants in Brazil. Their L1 speech was examined for VOT in word-initial /p t k/. Brazilian Portuguese (L2) stops are known to have very low VOT (approximately 20ms), whereas American English voiceless stops are very heavily aspirated (approximately 85ms). The speech data was recorded in two ways: (1) as wordlist recordings, (2) as informal conversations. Their speech was compared to that of two control groups: five native speakers of Brazilian Portuguese and three native speakers of American English. This study tested (1) whether the L2 will influence L1, (2) if increased L2 proficiency has a correlation with L2-L1 transfer, (3) whether casual speech will be affected more than formal speech since the latter is closely monitored by the speaker. The results indicated L2-L1 influence: two participants had merged their L1 and L2 phonetic categories as their English VOTs had shifted in the direction of Portuguese VOT. The study also reported higher loss in native casual speech against native formal speech, as well as a correlation between L1 loss in casual speech with increasing L2 proficiency. More importantly, Major argued that the bilinguals were engaged with their native American English daily since they were English teachers and/or staff members in English language institutes, therefore, it was not a lack of L1 use that led to this L2 influence. A factor that was instead found to have an effect on L1 phonetic drift was increased L2 proficiency and early L2 age of acquisition.

Barlow (2014) examined the effect of age of L2 acquisition in L2 influence on L1 in a group of Spanish-American English bilinguals. The bilinguals were divided into two groups: eleven early bilinguals (acquired English by age five) and fourteen late bilinguals (acquired English after age six), and they were compared to thirteen monolingual English speakers. The study examined bidirectional transfer for phonetic and phonological knowledge of the consonant /l/ in wordlist speech by examining F2 and F2-F1 difference. Spanish and English both have /l/ but they differ in their acoustic-phonetic properties and allophonic realisations. Spanish /l/ has a clear realisation in all word positions (Recasens, 2004, 2012), therefore a higher F2-F1 difference. American English /l/ is generally darker in comparison to the realisation of /l/ in Spanish and is marked by a smaller F2-F1 difference. In American English, this darkness also varies according to syllable-position. Therefore, American English has two allophonic realisations for /l/: clearer [l] at syllable-initial position and darker [ɫ] at syllable-final position. The results indicate that both bilingual groups maintained the allophonic differences in English which indicates their L2 phonological knowledge of /l/ velarisation that is comparable to English monolinguals. The late bilingual group also applied this knowledge in their Spanish by exhibiting a darker /l/ in syllable-final position. Though only marginally significant, this is indicative of the influence of L2 phonological knowledge on L1. Furthermore, while results showed L1 to L2 influence for phonetic production of /l/ for both groups, it is not that straightforward. While early bilinguals maintained a distinction between clearer /l/ in Spanish and darker /l/ in English, late bilinguals exhibit no difference in Spanish syllable final and English syllable initial /l/. Barlow (2014) argues that due to later English acquisition, late bilinguals were less likely to establish separate L1-L2 phonetic categories for /l/ phones and as a result, merged them, thereby not maintaining the distinction. Combined, these two results indicate an effect of age of acquisition on the formation of phonetic categories for L1 and L2 in bilinguals.

Similarly, Harada (2003) examined word-initial voiceless stops /p t k/ in early Japanese-English bilinguals. Their L1 Japanese VOT was found to have become longer, more English-like, which is evidence of assimilation.Kang and Guion (2006) also examined the effect of age of acquisition by examining a group of Korean-English bilinguals who were categorised into early (mean age of L2 acquisition 3.8 years) and late (mean age of L2 acquisition: 21.4 years) bilingual groups. They found that only the late group produced the Korean fortis stops with longer more English-like VOT values than the monolinguals. This indicates assimilation in late bilinguals, but not in early bilinguals.

In addition to assimilation in production, studies have also found instances of assimilation in perception. Lev-Ari and Peperkamp (2013) examined whether perception of L1 is also influenced by the L2 in a different group of late English-French bilinguals residing in France. The performance of these bilinguals was compared with monolingual English controls who resided in the US. The two groups participated in a phoneme categorization task in which they heard instances of ‘dean’ and ‘tean’. They were required to decide whether they heard ‘dean’ or ‘tean’. This task used VOT which is one of the cues used to differentiate /d/ and /t/ in the two languages such that in French, the VOT boundary between /d/ and /t/ is lower than in English (Abdelli-Beruh, 2009; Hazan, 1993; Hoonhorst et al., 2009). Therefore, the ‘dean’ and ‘tean’ tokens presented in the task differed in their VOT and covered the VOT range for both French and English. The results indicated that the tokens that were classified by monolingual native speakers of American English as ‘tean’ were classified as ‘dean’ by the bilinguals. This indicates a backward transfer in their perception of the boundary between /d/ and /t/ which seems to have shifted to a lower VOT value, like that in French.

There have also been several accent assessments where monolingual L1 speakers are asked to judge the L1 of bilinguals to determine if it developed a foreign accent. E. de Leeuw et al. (2007) examined this in a foreign accent assessment task. Nineteen monolingual native speakers of German judged the speech of two bilingual groups and one L1 monolingual native group. They were asked to decide if the bilinguals were native or non-native speakers of German in comparison to the monolingual group. The first bilingual group consisted of 34 L1 German speakers who resided in Anglophone Canada and the second group consisted of 24 L1 German speakers who resided in Dutch Netherlands. The monolingual group consisted of 5 native monolingual German speakers. The two bilingual groups were found to have significant foreign accent rating, wherein the rating for each group did not differ from the other. Furthermore, they found that late bilinguals who had higher L2 contact were perceived to have higher global foreign accent than those with lower contact. Bergmann et al. (2016) also examined German as the native language in a group of German-American English bilinguals residing in the US. This study also examined the effect of L2 length of residence and use on backward transfer. In a native-likeness assessment, thirty native German monolinguals rated the accents of thirty-three native German monolinguals residing in Germany and thirty-two German-English bilinguals residing in America. The results showed that the bilinguals were found to be rated non-native compared to the control group due to the changes induced in the L1 by L2. Furthermore, there was much variability in ratings for the bilingual group, such that, individuals who spent more years in the L2 environment and used the L2 more often, were rated as more non-native.

There is also evidence of the relation between L2 use and L1 perception as well as production. Mora and Nadeu (2012) studied the perception and production of two contrastive native vowels /ɛ/ and /e/ in Catalan-Spanish bilinguals. While Catalan contrasts between these vowels, Spanish only has /e/ in its five-vowel system. Perceptual accuracy tests showed that speakers who used Spanish (L2) more frequently than Catalan (L1) discriminated Catalan vowels /ɛ/ and /e/ less accurately and more slowly. Their production of Catalan /ɛ/ was also found to be acoustically like Spanish /e/. The results showed a backward transfer of Spanish on Catalan as an effect of extensive L2 use.

1.2.1.2.2 SLM versus the revised Speech Learning Model (SLM-r)

What is crucial in the SLM, is the appraisal of L1-L2 category relationships in terms of perceived similarity, which is said to exist on a continuum from 'identical' to 'similar' to 'new' (Bohn, 2018; Flege, 1995b). Thus, the ability to form new L2 categories depends upon the perceived similarity between L1-L2 diaphones, which may or may not be modulated by the age of L2 acquisition, as discussed above. According to the SLM, the L2 sounds that are either 'identical' or 'new' do not pose a problem in acquisition. If a sound category is identical across L1 and L2, it is quite easy to acquire, whereas if an L2 category is so dissimilar as to be new, then its differences from the closest L1 category are quite easily perceived, making it easy to create a new category for it. It is the 'similar' L2 phones that are harder to acquire because late learners may perceive such phones as "more or less deviant exemplars of L1 categories" (Bohn, 2018:224). This decreases the likelihood of discerning its differences from the most similar L1 category and increases the likelihood of creation of a merged L1-L2 category, where the L1 shifts in direction of the L2 (category assimilation). Early learners, on the other hand, who do not yet have fully developed L1 systems, are more likely to evade this process of equivalence classification. Thus, especially in late learners, those L1-L2 categories which are perceived as highly similar, are more susceptible to undergoing assimilation. This claim about similar L1-L2 categories by SLM is in direct opposition to the Contrastive Analysis Hypothesis (Lado, 1957), which argued that L2 categories that are similar to L1 categories are easier to acquire, but new L2 categories are the ones that are harder to acquire.

What is tricky, however, about this idea of perceived cross-linguistic similarity, is that there is no agreed upon objective method to measure it (Flege, 1995b; Flege & Bohn, 2021). Furthermore, it is not clear as to which features of the L1 category are actually perceptually relevant for interlingual identification and how they might be weighted to contribute to this aspect of overall similarity of the given category to another. Some research also suggests that some bilingual individuals with the same L1 might differ in their perception of L2 categories by weighting the L1 acoustic cues differently (Flege & Bohn, 2021; Schmidt, 1996). This raises the issue of whether individual bilinguals, with the same L1-L2 language pair, might differ in their assessment of cross-linguistic similarities between any given L1-L2 diaphones. Another drawback to the SLM is that while it is argued that increasing L2 input is related to changes in the perceptual linkage between L1-L2 diaphones, it is not clarified as to “how much L2 input learners will need in order to establish stable patterns of interlingual identification” (Flege & Bohn, 2021:13). Additionally, it is unclear if these patterns are reversible or remain dynamic over the lifespan of the bilingual individual to reflect the changes in their L2 input, leading to assimilation or dissimilation.

Based on the above discussion, one can deduce that the SLM implies the involvement of three factors in the process of backward transfer: age of L2 learning/acquisition (AoL), perceived similarity between L1-L2 categories, and L2 input and experience. The SLM argues that as the AoL increases, the ability to perceive cross-linguistic differences decreases due to the perceptual mechanism of equivalence classification. This leads to lower likelihood of forming new L2 categories and higher chances of merging L1-L2 categories (category assimilation) in late learners, but higher instances of category dissimilation in early learners. However, findings from previous research are mixed such that early bilinguals were found to have not only assimilated (Harada, 2003), but also dissimilated (Flege & Eefting, 1987b), and even not changed (Kang & Guion, 2006) their L1 categories. Not only this, it seems that the transfer processes may not be very consistent across all L2 learners in a given bilingual group of same AoL. For example, in a group of late German-English bilinguals, E. de Leeuw, Mennen, and Scobbie (2013) found that L1 attrition in the lateral phoneme /l/ showed a high degree of interpersonal and intrapersonal variation. So then, it seems that factors other than AoL (Barlow, 2014; Flege & Eefting, 1987b; Guion, 2003; Harada, 2003; Kang & Guion, 2006; Oh et al., 2011) and perceived cross-linguistic similarity might be involved in the process of backward transfer, which the SLM does not include (E. de Leeuw, 2009). Support for this comes from several studies which found many different factors affecting the process of backward transfer such as L2 proficiency (Chang, 2012, 2013; Lord, 2008; Major, 1992; Mayr et al., 2012; Sancier & Fowler, 1997), individual inhibitory skills (Lev-Ari & Peperkamp, 2013), contact with L1 (E. de Leeuw, 2009; Stoehr et al., 2017; Tobin, Nam, & Fowler, 2017), speech style (Major, 1992), length of residence (Lev-Ari & Peperkamp, 2013), and gender (Chang, 2012, 2013).

The revised Speech Learning Model (SLM-r; Flege & Bohn, 2021) builds upon the SLM, and revisits and revises some of its arguments in light of this contradicting evidence, but remains to be tested empirically. Primarily, the two models are different in their aims: while the SLM focused on the 'native-like' mastery of the L2, by way of illustrating differences between early and late bilinguals and L2 learners, the SLM-r is aimed at giving a clearer understanding of the processes involved in the development of the common phonetic space in response to L2 learning.

The SLM-r breaks away from the SLM in many ways. For example, the SLM held that "production errors often have a perceptual basis" (Flege, 1995:238). According to the SLM, accurate L2 production requires accurate appraisal of the phonetic properties of the given L2 category, and then correct production of the gestures associated with that representation. So then, "if a bilingual is unable to discriminate categorically an L2 vowel from neighbouring L2 vowels, as well as from neighbouring L1 vowels that are distinct phonetically from the L2 vowel, then the L2 vowel will be produced inaccurately" (Flege, 1995: 250). However, in the light of contradicting evidence this was revised as the 'co-evolution' hypothesis in the SLM-r which proposes that "production and perception co-evolve without precedence" (Flege & Bohn, 2021:29).

Furthermore, SLM-r replaces the 'age' hypothesis with the 'L1 category-precision' hypothesis which is yet to be tested. It argues that "the more precisely defined L1 categories are at the time of first exposure to an L2, the more readily the phonetic difference between an L1 sound and the closest L2 sound will be discerned and a new phonetic category formed for the L2 sound" (Flege & Bohn, 2021:33). Thus, according to SLM-r, regardless of what the AoL of the L2 learner is, individuals with better defined L1 categories are more likely to discern differences between similar L1-L2 categories and form a new category for the corresponding L2 category.

However, there are also concepts from the SLM that the SLM-r carries forward. Crucially, SLM-r maintains the concept of interlingual identification, and the role of perceived cross-linguistic differences/similarities in causing assimilation or dissimilation. However, unlike SLM, SLM-r acknowledges that transfer processes may be modulated by factors other than the degree of perceived cross-linguistic dissimilarity, L2 input and experience, as well as precision in L1 category specification (which replaces the SLM factor of AoL). These factors include the effect of phonetic contexts on the realisation of L2 categories which may ultimately affect how cross-linguistic mappings are built between such L2 categories and L1 categories.

The SLM-r also accounts for individual variation in the form of differences in frequency of L1-L2 use, quality and quantity of L2 input received, and argues that the context in which L2 input is received could also affect its retention. Additionally, the individuals' auditory acuity and processing ability, which may also affect their ability to form cross-linguistic linkages, can be the cause of this variation. Other factors are also proposed such as variation in cue-weighting based on different L1s, and how individuals might vary in their perception of cross-linguistic similarities. It also acknowledges that individuals may differ in their cognitive abilities like working memory, inhibitory skills, and their capacity to learn at any age which might also affect the amount of L2 input required by them. Finally, according to the SLM-r, the effect of L2 on

L1 might also be bigger when the L2 is strongly activated at the time of L1 examination or when the individual has attained higher proficiency in L2. Thus, SLM-r seems to identify that transfer processes are much more sophisticated than what SLM proposed.

1.2.1.2.3 Laeufer's Typology of Bilingual Systems

Weinreich (1953) accounted for the order and context of language acquisition in proposing three types of bilingual systems (coexistent, merged and super-subordinate systems), which were then adapted by Laeufer (1996) to formulate a typology of bilingual phonological systems with support from Keating's (1984) model of speech production. Laeufer's (1996) typology models bilingual phonological systems as hierarchically-ordered into the phonological, phonetic and realisational levels, and is based on evidence from and is illustrated using cross-linguistic interactions of the stop voicing system. The top *phonological level* is representative of the abstract phonemic categories, below which is the *phonetic level*, characterized by the context-specific allophonic rules, below which is the final *realisational level* which specifies the corresponding phonetic realization rules like "sensorimotor phonetic detail, such as exactly how long after release voicing starts" (Laeufer, 1996:327). So like PAM-L2 (Best & Tyler, 2007), this typology also implies and accounts for the distinction not only at the phonological and phonetic levels, but also argues for a motoric (realisational) level, which "might be considered an analogue of the gestural level in the PAM-L2" (Chang, 2010:49). Very importantly, with respect to the present study, Laeufer's (1996) typology offers an insight into the circumstances of cross-linguistic interactions in various types of bilinguals, and also predicts the outcomes of them such as the presence (or absence), degree, and direction of transfer (from L1 to L2 or L2 to L1) at various representational levels. The following describes how Weinreich's (1953) three types of bilingual systems were adapted by Laeufer (1996).

The *co-existent system* is exhibited by bilinguals who are very proficient in their two languages, as a result of acquiring them simultaneously and in separate contexts (for example, home and school). Even the L2 is characterized by native-like or near native-like proficiency and both languages are used actively. Due to these features, such a system is marked by an absence of cross-linguistic influences and transfer (or minimal influences if one language becomes more dominant at any point), in which case, for example, respective L1 and L2 stops will be produced with native-like realisations (Caramazza, Yeni-Komshian, Zurif, & Carbone, 1973; Williams, 1977). Sub figure 1.2(a) shows the separation of L1 and L2 stops at the three phonological, phonetic and realisational levels in a co-existent system.

Bilinguals who acquired their languages simultaneously, but in the same context, are said to exhibit a merged system (MS). Such a system is characterized by "one compound phonological series of voiceless stops, associated with different phonetic implementations for the two languages" (328) (Type I: Sub figure 1.2(b)), or merging at the phonetic level (Type II: Sub figure 1.2(c)), or merging at all three levels (Type III: Sub figure 1.2(d)). Cross-linguistic interference and transfer are present in all three merged systems, with the strength of interference increasing from Type I to Type III. Due to this, bilinguals with any of these three merged systems have non-native realisations of their L1 and L2 VOT. In MS Type I, Laeufer (1996) argues, there is a larger difference between L1-L2 VOT caused by the process of dissimilation of either L1 or L2 category (Flege & Eefting, 1987b). In MS Type II, by the process of partial-assimilation, there is a smaller difference between L1 and L2 VOT (of around 10 to 30 ms) (Major, 1992; Williams, 1979), whereas in MS Type III, there is a merging of L1-L2 VOT (VOT intermediate to either native realisation) by the process of complete assimilation (Flege, 1987). Additionally, such systems tend to be found in "fairly advanced to advanced late bilinguals with L1 or L2 dominance; or in early bilinguals with less recent or less intensive exposure to L2" (Laeufer, 1996:339).

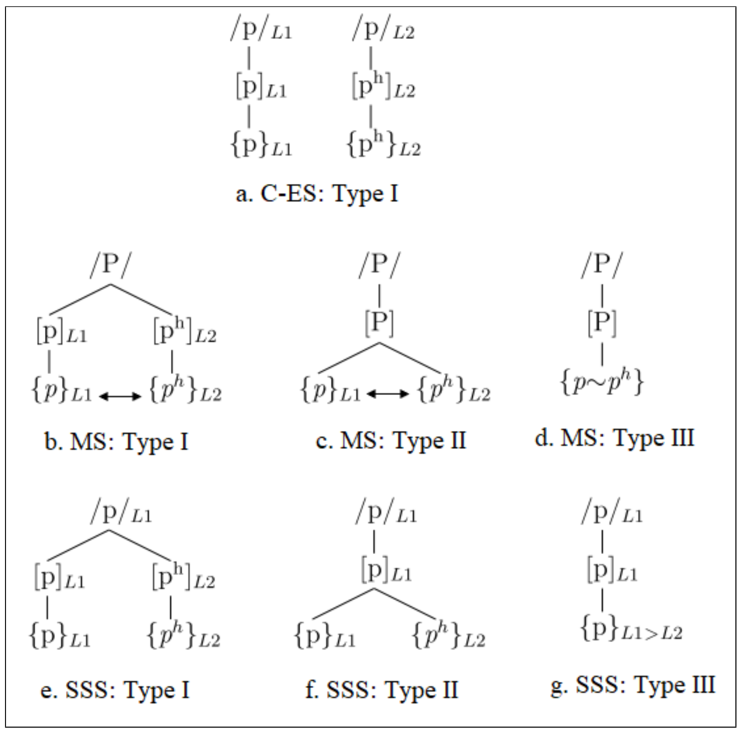


Figure 1.2: Chang's (2010:51) adaptation of Laeufer's (1996:329) typology of different bilingual systems of voiceless stops. C-ES stands for 'co-existent system' (sub-figure 1.2a), MS for 'merged system' (sub-figures 1.2.b-d), and 'SSS' for 'super subordinate system' (sub figures 1.2.e-g). "Slashes denote the phonological (phonemic) level; brackets, the phonetic (allophonic) level; and braces, the realizational (motoric) level. Capitals denote a mixed, non-language-specific representation, while italics indicate that the phonetic norm of the given language is not reached" (Chang, 2010:51)

Finally, bilinguals that acquire their L2 sequentially in a formal classroom setting are identified to have super-subordinate systems (SSS), which argues for the case of strong L1 influence on L2 (forward transfer). This system has a single L1 phonological series, with L1-specific realization rules (Laeufer, 1996:330), to which the L2 is linked via the process of interlingual identification. In such models, L1-L2 merging is possible at all three levels. Laeufer (1996) proposes two types of SSS (Type II: Sub figure 1.2(f), Type III: Sub figure 1.2(g)), to which Chang (2010) added a third (Type I: Sub figure 1.2(e)). In arguing for SSS Type I, Chang (2010) argues that "alternatively, the L2 sound may be associated with its own phonetic category, which does not cause dissimilation between the L2 sound and the corresponding L1 sound because of the L1-specificity of the phonological level" (52-53). In SSS Type II, the influence of L1 is such that there is very little distinction between L1 and L2 realisations, whereas SSS Type III exhibits complete assimilation of L2 stops to L1. In such bilinguals, L2 acquisition is not achieved, but L1 is realised in a native-like fashion. Furthermore, SSS systems are argued to be found in speakers with "less exposure to native L2 speech and/or less overall proficiency; speakers with less recent exposure to L2; or speakers whose L2 has fossilized at an elementary level of acquisition" (Laeufer, 1996:339).

Thus, Laeufer's typology has strong parallels not only with Flege's SLM and SLM-r, with respect to the processes of assimilation and dissimilation, L2 category formation and interlingual identification, but also with Best & Tyler's (2007) PAM-L2 (discussed below in §1.2.1.2.4), with respect to its concept of perceptual assimilation and the various levels of representation. However, as it refers to the entire bilingual system, it is not clear if this typology can be generalised to all L1-L2 categories, or if specific sound categories can be organised differentially. Evidence from studies on transfer indicates that transfer patterns of assimilation and dissimilation as well as the degree of transfer may not necessarily be generalised across the entire system or even across a given sub-segmental level, but may vary across individual categories (Bergmann et al., 2016; Chang, 2012; Lord, 2008; Oh et al., 2011). The SLM and SLM-r account for this via the crucial role of perceived cross-linguistic similarity between L1-L2 categories and it is not clear as to how strongly that is applicable here as well. What plays a crucial role in this typology in the development of these different bilingual systems is the involvement of multiple extralinguistic factors such as "the amount of past and present intensive exposure to the speech of native L2 speakers, the level of proficiency and dominance profile at the time a speaker is tested, and the age at which L2 acquisition began" (Laeufer, 1996:339).

This brings us to the focus of the present study, the experimental group of Glaswasians (Glasgow-Indians). As mentioned before, these Glaswasians were bilingual in Hindi and Indian English before migrating to Glasgow. This implies that they had developed their respective bilingual systems before getting exposed to the host dominant language (with respect to Hindi) and dialect (with respect to Indian English). With reference to Laeufer's (1996) typology, then, it is important to highlight that there is substantial variation in how these Glaswasians may have acquired their Hindi and Indian English, and at what age. Some Glaswasians acquired both languages simultaneously early on at home, others acquired them simultaneously in different contexts (home and school), whereas some of them acquired Indian English sequentially after Hindi (with a gap of few years in between). So, to begin with, these Glaswasians may have had different types of bilingual systems when the exposure to Glaswegian English set in. This already creates a sort of unlevelled ground with respect to the nature of their Hindi and Indian English categories. That is, it is highly unlikely that they were similarly merged or separate or even dissimilated across all Glaswasians. Individuals who possibly merged their Hindi and Indian English categories, could also differ in the extent of merging, as exhibited by MS Type II (partial-assimilation) and MS Type III (complete assimilation) conditions. Furthermore, there is a strong possibility of merging of Hindi and Indian English categories because of the fact that Indian English phonology is influenced by the phonologies of the Indic languages, and shows some similarities. This prompts the question: are shared Hindi and Indian English phonological categories so different in their phonetic makeup so as to be kept separate? Fortunately, it will be possible to answer this question with the help of the Indian control group recruited for this study (which has never been in contact with Glaswegian English). In any case, the same cannot be tested on Glaswasians and it is uncertain if the examined influence of Glaswegian English is exerting itself on separate, partially-assimilated or dissimilated Indian English and Hindi categories, or on a single completely assimilated category. In addition to variation based on the age and order of acquisition of these native varieties, Glaswasians may also differ in relation to the amount of past and present exposure to Glaswegian English, which could affect the extent of influence from Glaswegian English. It is exactly the involvement of extralinguistic factors of such kind that the present study aims to capture by examining backward transfer as a function of multiple sociolinguistic and psycholinguistic factors.

1.2.1.2.4 The Perceptual Assimilation Model (PAM) and PAM-L2

There are other models that provide an explanation for non-native and L2 speech perception like the PAM (Best, 1991, 1995) and PAM-L2 (Best & Tyler, 2007). However, unlike SLM, SLM-r and Laeufer's typology, these models do not address L2 speech production, and therefore, do not address the matter of backward transfer in production in any capacity. However, like the SLM and SLM-r, perceived cross-linguistic similarities between L1 and L2 categories play an important role in these models as well.

PAM (Best, 1991, 1995) holds that the basic unit of speech perception are articulatory gestures. It argues that perception involves directly picking up information on the involved articulatory gestures that result in an acoustic output from the acoustic output itself. Simple articulatory gestures are combined to form 'gestural constellations' that are complex articulatory events which incorporate information on contextual variations. So then, cross-linguistic differences arise in how (1) simple gestures are combined with specific phasings between them or differ in degree of constrictions to form specific gestural constellations, or (2) certain gestures may be present in the L1, but not in the other language, thus giving rise to different gestural constellations which are harder to perceive.

The monolingual 'perceptual space' is the result of high attunement to the speakers' L1-specific gestural constellations, and issues in cross-linguistic perception arise in how non-native or L2 segments are perceived in relation to this pre-existing ‘native phonological space’. PAM claims that non-native segments “tend to be perceived according to their similarities to, and discrepancies from, the native segmental constellations that are in closest proximity to them in native phonological space” (Best, 1995: 193). Comparisons are made between similarity in constriction degrees and gestural phasings between L1-L2 segments, and spatial proximity in constriction locations and active articulators. Based on these comparisons, the non-native sound may be (1) assimilated to an existing, L1 category (‘two-category assimilation’, ‘category-goodness difference’, and ‘single-category assimilation’), (2) perceived as a new non-native sound, or (3) taken as a non-speech sound (‘non-assimilable’). In this way, PAM is more detailed and specific in its formulation of perceived cross-linguistic differences than the SLM, but agrees with SLM, at least with respect to perception, on the idea that it is the L2 categories that are very similar to L1 categories that are harder to distinguish. The aim of L2 learning, then, according to PAM-L2, is the acquisition of the correct gestural constellations of the L2 for accurate L2 perception (Best & Tyler, 2007; Bohn, 2018).

Like SLM and SLM-r (Flege, 1995b; Flege & Bohn, 2021), PAM-L2 (Best & Tyler, 2007) agrees that L1 and L2 phonological categories exist in the same space, but unlike the former models, PAM-L2 argues two levels to these categories: the phonological level which encodes contrastive and categorical information, and the phonetic level which encodes non-contrastive, gradient information (Best & So, 2010; Best & Tyler, 2007), Additionally, “phonological assimilation need not imply that the associated phones are perceived as identical at the phonetic level” (Best and Tyler, 2007:26). This implies that the L2 learner should be able to perceptually learn and maintain the phonetic distinction between L1-L2 phones that are assimilated to the same phonological category. PAM-L2 argues that these multiple phonetic levels of a single phonological category differentiates monolinguals and bilinguals, and for the latter group, increasing awareness of this phonetic distinction may also lead to shifts in the exact details of the L1-L2 phonetic properties. Such shifts may also take place due to ambiguity in L1-L2 contrasts at the phonological and phonetic levels, specifically because of a mismatch in L1-L2 phonological and phonetic characteristics. Best and Tyler (2007) illustrate this based on the stop voicing contrast in English and French. While the categories /p/ and /b/ are contrastive in both languages, they posit an overlap in their phonetic properties such that the French unaspirated [p] overlaps in VOT with the English phoneme /b/. It is such situations of conflicts between L1-L2 phonetic characteristics and interlanguage phonological contrasts where bilinguals struggle to maintain the contrast between L1-L2 phonetic categories. Best and Tyler (2007) argue that such situations can compel L2 learners to dissimilate such L1-L2 categories in order to maintain a contrast between them, and may even generalise this dissimilatory process to all related L1-L2 categories at the phonetic level. By contrast, the SLM and SLM-r’s argument for L1-L2 interaction applies only at the phonetic level. So, PAM-L2 assumes equivalence classification not only at the phonological, but also phonetic level.

However, PAM-L2 also does not make any direct predictions on the effects of L2 learning on L1 speech production. This is also the case with other L2 perception models such as Escudero's Second Language Linguistic Perception (L2LP; Escudero, 2005, 2009; van Leussen & Escudero, 2015).

1.2.1.2.5 Other models of Bilingual Organisation and Interaction

There are also other theoretical formulations that account for various factors (psycholinguistic, sociolinguistic as well as cognitive) in influencing speakers' experiences of interference and transfer. For example, Weinreich (1953) identified several characteristics as the cause of individual variation in situations of language contact. These are differences in aptitude for language learning, cognitive abilities like language switching skills, relative proficiency and dominance in either language, order and age of language learning, perception of languages in terms of usefulness, status, literary-cultural value and social mobility, as well as immigrants' own emotional involvement with the relevant languages. At the same time, the social setting for bilingualism may favour certain types of circumstances in relation to, for example, the order and age of learning, language status and dominance in various domains. It is based on this that Weinreich (1953) argues that "when a language-contact situation is examined in detail, the inter-relation of socio-cultural conditions and linguistic phenomena is apparent" (83).

Paradis (2001, 2007) proposes a neurolinguistic theory of bilingualism which comprises a common linguistic system wherein separate L1 and L2 subsystems are connected to a separate conceptual store (the 'three-store hypothesis'; Paradis, 2007). The selection, use and processing in one linguistic system requires the inhibition of the other language system and activation of the required linguistic system which is controlled by the cognitive processes and requires the achieving of a certain activation threshold. This is the *Activation Threshold Hypothesis* (Paradis, 1993, 2007). Activation Threshold is the amount required by an item for its activation. Furthermore, the more frequent an item is, the lower is its activation threshold. However, this threshold also gradually rises again. For an item which has not been used in a long time, the activation threshold will be higher, making it harder to retrieve, and thus increasing its susceptibility to attrition or loss. Therefore, this threshold is influenced by factors like frequency and recency of language experience and use, which may differ from individual to individual. The role of cognitive processes is also crucial in the activation threshold hypothesis. Hence, variation in such cognitive abilities as language inhibitory and switching skills may also lead to differential interference effects, along with another factor, that is, motivation to acquire a language (Paradis, 2001, 2007).

The emphasis on individual experiences of bilingualism is central to Herdina and Ulrike's (2002) *Dynamic Model of Multilingualism* (DMM) which views language change as a function of time with the focus on the variability and dynamics of the individual speaker system. Similarly, de Bot's (2007) *Dynamic Systems Theory* (DST) argues for a dynamic system which takes into account the various changes in an individual's lifespan. These changes may involve various factors which also mutually influence each other over time. Both DMM and DST highlight the dynamic nature of language systems. Similar to these models, Köpke (2007) proposes a multi-componential perspective to L1 attrition which also identifies the involvement of several factors like plasticity, inhibition and activation (which are both related to the frequency and type of L1 use), emotional involvement with the relevant languages, memory, language aptitude, motivation, and also cultural contexts for immigrants.

In addition to these models, arguments for L1-L2 interaction and backward transfer also come from models of language organisation in the bilingual mind. Earlier such models formed the two ends of a continuum. For example, at one end is the *Separation Model* (in Cook, 2003) which argued that the two languages in a bilingual mind exist in two separate watertight components which prevents any form of interaction or connection between the two language systems. Based on this model, there is no possibility for language interference and transfer, which has now been established as highly unlikely in face of mounting evidence of bidirectional transfer. The other end of the continuum is represented by the *Integration Model* (in Cook, 2003), according to which L1 and L2 form a single common linguistic system in the bilingual mind. The contents of both languages are stored alongside each other and based on their need, context and knowledge, bilinguals have control over what they choose from this common language inventory. However, Cook (2003) believes that these models cannot be absolutely true as both total separation or integration is unlikely since users can keep the languages apart but there is also evidence of interference. Even Weinreich (1953) argued that "a composite psychological theory of bilingualism ought…to account for both the effectively separated use of the two languages and for interference of the languages with other" (71).

Some other propositions have taken this into consideration, such as models which assume separate L1 and L2 systems that are connected to each other via links (*Linked Languages Model*; in Cook, 2003 and *Revised Hierarchical Hypothesis*; Kroll & Stewart, 1994). Some models argue for a more flexible organization such as the Integration Continuum (in Cook, 2003) which argues that the organization of linguistic systems in a bilingual mind can change over time going from complete separation to partial integration to complete integration. This need not necessarily apply to the whole language system, that is, one component of the language may get integrated (for example, phonology) and the others may not. Furthermore, not all individuals are necessarily affected in the same way – one may be more integrated than the other. This is argued to be influenced by the individuals' language mode (Grosjean, 1989, 2008; Grosjean & Li, 2013) or different stages of L2 development. Other propositions include Paradis's (2001; 2007) *Subsystems' Hypothesis* which argues for two separate and independent language subsystems which are connected to a separate conceptual store. Additionally, the various components of each language subsystem (phonology, morphology, syntax, lexical, semantics) are separate which makes them differentially susceptible to the kind and degree of interference.

1.2.1.2.6 Summary

This section discussed various models of L2 production and perception, and organisation and interaction between L1 and L2 in the bilingual mental space. Among these, the SLM and SLM-r, along with Laeufer's typology of bilingual systems, are especially highly relevant to the present study as they make direct predictions about backward transfer effects in production. SLM and SLM-r's mechanisms of assimilation and dissimilation will be crucially helpful in predicting backward transfer effects for the particular linguistic context here. This section also highlighted the role that various linguistic and psycholinguistic factors have been found and argued to play in this interaction between L2 and L1 from the perspective of backward transfer.

Now moving forward, as argued in Section 1.1.1, separate from backward transfer is the phenomenon of L1 speech accommodation, which is the subject of the following section. This phenomenon argues that short- or long-term contact between the speakers' D1 and another dialect of the same language (D2) can lead to phonetic changes in the D1 due to the influence of the D2. This is highly relevant to the present study in relation to the interaction between Glaswegian English and Indian English, and the transfer of features from the former to the latter.

1.2.2 L1 Change due to Speech Accommodation

The phenomenon of speech accommodation holds that native or non-native speakers of a language adapt their native speech to that of other speakers (or their speech partners) of the same language, or to a different dialect of their language, especially without having to learn that specific linguistic variety beforehand. The aim of the present section is to discuss this phenomenon of accommodation between different dialects of the same language.

More specifically, the focus of the present study is long-term accommodation which refers to the more permanent changes in one's dialect due to increased accumulation of short-term shifts in it with increasing contact with an ambient dialect over time (Chambers, 1992; MacLeod, 2012; Trudgill, 1986) (may also be recognised as instances of attrition). The Change-by-Accommodation model of language change (Niedzielski & Giles, 1996) claims that such short-term shifts of the D1 that turn into more permanent long-term changes are the basis of community-wide shift of the D1 to D2, and can even set SDA in motion (Trudgill, 2008).

Section 1.2.1 discussed the mechanisms of interaction between two languages (here, Hindi and Glaswegian English). Now, the present section on L1 phonetic accommodation argues for the mechanisms of interaction between two dialects (here, Glaswegian English and Indian English). This will contribute to our understanding of the possible long-term phonetic accommodation of Glaswasians' native Indian English to the host dominant Glaswegian English.

1.2.2.1 What is Speech Accommodation?

Simply put, speech accommodation is the tendency of speakers to align or adjust their speech to the patterns of their speech partner or partners (M. Kim et al., 2011; Solanki, 2017; Wagner et al., 2021), which is reflective of the pervasive cognitive mechanisms that motivate us to acquire the ambient speech variety as infants (Babel, 2012; Kuhl, 1993). This adjustment can be expressed in three ways: convergence, divergence and maintenance (Giles & Powesland, 1997). In *convergence*, the speaker adjusts their speech in the direction of their speech partner, whereas in *divergence*, the speaker adjusts their speech away from their speech partner. In *maintenance*, the speaker maintains their speech and does not adjust to their speech partner in either direction. These outcomes appear to be somewhat functionally parallel to the SLM and SLM-r's (Flege, 1995b; Flege & Bohn, 2021) predictions of assimilation, dissimilation and no change in relation to L1-L2 interaction.

Several studies have established that accommodation can occur at any level of linguistic processing and instances of accommodation at the acoustic-phonetic level come under the term 'phonetic accommodation' or 'phonetic convergence' (Babel, 2009, 2012; M. Kim, 2012; M. Kim et al., 2011; Olmstead et al., 2021; Pardo, 2006; Wagner et al., 2021). Here I define accommodation in two contexts: (1) accommodation in the monolingual context (section 1.2.2.2), and (2) accommodation in the bilingual context (section 1.2.2.3). The former context is concerned with accommodation in monolinguals to speakers with the same or different native accent, whereas the latter context is concerned with bilingual speakers accommodating to speakers with a different accent as non-native speakers of that language, or accommodating their L1 and L2 to the ambient linguistic variety.

1.2.2.2 Phonetic Accommodation in Monolingual Context

Here, accommodation in the monolingual context refers to situations of accommodation by a monolingual speaker to either (1) the same native accent of another speaker (Biro, Toscano, & Viswanathan, 2022; Nielsen, 2011; Ostrand & Chodroff, 2021; Pardo, 2006; Pardo et al., 2013; Sanker, 2015; Solanki, 2017), or (2) a non-native accent of their L1 (Alshangiti & Evans, 2011; Babel, 2010; Evans & Iverson, 2007; Giles, 1973; Simard, Taylor, & Giles, 1976; Soquet & Delvaux, 2007; Wade, 2022).

The present section presents two different theoretical accounts of mechanisms involved in phonetic accommodation, that is, socio-psychological and socio-cognitive.

1.2.2.2.1 Accommodation Theory

A major component of speech accommodation is sociolinguistic. This can be traced back to its conception which recognised social and psychological motivations as its driving force.

In 1966, Labov examined pronunciation shifts in Lower East Side New Yorkers. He found that speakers shifted between phonological variants depending upon the context; formal contexts elicited more prestige pronunciation variants whereas casual contexts less so. Labov (1966) argued that speakers bear the knowledge of the social significance of phonological variants whereby some variants are recognised as prestige markers. As a result of their linguistic insecurity and resultant pressure to conform to "establish oneself as an authentic member of one's immediate groups" (1966:567), speakers used this linguistic knowledge to shift between prestige and native variants according to different contexts to satiate their need for "self-identification with particular sub-groups in the social complex" (1966:450).

Giles (1973) reflected on Labov's study and observed that something other than contextual effects could be causing the pronunciation shift, particularly interpersonal aspects where due to an 'experimenter effect' the speech of the interviewer might act as a stimulus to be responded to by the interviewees. He illustrated this by conducting interviews with thirteen male Bristol-accented working-class teens. With each participant, two separate interviews were conducted: one with a speaker of Bristol accent and the other with a Received Pronunciation (RP) accent. Speech samples from these two interviews were then played to two groups of listeners (native listeners of Bristol accent and non-native listeners from Wales). The results showed that most listeners from the two groups found the speech samples from the interview with the Bristol-accent interviewer to be broad-accented as compared to their speech samples from the interview with the RP interviewer.

This prompted Giles and colleagues to develop the Accommodation Theory (Speech Accommodation Theory which was later turned into the Communication Accommodation Theory (CAT)) and has been revised multiple times since (Sachdev, Giles, & Pauwels, 2012).

According to CAT, the need for accommodation arises from social and psychological motivations for the speaker to manage their social distance from their speech partner and is an indication of social category membership and desire for social approval (Giles & Powesland, 1997; Ogay & Giles, 2007). Later revisions also included the desire for communication efficiency as one of the many reasons for accommodation (Coupland, 1984), as also shown by Hwang, Brennan, and Huffman (2015). This adjustment of social distance is achieved using communication by processes of convergence, divergence and maintenance, which operate on the need for social approval. Convergence is assumed to arise out of the speaker's wish to gain social approval of their speech partner, whereas divergence is assumed to be a consequence of their wish to project dissimilarities in speech due to perceived unfavourable or opposite tendencies or characteristics of their speech partner. Other factors that may contribute to L1 accommodation are accent prestige, socio-economic status, accent loyalty, social attitudes, situational constraints and context, and speech partner-specific characteristics like personality or mannerisms (Babel, 2010, 2012; Yu, Abrego-Collier, & Sonderegger, 2013).

This relationship between social perceptions and language shifting has also been found in other studies. Simard et al. (1976) found that speakers will perceive their speech partner less favourably if they find the partner unwilling to accommodate to them. Furthermore, Coupland (1984) found that an assistant in a travel agency accommodated to the phonological variants used by her 52 clients such that more standard/higher social class accented clients elicited shifts to more standard variants, and lower social class/more non-standard and regionally accented clients resulted in shifts away from standard variants. The author speculated that this convergence is a consequence of the assistant's motivation to gain her clients' approval and improve communication efficiency. Evans and Iverson (2007) also examined the accommodation of Northern English (NE) to Standard Southern British English (SSBE) in a longitudinal study. Twenty-seven young adults were recorded at various stages of their university life: at the beginning, after 3 months, after 1st year and after 2nd year. The subjects were instructed to read a wordlist and a passage. Their speech was examined for a variety of vowels like *bad*, *bard*, *bawd*, *bed*, *bird*, *booed*, *bud*, *bead*, *cud*, *could*, and *bath* for F1, F2 and duration. Acoustic analysis of these vowels at the four time periods showed convergence towards SSBE for *bud*, *cud*, *could* and *bath* for both F1 and F2, while the rest of the vowels remained unchanged. One possible reason behind this may be that some of the vowels are social-regional markers which may be used to mark affiliations, or distinctness and separation (Alshangiti & Evans, 2011; Pardo et al., 2013).

More recently, Wade (2022) argues that convergence can be 'input-driven', that is, based on immediate input, and also 'expectation-driven', which is not based on immediate input, but on "expectations stemming from pre-existing knowledge" (64). To illustrate the latter, non-Southern speakers of American English participated in a word-matching game, before which, those participants in the experimental condition were exposed to a Southern American English talker, whereas those participants in the control condition were exposed to a Midland talker. Wade (2022) found that participants in the experimental condition produced more salient Southern-like, glide-weakened /aɪ/ tokens, even though the Southern talker produced no instances of this vowel. However, those in the control condition did not produce any such shifts in their vowel. This difference between the groups is attributed to an expectation-driven linguistic behaviour wherein exposure to Southern speaker activates a whole cluster of socially-salient phonetic stereotypes for that accent in the participants of the experimental condition, thereby indicating the role of social cognition in accommodatory behaviour.

1.2.2.2.1.1 Accommodation from the immigrants' perspective

It is also highly important and relevant for the present study, which examines first-generation immigrant bilinguals, to understand the kind of social motivations they may have as an ethnolinguistic minority in a host country such as the UK, especially with reference to their lowered social status and the uneven power-dynamic between them and the host community (Fought, 2013; Vertovec, 2007). Such a transformation in their sociolinguistic and cultural reality might eventually affect their linguistic behaviour and potential to accommodate. For example, Sachdev et al. (2012) argue that immigrants may converge to the language of their host country as proof of their acculturation of the host values, but they can also diverge to maintain "intergroup distinctiveness" (397).

As Kerswill (2006) points out, international borders mark drastic changes in culture, economic conditions and prospects, education, and languages, which may stand in stark contrast to migrants' own ethnolinguistic, cultural, linguistic, and economic backgrounds. Adsera and Pytlikova (2015) argue that this is exactly why immigrants prefer to cluster geographically and form distinct ethnolinguistic communities where the use of their native language/s and customs is facilitated. Additionally, if they are not already experienced in the host language, that may act as a hurdle in availing the public and private services available to them (J. S. Siegel, 2018). Therefore, such 'linguistic enclaves', which comprise their ethnic shops, restaurants, businesses, and service providers, provide them a sense of security and support from their ethnic community. At the same time, this also limits their interaction with the host community, specifically linguistic language, thus preventing notable language contact and accommodation with respect to the host language (Polek, Wöhrle, & van Oudenhoven, 2010).

Kerswill (2006) argues that there are other psycho-social motivations that may shape immigrant contact with the host community. While the motivation for creation of linguistic enclaves could be mainly support-oriented, some migrants may be motivated by the fear of extinction of their minority ethnolinguistic group or to preserve their ethnolinguistic/cultural/religious identity. A completely reverse motivation to this is attempting plenty of contact and participation with the host community and use of host languages to improve one's social mobility and economic circumstances as an ethnolinguistic minority. Such groups will exhibit notable language contact with the host community, which may also result in phonetic convergence of their native linguistic variety towards the host language to signal their desire for approval and conformity to the host norms.

The degree of permanence of migration can also lead to varied language attitudes among immigrants (Kerswill, 2006). Motivation for interaction with the host dominant language may be different when migration is permanent, and the immigrants plan to settle in the host community and never return to the community of origin. They may wish to assimilate to the culture and languages of the host country, resulting in phonetic convergence towards the host dominant language. However, if the migrants plan or even hope to return to their country of origin eventually, they may want to maintain their native language and avoid mixing it with the host language. This could result in either phonetic divergence or maintenance.

Other issues like purpose for migration, legality of migration, willingness to migrate, and factors like migratory patterns of distance and time, may also give rise to different language attitudes, and shape the amount of language use and contact that the immigrants engage in (Berry, 2001; Berry, Phinney, Sam, & Vedder, 2010; Köpke & Schmid, 2004; J. S. Siegel, 2018). It is also important to point out that migrants' attitudes are complex and may be shaped by multiple factors and motivations at the same time, as shown by Al-Asiri (2023) in migrant Iraqi Arabs in London and Glasgow. J. S. Siegel (2018) cites complex and rapid shifts in international migratory patterns, migrant identities, backgrounds and motivations, as well as globalisation and advances in technology as the cause for rapid and complex language change.

Equally important to migrant attitudes are the attitudes of the host community towards them, and by extension towards their languages. Some members of the host community may welcome immigrant ethnolinguistic minorities and believe that they add to the community economically, culturally and linguistically. Others may perceive migration as a source of cultural and linguistic contamination (J. S. Siegel, 2018), which may be elevated when such ethnolinguistic minority immigrant groups are more visually and culturally distinct (Jasinskaja-Lahti, Liebkind, & Perhoniemi, 2006). They may also form negative assumptions and generalise perceptions towards immigrant groups based on the circumstances of their migration (J. S. Siegel, 2018). With increased prolonged contact between the host and immigrant communities, such negative assumptions can not only decrease, but also increase over time (Jasinskaja-Lahti et al., 2006). Robinson (2005) observes that "attitudes of the larger society toward immigrants is likely to be reflected in the feelings of immigrants about the society. Thus, it is possible that when immigrant adolescents feel that they are viewed negatively by others, they will be more likely to view the host society negatively and reject being part of it..." (191). Such feelings can then possibly manifest as divergence in their speech.

While both these attitudes towards the immigrant groups may be present in the host community (Al-Asiri, 2023), J. S. Siegel (2018) argues that the relationship between the host and immigrant community is usually that of dominance and subordination (Hickey, 2010), which can also be extended to the language/s of immigrants and the host community. Traditionally, when crossing an international boundary, it is the language of the host country that the immigrants have to adopt. This leads to multilingualism in these immigrant communities, whereas it is highly unlikely for the host community to learn the immigrants' languages as well. At the very outset, this behaviour creates an asymmetry in social roles for the different languages of immigrant bilinguals. This hierarchy in the social roles allotted to the languages involved contributes to the social evaluation of these languages as positive or negative (Robinson, 2005), and affects the evaluation and attitudes, especially of the younger immigrant generation (Ghuman, 2003), which may lead them to use their heritage languages less frequently, as a sign of 'symbolic dominance' (Hickey, 2010). By contrast, the 'dominant' languages that are used more frequently and occupy more domains of social activity and communication, are regulated by standardisation under institutional establishment framework (Matras, 2009). As a result, the host languages (especially in Western industrialised societies) are less likely to get influenced by minority languages that are used less frequently and are associated with a smaller number of public domains and sometimes to none. Therefore, immigrant minorities must strive harder to resist influence from the dominant language and maintain their native languages. This situation is summed up wonderfully by Weinreich (1953) who argues that "the realisation that one's mother-tongue as not a standardised language applicable in all types of formalised communication (governmental activities, literature, radio, schools, etc.) often makes people indifferent to interference in it" (88).

Based on the above discussion, it appears that social motivations have strong implications for phonetic accommodation. However, it has also been suggested that accommodation can be an “automatic consequence of linguistic representation" (Babel, 2010:20), as argued by various exemplar-based models.

1.2.2.2.2 The Exemplar Theory

According to the Exemplar Theory, phonetic distributions of words are made up of large number of tokens or exemplars that a speaker has been exposed to and are stored in memory. Highly similar exemplars will be close together and distant from dissimilar exemplars. An incoming token, that is, hearing a new instance of a word, will be classified based on its similarity (and dissimilarity) to other tokens. All these exemplars, thus, represent the range of variation in the physical manifestation of that distribution. These tokens are also highly detailed in that they consist of acoustic and phonetic, social and talker-specific information (Babel, 2009; Enzinna, 2018; Frisch, 2018; Hay, Warren, & Drager, 2006; Pierrehumbert, 2016). Each exemplar has a resting activation. The exemplars encoding frequent, recent and familiar experiences have a higher resting activation level than those encoding less frequent and remote experiences. This also explains the ‘recency effect’ noted in imitation studies where speakers were found to be more likely to imitate recent speech. In a study with two shadowing conditions (immediate shadowing condition and delayed shadowing condition), Goldinger (1998) found more imitation in speakers in the immediate condition (response right after hearing the stimulus) than in delayed condition (response 3-4 seconds after the stimulus). This was also found by Soquet and Delvaux (2007), where the participants quickly accommodated to the new exemplars.

When exposed to a new exemplar, all similar activated tokens will be activated to create a “generic echo” (Goldinger, 1998) and the output which is selected for production is the mean of this activated set. Furthermore, more frequent categories will have a higher number of exemplars, whereas less frequent categories will have a smaller number of exemplars. Therefore, when a speaker encounters a low frequency and novel exemplar, fewer ‘similar’ exemplars will be activated because of the little experience with such exemplars. The mean of such a distribution will naturally lean towards the values of this input exemplar. In the same study, Goldinger (1998) found that in both shadow conditions, imitation increased when the tokens were low frequency words. Thus, an exemplar approach presents an explanation for this ‘novelty effect’ which was also proposed by Chang (2013). Because there are fewer similar tokens for an infrequent and novel exemplar, only those tokens will be available to calculate the mean of that activated set. In addition to being new, these tokens will also be recent tokens. The SLM-r (Flege & Bohn, 2021) also relies on such an exemplar approach to explain the formation of L1 and L2 categories, which are “defined by the statistical properties of input distributions" (40). Even in a category with higher number of tokens, as the input of new similar tokens increases, because of long-term, constant and direct exposure to it, the typical mean of that category can shift over time, ultimately leading to sound change in production (Bybee, 2001; Todd, Pierrehumbert, & Hay, 2019).

What the above discussion also highlights is that just like the SLM and SLM-r (Flege, 1995b; Flege & Bohn, 2021), the role of similarity is crucial for comparison between old and new tokens, and categorization of the new tokens in the exemplar approach as well, and therefore in L1 accommodation by extension (Pardo, Pellegrino, Dellwo, & Möbius, 2022). Nevertheless, this concept of similarity, as pervasive as it is, remains ambiguous and hard to quantify (Bybee, 2001; Frisch, 2018; Gil-Vallejo, Coll-Florit, Castellón, & Turmo, 2018). Bybee (2001) argues that the issue with this concept lies in specifying the features by which similarity can be measured; one might take trivial and irrelevant aspects into account to describe and quantify similarity but omit crucial ones. Additionally, these aspects might be related to other linguistic aspects which are not relevant or accounted for, and that too on different levels.

Several accounts of similarity-measurement have been proposed in general, which Goldstone and Son (2005; also qtd. in Gil-Vallejo et al., 2018), have attempted to contain into four models: Geometric, Feature-set, Structure-mapping and Transformational models. In the geometric models, similarity between two tokens/sounds/words/concepts may be calculated based on the distance between them in the representational space, that is, closer tokens are more similar (to each other) than those at a distance. Feature-set models identify concepts as a list of features, and similarity between them is measured on the basis of similar and distinctive features between concepts. Structure-mapping models or alignment-based models acknowledge the role of features as well, but similarity is measured based on the role that each feature has in the representations. Finally, transformational approaches hold that a mental representation can be transformed into a different one and similarity is measured by the number and type of transformational stages that are required for that transformation to take place. However, underlying all these models and approaches is the basic idea that similarity is a linking process applied on mental objects based on their matching features (Gil-Vallejo et al., 2018). All in all, while there certainly have been many attempts to quantify similarity, the ultimate fact still remains: there is no one universally accepted measure of similarity.

With reference to the socio-cognitive nature of accommodation, then, much research has examined it in monolinguals speakers of the same, but also different accents.

For instance, Soquet and Delvaux (2007) examined accommodation in monolingual speakers of Belgian French, but across two regional dialects that are spoken in the Belgian cities of Mons and Liege. They studied whether the Belgian variety of French spoken in Mons would adjust towards the Belgian variety of French spoken in Liege. Their focus was on investigating whether adult speakers unintentionally imitate ambient speech in real life without any social motivation or realisation of the relationship between the two linguistic varieties. Short-term shifting was examined for two vowels (/ɛ, o/) in a sentence production task. The recordings in the pre-accommodation phase for both Mons and Liege speakers showed clear distinction for the acoustic properties for these vowels. However, when Mons speakers were exposed to the Liege regiolect, Mons vowels significantly shifted acoustically in the direction of the Liege vowels.

Babel (2010) examined the role of social interaction in D1 accommodation to D2 using a shadowing task. This study also investigated accommodation in monolingual speakers of English, but between native speakers of New Zealand English (NZE) and a male native speaker of Australian English (AusE). The vowels *kit*, *dress*, *trap*, *start*, *strut*, *thought* were examined for normalised F1 and F2. The results, in general, showed that NZE speakers converged to AusE. However, there were differences based on gender. Female NZE speakers showed convergence for all vowels whereas male speakers showed convergence for *dress*, *strut*, *thought*, *start*, but divergence for *kit* and *trap*. Furthermore, NZE speakers with pro-AusE bias showed a higher degree of convergence towards the AusE speaker. In addition to this, like in Soquet and Delvaux (2007), NZE speakers retained the convergence in the post-task block after exposure to AusE speaker was stopped. Additionally, speakers with pro Aus-bias were more likely to retain accommodation to AusE. In conclusion, NZE speakers showed convergence towards AusE vowels regardless of their positive or negative feelings or biases towards the AusE speaker. However, NZE speakers with a pro-Aus bias showed a higher degree of convergence which was also retained after exposure to AusE was ceased. This indicates that by accommodating to the AusE vowels, these NZE speakers effectively tried to decrease their distance with the AusE speaker to indicate a positive affiliation. Based on these findings, Babel (2010) concludes that "the default behavior is for accommodation and convergence, and this may be due to psychological mechanisms stemming from the organization of language systems" (452), whereas social factors like biases, views, affiliation and distancing influence the degree of this accommodation.

Nycz (2016) examined changes in D1 in adult native speakers of Canadian English (D1) who moved to the New York City region. Their D1 speech was examined for two features. First, the quality of the diphthong /aʊ/ before voiceless stops, which is characterised by 'Canadian-Raising' in the D1, but not in the English spoken in the New York City region. The participants were particularly explicitly aware of this feature of Canadian-Raising and also of its social meaning. Second, the realisations of the vowels in the words COT and CAUGHT. In D1, there is a COT-CAUGHT merger, but not in the English spoken in the New York City region. For this feature, the Canadian participants varied more in their awareness of the COT-CAUGHT distinction in the D2. The data was elicited from seventeen native Canadians using sociolinguistic interviews. An effect of lexical frequency was found for the first feature such that more frequent words showed less raising, indicating an accommodation to ambient dialect regardless of their explicit awareness of Canadian-Raising. Moreover, despite no explicit awareness of the COT-CAUGHT distinction in D2, participants were found to be maintaining a distinction between COT-CAUGHT words. These results indicate an automaticity in accommodative processes, which are not necessarily informed by explicit awareness.

Another instance of accommodation between different accents of English in monolinguals comes from Alshangiti and Evans (2011), who examined speakers of North-East (NE) English and SSBE in the UK. The authors found two important patterns. First, not all NE speakers were found to have accommodated to SSBE, which is taken to indicate differential attitudes towards SSBE. Second, the same NE speakers were judged to have converged in accent-neutral snippets (recordings that did not contain keywords that were phonetically different across the two dialects) but diverged in accent-revealing snippets (recordings that contained keywords that were phonetically different across the two dialects). This was argued to indicate that “they had developed a hybrid accent, in which they used SSBE-like variants to show belonging to their new community but retained some NE variants to show allegiance to their home community” (227). So, it appears that while accommodation can affect low-level phonetic features like tempo, rate, f0 quite continuously, the structural linguistic/phonological features are subject to (still low-level) constraints reflecting, for instance, the social evaluation of those variables for the speakers and their community.

Inspired by Goldinger’s (1998) examination of accommodation in shadowed-speech, Pardo (2006) examined phonetic convergence in a group of monolingual speakers of American English, but in a conversational setting. The results showed evidence of convergence which persisted after the conversational task and was modulated by effects of talker role and sex. It had previously been argued that females generally converge more because of their greater perceptual sensitivity and attention to a speakers’ indexical features as compared to men (Babel, 2010; Babel, McGuire, Walters, & Nicholls, 2014; Namy, Nygaard, & Sauerteig, 2002). Additionally, it has been found that talkers converged to the more dominant speaker (Giles, 1973; Labov, 1966) (here, the instruction ‘giver’). However, Pardo’s results showed that males converged more to their partners, and in male pairs, receivers converged more than givers than the reverse, whereas females converged to their partners less, and in female pairs, givers exhibited convergence to receivers and not the other way round. The author argued that such differences may hint that men and women vary in their perceptual sensitivity across circumstances, and in their perception and interpretation of role labels in an implied dominance relationship such as that of the giver and receiver in the conversational map task.

It is also possible that the results of Pardo (2006) are related to the kind of measure examined for convergence, that is global perceptual similarity. So, Pardo, Jay, and Krauss (2010) built on the previous study and examined not only global perceptual similarity but also specific production cues such as articulation rate and vowel formants. The results replicated that of Pardo (2006), but the degree of accommodation was less, even when the participants were instructed to imitate their speech partner. Furthermore, for pairs where the instruction givers were asked to imitate the receiver, only male pairs converged to a moderate degree, whereas female pairs showed divergence. For pairs where the receivers were asked to imitate the givers, however, all pairs converged. Finally, no imitation and inconsistent imitation were found for articulatory rate and vowel formants respectively, which indicates a lack of correspondence between these production cues and global perceived similarity. The authors suggest that speakers adjust their speech in relation to the situational demands which lead to variability in the form of convergence and divergence (Pardo et al., 2022).

Having found such an effect of talker role previously, Pardo et al. (2013) examined the effect of talker role-reversal on phonetic convergence. The study employed similar methodology as Pardo (2006) and Pardo et al. (2010) with the exception that this time, talkers alternated roles as givers and receivers. The results highlight that convergence is not completely automatic as talkers who were assigned the dominant role of instruction givers in the first map, not only continued to dominate the complete interaction in terms of time-taking, but also showed convergence when acting as the receiver, whereas their partners did not. Results from Pardo et al. (2018) also shed light on the various factors that affect convergence. They report that as compared to males, female convergence was more susceptible to lexical factors like lexical frequency and lexical syllabic length, and also talker roles, task setting and talker identity.

Accommodation in American English speakers was also investigated by Ostrand and Chodroff (2021), who examined it in relation to Pickering & Garrod's (2004) Automatic Alignment Model, which holds that "interlocutors will tend to align expressions at many different levels at the same time" automatically (175). Based on this, Ostrand and Chodroff (2021) examined whether the process of accommodation was indeed as automatic as to generalise convergence across all linguistic levels as well as all features at a given level. Ninety-six monolinguals participated in an interactional picture-matching game, the results of which indicated that participants aligned to some linguistic levels and features, but not others. Additionally, it was not the case that all speakers aligned for the same level/features (Alshangiti & Evans, 2011; Gessinger, Raveh, Steiner, & Möbius, 2021). From an exemplar approach, Hay et al. (2006) attribute such individual effects to the fact that every individual starts with different exemplars depending upon their linguistic experience. These exemplars will, in turn, have different resting activations based on their recent linguistic interactions. They also found effects of gender and age, as well as individual production of categories in causing individual variation. Individuals could also differ in how they index separate exemplar distributions with social and phonemic labels. This indicates social agency on part of speaker - and undermines an assumption of fully automatic accommodatory processes. In addition to this, there is also some evidence that indicates that individuals may differ in their sensitivity to various phonetic cues. Wade (2022) also found much variation in the extent to which individuals converged to the model speaker, and even in their direction of accommodation (convergence versus divergence).

Sanker (2015) argues that individuals may differ in how they weight the exemplars for various characteristics, thus leading to variation. To find this out, Sanker (2015) investigated eight measures (F1, F2, vowel duration, F0, intensity, turn duration, duration of pauses marking the transition to a new speaker, and duration of pauses after which the same speaker resumed). Native American-English speakers were recruited and divided into pairs. As they interacted as per the instructions, their audio and video recordings were made. While the results indicated convergence between talkers in speaker pairs in general, not every speaker pair was reported to have converged for every measure, which was taken to indicate that individuals may differ in their sensitivity to various speech characteristics.

While Sanker (2015) argued that different cues may vary in their susceptibility to accommodation, Babel (2012) showed that different vowel categories may also be differentially sensitive to accommodation effects. The author reported that there was a higher tendency for the participants to imitate the low vowels /æ ɑ/ (as was also found by Sanker, 2015), than /i o u/ such that the former vowels were imitated more consistently and to a greater degree than /i o u/. This was attributed to the regional variation in acoustic distance for low vowels in North American English. That is, the difference in these low vowels between the participant and the model speaker was higher and provided a greater scope for convergence. Not only this, higher convergence was reported in the visual prompt condition which, again, highlights that convergence is socially modulated.

1.2.2.3 Phonetic Accommodation in Bilingual Context

In this study, accommodation in the bilingual context refers to situations of accommodation by a bilingual speaker to either (1) a non-native accent as a non-native speaker of that language (Enzinna, 2018; M. Kim, 2012; M. Kim et al., 2011; Olmstead et al., 2021; Tobin, 2022; Wagner et al., 2021), or (2) an L2 as a non-native speaker (Sancier & Fowler, 1997; Tobin et al., 2017).

1.2.2.3.1 Accommodation to non-native accent as a non-native speaker

M. Kim et al. (2011) examined the influence of language distance on accommodation. They labelled distance in three ways: ‘close’ (involved native speakers for the same native language and dialect), ‘intermediate’ (involved native speakers of the same language but different dialect), ‘far’ (involved native speakers of different languages). The ‘close’ group consisted of interlocutor pairs who were both either native speakers of American-English or Korean. The ‘intermediate’ pairs were both speakers of different dialects of either American-English or Korean. The ‘far’ interlocutor pairs consisted of one native speaker of American English and the other was a native speaker of either Korean or Chinese. Phonetic convergence was examined for English only. They speculated two possibilities: (1) closer linguistic forms could show more convergence if phonetic convergence is “limited to parameters and categories that are already well-established within the talkers’ linguistic sound systems” (M. Kim et al., 2011:128), (2) distant linguistic forms could show more convergence because they allow more room for accommodation and adjustment. The results revealed that phonetic convergence was significantly most likely to take place in the ‘close’ distance condition as compared to either of the other two conditions. That is, native speakers of English were found to be judged as having converged to native speakers of the same dialect of English. Furthermore, in the 'intermediate' distance condition, divergence was more likely than in either of the other conditions. However, the authors argue that this result could be caused by factors like unequal proficiency in the target language, limited dataset or extra demands of non-native speech production or perception.

Because of these possible issues, M. Kim (2012) followed up on M. Kim et al. (2011) with somewhat different methodology with linguistic distance still at its core but along with psychological implicit attitudes. Female native speakers of English were tested for phonetic accommodation by exposing them to English speech of native or non-native model female speakers in a passive auditory exposure task. Data on implicit attitudes was collected using an Implicit Association Test (as in Babel, 2010). Beforehand, two female monolingual native speakers of American English (US Northern dialect) and two native Korean speakers (with high proficiency in English) were recorded reading word and sentence lists in English. A group of monolingual native speakers (composed of those with native US Northern and Non-Northern dialects) were exposed to model recordings. Linguistic distance was again 'close', 'intermediate' and 'far' (M. Kim et al., 2011) such that US Northern dialect listeners exposed to US Northern dialect model speaker made the same L1/same dialect condition (close), US Non-Northern dialect listeners exposed to US Northern dialect model speaker made the same L1/different dialect condition (intermediate) and listeners exposed to non-native Korean speakers of English made the different L1 condition (far). For all wordlist and sentence list data, listeners displayed convergence in the 'far' condition for all acoustic measures, whereas for the 'close' condition they showed convergence for measures in the wordlist data, but divergence in the sentence list data. In the 'intermediate' condition, there were a few instances of divergence in the monosyllabic words and sentence list data, but all instances of convergence for disyllabic word data. Therefore, in general, the results showed convergence, a pattern that was also generalised to items that the listeners were not exposed to. More importantly, it was found that the listeners' negative or positive implicit attitudes towards foreigners did not directly affect the degree of convergence with the non-native speaker. The author argues that this may be because the implementation of the 'social' setting in the auditory exposure task was passive. Furthermore, the more the acoustic distance between listener and model speech, the more the degree of convergence was to the model speech. This might be motivated by the need for intelligibility to improve the quality of conversation. Thus, phonetic convergence is described as conditionally automatic and modulated by linguistic factors like acoustic distance. At some level, the speaker is aware of the stimulus and "through this awareness, many linguistic, psychological, and social factors influence the relatively automatic phonetic accommodation process" (M. Kim, 2012:140). Thus, phonetic convergence was found in a situation of passive exposure to speech where the participants did not directly interact with the speaker or imitate them.

While examining accommodation in native versus non-native speakers for VOT in voiceless stops in English, Enzinna (2018) examined two types of speaker groups (Spanish-English bilinguals, and English monolinguals), who interacted with both a model English monolingual speaker and a model Spanish-English bilingual speaker. The participants were divided into four groups (English monolinguals from Ithaca, Spanish-English bilinguals from Ithaca, English monolinguals from Miami, and Spanish-English bilinguals from Miami) such that Ithaca represents a majority English-speaking monolingual community, whereas Miami represents a majority Spanish-English bilingual community. The results showed that all participant groups produced longer English-like VOTs with the monolingual English talker and shorter Spanish-like VOTs with the Spanish-English bilingual talker. While this indicated that accommodation could have been automatic across all participants, this convergence was found to be modulated by the social factor of group affiliation. This was such that bilinguals in Ithaca converged more to the English monolingual model speaker, and the monolinguals in Miami converged more to the bilingual model speaker. This indicates their social motivation for higher convergence with the speech of the community in which they are linguistic outsiders. Importantly, Enzinna (2018) adds that it is socially-motivated phonetic adjustments that leads to long-term accommodation.

Tobin (2022) also examined accommodation for VOT. More importantly, the study compared accommodation effects in two bilingual groups (Korean-English and Spanish-English bilinguals), to investigate if the stability of VOT patterns in a given group of speakers can determine whether it will undergo convergence and to what degree. The author argued that because in terms of motor coordination, aspirated Korean and Korean-accented /k^h/ are more unstable (with longer VOT) than Spanish and Spanish-accented /k/ that has shorter VOT, the Korean-English bilinguals will show greater convergence towards moderately stable English /k/. The results were confirmatory of the 'coordination stability hypothesis' such that VOT indeed shifted in the case of Korean-English bilinguals, but not for Spanish-English bilinguals.

Like Enzinna (2018) and Tobin (2022), Olmstead et al. (2021) also examined accommodation in native versus non-native speakers. They examined interaction in two types of speaker pairs: (1) both Mandarin-English bilinguals, and (2) one Mandarin-English bilingual with one English monolingual. They examined the *kit* and *fleece* vowels for vowel length and spectral properties. The experiment consisted of the stages of pre-test, matching task and post-test. The pre-test and post-test stages were supposed to elicit baseline values before and after interaction with the speech partner in a matching task where the speech partners alternatively played the director and matcher. The results indicated that the Mandarin-English bilinguals adjusted to the speech of their partner differently depending upon whether they were another Mandarin-English bilingual or English monolingual. This was such that with the English partner, bilinguals started accentuating differences in spectral properties to distinguish the vowel pairs (evidence of convergence), which was not the case with bilingual partners.

Another account of phonetic accommodation in native to non-native speech comes from Wagner et al. (2021) who examined it in Dutch instead of English. Female Dutch speakers were exposed to the Dutch of a model bilingual female Croatian-Dutch speaker, with self-reported intermediate proficiency in Dutch. In the repetition task as well, the participants in general were found to converge to the speech of the non-native speaker. The results showed phonetic convergence to the non-native model Dutch speaker in general. Furthermore, convergence was weak for speakers when they perceived the model speaker's accent as strong. So, while the model speaker's non-native status did not completely block the tendency to accommodate, it was modulated by the social factor of perceived accentedness. That is, speakers converged less when they believed that the model speaker had a strong accent. The authors conclude that "both social and automatic mechanisms underlie convergence, with the relative weight of each depending on the setting in which it is evaluated and perhaps even the particular item of analysis" (18).

1.2.2.3.2 Accommodation to L2 as a non-native speaker

This context involves studies that make the boundary between transfer and accommodation murky as they can necessarily come under transfer (acquisition of L2), but have been included under accommodation, to reflect the common aspect of changing ambient language. This refers to the specific situation where a bilingual speaker knows both linguistic forms (L1 and L2) that may be involved in the act of accommodation, but the ambient language keeps changing, leading to constant shifts in the speakers' L1 and L2 towards the ambient language at any given period of time.

Sancier and Fowler (1997) examined the effect of recent, short-term yet repetitive L2 exposure on L1 speech in a production task. This study involved a single speaker of L1 Brazilian-Portuguese and L2 American English who went back and forth between the US and Brazil and resided in either country for months. Through a series of recordings, her speech was always recorded right before she travelled back to the other country. They examined whether this speaker's VOT for Brazilian Portuguese [p, t] and English [p^h, t^h] would shift in relation to the language they were exposed to. Results indicated that in general, both English and Portuguese VOTs became longer (like in American English) after a stay in the US as compared to a stay in Brazil. These results indicate that a few months of exposure to the L2 could be profound in causing L1 phonetic change. Furthermore, they examined this L2 influence on L1 in an accent judgement task. The Brazilian-Portuguese tokens produced by this speaker were presented to a group of monolingual native Brazilian-Portuguese listeners. These listeners rated her Brazilian Portuguese as having a foreign accent after a stay in the US as compared to after a stay in Brazil.

Tobin et al. (2017) tried to replicate the above study on multiple Spanish-English bilinguals. Like Portuguese, Spanish voiceless stops also have short VOTs. They predicted that the VOT in both languages would lengthen when exposed to English as the ambient language and shorten when exposed to Spanish as the dominant language. Data from ten participants was examined. While L2 English VOTs shifted towards the VOT of the ambient language, the L1 Spanish VOTs did not. Therefore, the results did not exactly mirror those of Sancier and Fowler (1997) that showed both L1 and L2 accommodating to the ambient language. These differences in results can be argued for on the basis that while Sancier and Fowler (1997) examined only one participant, Tobin et al. (2017) examined ten participants. Individual differences in language use across the ten participants could have contributed to the results. Additionally, Tobin et al. (2017) report that these participants spoke both Spanish and English while living in the US and exclusively spoke Spanish when in the L1 country. This could have maintained the stability of L1 phonetic categories which, as a result, did not accommodate to the L2 VOTs.

1.2.2.4 Summary

The above discussion on speech accommodation paints L1 phonetic accommodation as a complex and sophisticated process that is modulated by various social and linguistic factors such as talker roles (Pardo, 2006; Pardo et al., 2013, 2010; Zellou, Cohn, & Kline, 2021), sex (Namy et al., 2002; Pardo, 2006; Pardo et al., 2013, 2010, 2018), task setting (Gessinger et al., 2021; Pardo et al., 2018; Zellou et al., 2021), talker identity (Babel, 2012; Pardo et al., 2018), lexical factors (Goldinger, 1998; Nielsen, 2011; Pardo et al., 2018), phonetic abilities (Lewandowski & Jilka, 2019), phonetic distance (Babel, 2012; Tobin, 2022), speaker personality and attitude (Lewandowski & Jilka, 2019; Yu et al., 2013), cognitive capabilities (Lewandowski & Jilka, 2019; Yu et al., 2013), amount of exposure (Goldinger, 1998), perception of the speech partner (Babel, 2010, 2012; Sanker, 2015; Wade, 2022; Yu et al., 2013), salience of the acoustic cues (Biro et al., 2022; Gessinger et al., 2021). More importantly, this section highlighted the role of psycho-social motivations in affecting L1 phonetic accommodation which reinforces the need to examine Glaswasians not only as individual multilinguals, but also as members of a bigger multilingual community.

1.2.3 Interaction between Languages in Trilinguals: Models of L3 Acquisition

While backward transfer studies have only examined L2 to L1 transfer and L1 phonetic accommodation studies have only examined D2 to D1 transfer, there may be a way of combining L2 to L1 and D2 to D1 transfer scenarios to reflect a situation of simultaneous bilingual and bidialectal contact with the help of models of third language acquisition.

As mentioned earlier, the present study approaches the interaction between Glaswegian English, Indian English and Hindi from the perspective of second language and dialect acquisition. This is because even though there are three linguistic varieties involved here, it is not a case of third language acquisition: the Glaswasians' two L1s (Hindi, Indian English) are in contact with an L2 (Glaswegian English) which is both a new language with respect to one of the native languages (Hindi), and a new dialect with respect to the other native language (Indian English). This situation cannot be addressed under the umbrella of L3 acquisition because it involves only two languages – English and Hindi. It also cannot be examined solely under the umbrella of either bilingual or bi-dialectal interaction, because this is a situation of simultaneous bilingual (Hindi, Glaswegian English) and bidialectal (Indian English, Glaswegian English) interaction between the three linguistic varieties.

However, while not exactly representative of the present situation of linguistic contact, the various models of L3 acquisition may be highly relevant here because of the propositions they make about the representation and interaction between three linguistic varieties in a mental space, and the role of structural similarity in transfer processes. This may help contribute to our understanding of how the three linguistic varieties can possibly interact in Glaswasians, (by viewing D2-D1, L2-L1 effects simultaneously, not as separate as is done in attrition and accommodation research) and the role that linguistic proximity plays in this interaction. The latter is crucial to investigating whether Glaswegian English will show higher transfer effects on Indian English than Hindi.

The models of L3 acquisition that are relevant here can be divided into two types. The first type of models are those that make propositions about forward transfer from L1 and L2 in initial stages of L3 acquisition. These include the Typological Primacy Model (TPM; Rothman, 2010, 2013, 2015), the Cumulative Enhancement Model (CEM; Flynn et al., 2004), L2 Status Factor (L2SF; Bardel & Falk, 2007), the Scalpel Model (Slabakova, 2017) and the Linguistic Proximity Model (LPM; Westergaard et al., 2017) among others. The second type of L3 acquisition models make propositions about backward transfer, or how acquisition of an L3 can influence the previously acquired L1 and L2. These include the Differential Stability Hypothesis (Cabrelli Amaro, 2017), which is based on the Phonological Permeability Hypothesis (PPH; Cabrelli Amaro, 2013, 2017). Except PPH, traditionally, these models have been applied to the morphosyntactic domain.

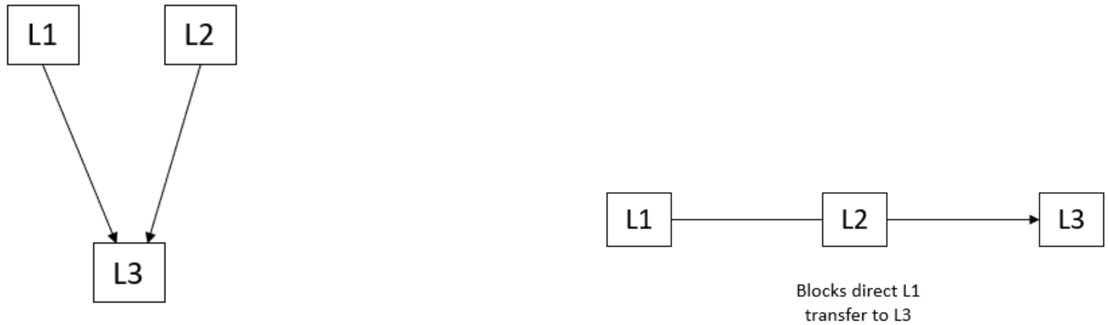
1.2.3.1 Models of L3 Acquisition: Forward Transfer

One of the earlier models in this space is the *Cumulative Enhancement Model* (CEM; Flynn et al., 2004), which argues that cross-linguistic influence to the L3 can come from either L1 or L2, not just L1, which was previously believed to hold a privileged role in transferring to the L3. Therefore, all languages that are previously known to an individual (L1 and L2) cumulatively contribute to L3 acquisition as long as their contribution is only facilitative. That is, if their contribution does not enhance and support L3 acquisition, it will be blocked off. However, evidence suggests that transfer from L1 and L2 to L3 can also be non-facilitative, as is also the stance of the *Typological Proximity Model* (TPM; Rothman, 2010, 2013, 2015). Like CEM, TPM also holds that both L1 and L2 can be the source of transfer to L3. What plays a crucial role in the TPM, however, in determining the source of transfer to L3 is actual or perceived structural proximity between the languages involved. That is, the overall more structurally proximate language (across domains) – L1 or L2 – transfers to the L3 in its entirety (Rothman, 2015), even for aspects that are not facilitative to L3 acquisition. This full transfer is attributed to the more economical choice of saving processing costs. The overall structural proximity between languages is determined by an internal parser that takes into account proximity across four factors in the order of most to least impact: the lexicon, phonological/phonotactic cues, functional morphology and syntactic structure (Rothman, 2013, 2015).

Similar to these two models in their idea of both L1 and L2 being sources of transfer to L3 are the more recent *Scalpel Model* (Slabakova, 2017) and the *Linguistic Proximity Model* (Westergaard et al., 2017). The Scalpel Model is in opposition to TPM's proposition of full transfer from either L1 or L2 to the initial stages of L3 acquisition, and in opposition to CEM's argument of transfer being only facilitative. Slabakova (2017) argues for transfer from the previously acquired languages to function with 'scalpel-like precision' to only transfer the L1 or L2 options that are relevant to L3 acquisition. In this way, transfer is selective, working on a feature-by-feature basis. More importantly, the Scalpel Model argues that it is not only structural similarity that affects transfer to L3, but also factors such as construction frequency, availability of clear unambiguous input, prevalent use, and structural linguistic complexity. Like the Scalpel model, LPM also argues that transfer occurs on a feature-by-feature basis and can be both facilitative (as a result of comparison of structural similarity) and non-facilitative (as a result of insufficient L3 input or misinterpretation of L3 input). However, LPM argues that the main determiner of transfer is not general typological proximity, but the similarity between the prior languages and L3 in terms of abstract linguistic properties.

So, despite their disagreements on certain points, the interactions between L1, L2 and L3 from the perspective of forward transfer in these models can be visualised together as in Figure 1.3a.

Unlike the above models, the L2 Status Factor model (L2SF; Bardel & Falk, 2007), holds that being the more recently acquired language, the L2 is the source of transfer to L3. This is attributed to L2's psychological and cognitive prominence, and its storage in relation to the L1 and L3. Bardel and Falk (2007) argue that at the early stages of L3 transfer, both L2 and L3 are stored in declarative memory, whereas L1 is stored in procedural memory. This allows for L2 to transfer to L3, while simultaneously blocking or filtering straightforward transfer from L1 to L3. This type of proposed interaction between the L1, L2, L3 in relation to forward transfer is visualised in Figure 1.3b. So, in general, it seems that forward transfer to L3 from L1 or L2 can be independent of each other (Figure 1.3a) or mediated (Figure 1.3b).



(a) Transfer to L3 can come from L1 or L2, as proposed by CEM, TPM, LPM and Scalpel Model

(b) L2 blocks direct transfer from L1 to L3, as proposed by the L2SF model of L3 acquisition

Figure 1.3: Interaction mechanisms involved in forward transfer of L1 and L2 to L3 as proposed by CEM, TPM, LPM, L2SF, and Scalpel Model of L3 acquisition

1.2.3.2 Models of L3 Acquisition: Backward Transfer

Attrition of previously known languages or backward transfer due to the acquisition and influence of an L3 is a relatively new area of exploration in the L3 acquisition literature. However, Cabrelli Amaro's 2013; 2017 *Phonological Permeability Hypothesis* (PPH) addresses this. The PPH argues that the basis of prior language attrition is the stability of the respective linguistic systems. This is such that the earlier the language is acquired, the more stable it will be, and therefore, less susceptible to influence from the L3. By this logic, as the L2 is learnt later, it will be comparatively less stable than the L1, thereby more susceptible to influence from the L3. This vulnerability of L2 to L3 influence should be additionally supported in light of L2SF's (Bardel & Falk, 2007) argument that both L2 and L3, at least in the early stages of L3 acquisition, share the same storage space. However, the results from Cabrelli Amaro (2017) only support a weaker version of this hypothesis, as vulnerability of L2 to L3 effects was found in production, but not in perception. In addition to this, as this hypothesis is relatively recent, it still requires more evidence to support or negate its arguments.

Although the type of linguistic contact situation examined by the above models and the present study are different, the proposed forward and backward interactions between L1, L2, L3 in these models can help better understand the various ways in which the host dominant language Glaswegian English may interact with and affect Glaswasians' native varieties Hindi and Indian English.

1.2.3.3 Modelling interaction between Glaswegian English, Hindi and Indian English on models of L3 acquisition

Based on the forward transfer models of L3 acquisition and the PPH, I propose two types of models of backward transfer: Independent Transfer Models and Mediated Transfer Models. These models can have a variety of configurations, and one goal of this thesis is to determine how best to understand the configuration that applies in this context.

The Independent Transfer Models are inspired by the argument proposed by the CEM, TPM, LPM, Scalpel models of L3 acquisition, that is, either L1 or L2 can contribute to L3 in terms of transfer. Similarly, in relation to backward transfer of Glaswegian English, I predict that Glaswegian English can affect both Hindi and Indian English separately, as shown in Shaktawat (2018a). The basic idea behind Independent Transfer models is that Glaswegian English affects each native system independently, which will be evident in transfer affecting different features across Hindi and Indian English.

The Mediated Transfer models are inspired by the L2SF model of forward transfer and the PPH. On one hand, the L2SF model argues that being the more recently acquired language which also shares the storage space with L3, L2 should be the source of transfer to L3. On the other hand, the PPH argues that L2 being the more unstable language should undergo transfer from L3. What is common across both these models is that L2, in a way, blocks direct access between L1 and L3. With respect to this, I propose the Mediated Transfer models which argue that Indian English being the more typologically proximate L1 to Glaswegian English, forms a bridge between Glaswegian English and Hindi, which then mediates backward transfer from Glaswegian English to Hindi. This type of transfer will be evident if both Indian English and Hindi show transfer from Glaswegian English to the same features, but Indian English shows quantitatively higher transfer than Hindi on account of being in direct contact with Glaswegian English.

Under both these types of models, various sub-models are proposed, depending upon the degree of influence of Glaswegian English to either native variety.

There are four types of proposed Independent Transfer models of backward transfer.

Independent Transfer 1 is depicted in Figure 1.4(a). This holds that Glaswegian English will independently affect only the structurally more proximate variety which is Indian English; Hindi will remain unaffected by Glaswegian English. This is based on TPM's argument that it is the more typologically similar language which transfers to the L3 in initial stages of its acquisition. Thus, this model highlights the crucial role of structural similarity between linguistic varieties.

Independent Transfer 2 is depicted in Figure 1.4(b). This holds that Glaswegian English will affect both Hindi and Indian English – but transfer to Indian English will be higher on the account that it is, on the whole or even phonologically, more structurally proximate to Glaswegian English than Hindi.

Independent Transfer 3 is depicted in Figure 1.4(c). This holds that Glaswegian English will affect both Hindi and Indian English independently, but equally. That is, neither language shows higher or lesser transfer effects. Different features may be affected in either native language depending upon their individual perceived similarity with Glaswegian English. This may be the case if overall structural similarity between Indian English and Glaswegian has no effect on backward transfer effects.

Finally, Independent Transfer 4 is depicted in Figure 1.4(d). This represents a possibility that Glaswegian English will show higher transfer effects to Hindi than Indian English. This is possible (though highly unlikely) if Hindi is perceived to be more similar to Glaswegian English phonologically (based on TPM's argument that different degrees of similarity may exist between separate languages). This will, again, reinforce the idea that overall structural similarity between Indian English and Glaswegian has no effect on backward transfer effects.

Additionally, Independent Transfer models 2 and 4 also prompt the interesting question of what does 'higher' or 'greater degree' of transfer mean? With reference to the present study, the following categories and features are examined: /l/ for F2-F1 difference, /t/ for VOT, /b d g/ for VOT, VCD and RBI, /u/ for F1, F2, F3.

Here, 'higher' transfer has been discussed in relation to 'domain' and 'degree'. More domains of transfer means more features and phones are affected by backward transfer, whereas higher degree of transfer means larger acoustic effect within a phone or feature. Transfer from Glaswegian English, then, can be higher in relation to domain or degree. It is also not clear if transfer to the more primary as against to secondary acoustic and phonetic features of a category should count as higher transfer or not.

An alternative arrangement can be found in two variants of my Mediated Transfer model. In Mediated Transfer 1, which is depicted in Figure 1.4(e), Indian English mediates, or filters transfer from Glaswegian English to Hindi such that both native varieties will show transfer to the same features, but with differences in quantity. That is, Indian English will receive more transfer from Glaswegian English than Hindi, as it is in direct contact with Glaswegian English. Mediated Transfer 2, which is depicted in Figure 1.4(f) holds that Indian English being the bridge between Glaswegian English and Hindi, blocks transfer to Hindi. Consequentially, transfer effects will only be found in Indian English and not in Hindi.

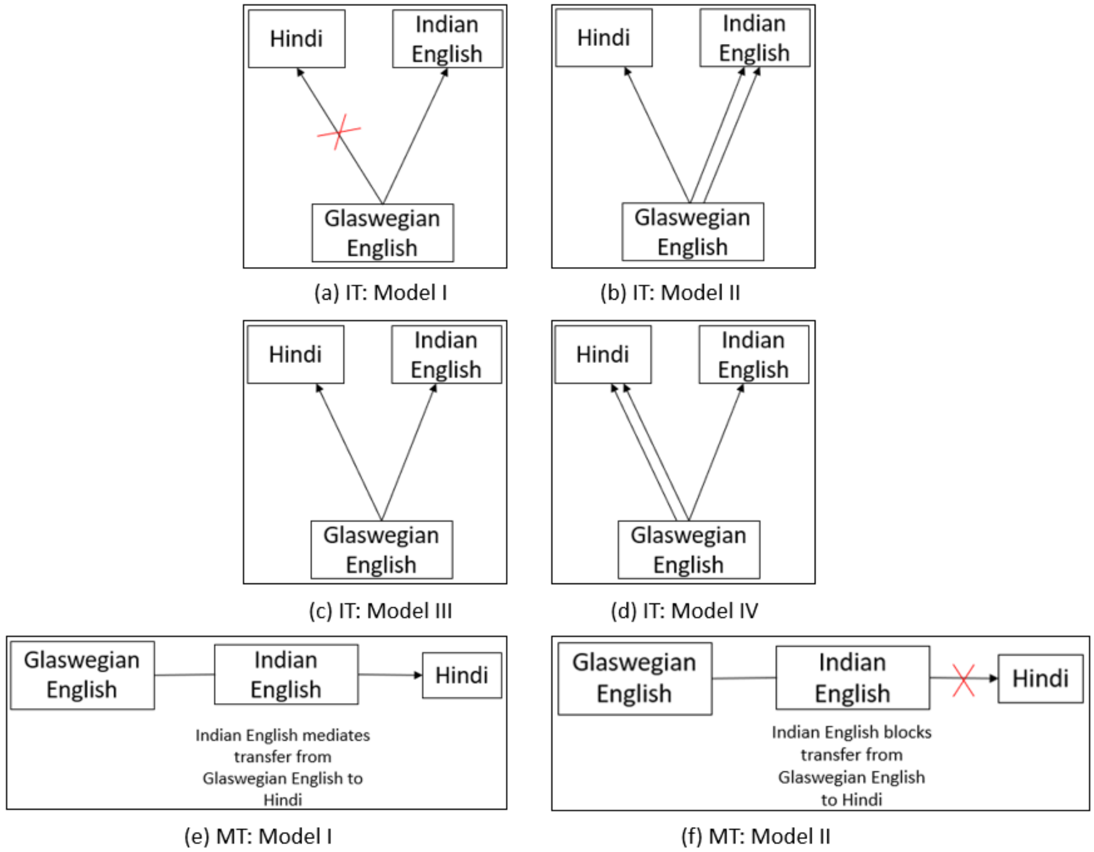


Figure 1.4: The two proposed interaction models of backward transfer of Glaswegian English on Hindi and Indian English. ('IT' = Independent Transfer; 'MT' = Mediated Transfer)

With respect to the above proposals about the type of interaction between Glaswegian English, Hindi and Indian English, the findings on backward transfer will shed more light on at least two points in this situation of simultaneous bilingual and bidialectal interaction. First, it will add to our understanding of how the host dominant language Glaswegian English interacts with the two native varieties, one of which is typologically proximate to it (Indian English), and the other more typologically distant (Hindi). Second, if Glaswegian English indeed influences Indian English more than Hindi, it will allow the opportunity to examine how these higher transfer effects manifest – in relation to domain or degree, or to more primary features, or through all of these.

Furthermore, based on the models of L3 acquisition, some proposals and predictions are made with regard to the interaction between Glaswegian English, Hindi and Indian English. The confirmation of any of these models will be revealed eventually based on the findings of later chapters.

1.2.4 Tying it all up

The experimental group in the present study exhibits a case of both SLA and SDA. This is because these Glaswasians were bilingual prior to migrating to the UK as they spoke Hindi and

Indian English as their native languages. Furthermore, because one of their native languages is a dialect of English (Indian English), they did not have to acquire an entirely new language after moving to Glasgow where English is spoken (although a different dialect - Glaswegian English). Therefore, they have been naturalistically acquiring (learning without formal teaching) this host dominant language and dialect due to the continued contact with it for at least three years now. Consequently, these Glaswasians present a case of simultaneous bilingual and bidialectal linguistic contact. Previously, however, this type of contact has been studied separately: bilingual contact under the L1 attrition or transfer framework (Chang, 2013; E. de Leeuw, Mennen, & Scobbie, 2013; Kartushina, Hervais-Adelman, et al., 2016; Schmid, 2013) and bidialectal contact under the accommodation framework (Babel et al., 2014; Giles, 1973; Goldinger, 1998; Pardo et al., 2022). The present study presents an attempt at combining these two types of linguistic contacts with the aid of various models of L3 acquisition (Bardel & Falk, 2007; Cabrelli Amaro, 2013; Flynn et al., 2004; Rothman, 2015; Slabakova, 2017; Westergaard et al., 2017) to better understand whether and how backward transfer across languages may be different from that across dialects.

Additionally, important in explaining backward transfer effects in bilingual interactions are psycholinguistic factors and important in explaining accommodation effects in bidialectal interactions are sociolinguistic factors. So, a situation examining simultaneous L2 to L1 and D2-D1 influence would strongly benefit from these two frameworks and an examination of psycholinguistic as well as sociolinguistic factors. This also highlights that while Glaswasians are individual bilinguals with multiple languages interacting in their minds, they do not exist in a sociolinguistic vacuum (Hickey, 2010), and are also members of a multilingual migrant ethnolinguistic minority.

Finally, the findings of backward transfer in this study will be interpreted in relation to SLM and SLM-r's (Flege, 1995b; Flege & Bohn, 2021) predictions of assimilation and dissimilation, which are functionally similar to the propositions of convergence and divergence in the L1 accommodation framework.

Given what has been said, I bring the present chapter to a close by reiterating the three research questions at the heart of this thesis:

1. Is there a backward transfer of Glaswegian English on Indian English and Hindi in production?

2. Is backward transfer greater for dialect acquisition than language acquisition?

3. Which psycholinguistic and sociolinguistic factors play a role in affecting backward transfer effects of assimilation and dissimilation?

Chapter 2

XAB Similarity Judgement Task

2.1 Introduction

The previous chapter argued that L1 phonetic changes can be brought about due to influence from other linguistic varieties. On the one hand, previous research under the backward transfer framework has examined and presented much evidence of the influence of SLA on the speaker's native language (for example, Bergmann et al., 2016; Chang, 2012; Flege & Bohn, 2021; Flege & Eefting, 1987a, 1987b; Kartushina, Frauenfelder, & Golestani, 2016). On the other hand, previous research under the L1 phonetic accommodation framework has argued, with support from much evidence, that an ambient dialect or accent can cause shifts in the speaker's native accent without necessarily acquiring it (for example, Babel, 2009, 2010; Evans & Iverson, 2007; Giles & Powesland, 1997; Pardo et al., 2013, 2010).

The present study, however, investigates a situation of language contact that has not been studied before, focusing on Glaswasians who are bilingual native speakers of Hindi and Indian English, which they had acquired before migrating to Glasgow. So now, Glaswegian English, which is the variety of English spoken in Glasgow, is the host dominant language with respect to Glaswasians' native language Hindi, and the host dominant dialect with respect to Glaswasians' native dialect of English, Indian English. The former linguistic interaction has traditionally been examined under the transfer framework and the latter interaction has traditionally been examined under the accommodation framework. Both of these kinds of interactions in the same speaker simultaneously, however, has not been examined before.

This situation allows us to ask a crucial question: how is backward transfer between languages different from that between dialects? That is, can one expect higher transfer from Glaswegian English into Indian English than Hindi? As discussed in the previous chapter, higher transfer here refers to the domain and degree of transfer. Higher transfer in domains relates to more number of features or categories affected by transfer, whereas higher transfer in degree relates to a larger acoustic effect in a feature or category.

A reason that suggests that we can expect higher transfer in Indian English is based on typological distance between the varieties involved. That is, Glaswegian English and Indian English are dialects of the same language, and therefore typologically close. Therefore, on account of structural proximity, Indian English may exhibit higher transfer, as also argued by models of L3 acquisition (§1.2.3 in Chapter 1).

However, at the same time, while Glaswegian English and Indian English are dialects of the same language, the phonology of Indian English may be more similar to that of Hindi, and therefore, at a similar distance from Glaswegian English as Hindi, because it is influenced by the phonology of Indic languages with which it co-exists. So, instead of assuming either proposition and to find a more definitive answer, the present chapter is centered around the following question: Is there higher perceptual similarity between Indian English and Glaswegian English as compared to Hindi and Glaswegian English? This would directly answer to the possibility of higher transfer in Indian English than Hindi in Glaswasian speech.

No previous study seems to have explicitly examined whether the amount of transfer exhibited from an L2 will be higher when the L1 is the dialect of the same language, as compared to when it is an entirely separate language. The case of Glaswasians, who speak both Hindi and Indian English as their L1s, presents a unique opportunity to explore it. E. de Leeuw (2009) made a similar prediction but regarding similar languages, not dialects. In a foreign accent assessment, de Leeuw expected to find L1 attrition at the level of perception in native German speech of bilinguals with L2 Dutch, as against in those native Germans with L2 English. This prediction was based on the reasoning that Dutch is phonetically more similar to German than English is to German. So, based on this, German-Dutch speakers were expected to show more L1 attrition than German-English speakers. However, the results did not show any difference in the amount of attrition between Dutch L2 and English L2 speakers. This was attributed to the possibility that different L2s may not have the same effect on the same L1 or that maybe listeners confused potentially Dutch foreign accented speech with German regionally accented speech. Therefore, while this influence was not reported for similar languages, it is possible that it may be present in mutually intelligible dialects.

2.2 Previous Research

Several researchers (De Angelis, 2007; Nelson, Krzysik, Lewandowska, & Wrembel, 2021; Rothman, 2010, 2013, 2015; Schmid, 2011) have identified language distance or the degree of differences between languages as a major contributing factor in L2/L3 acquisition and proficiency, and cross-linguistic influences. Interference and transfer are more likely to occur between languages or sounds that are proximate as compared to those that are distant (De Angelis, 2007; Kellerman, 1977; Leusink, 2017; Schmid, 2011; Trudgill, 1986). Based on this idea, Shaktawat (2018a) predicted that because Indian English and Glaswegian English are dialects of the same language family, Indian English should exhibit more transfer from Glaswegian English as compared to Hindi, which is a separate language entirely. However, the results did not support this prediction as Indian English did not exhibit more transfer from Glaswegian English as compared to Hindi.

However, Shaktawat (2018a) overlooked a key issue in the study design –namely, that language distance can be understood in two ways. The first type is 'language typology' which is also referred to as 'systemic' or 'objective' distance (De Angelis, 2007; Leusink, 2017; Nelson et al., 2021). This is the objective distance between two languages, language families or sub-groups, based on which languages are classified. Shaktawat (2018a) assumed that systemic proximity between Glaswegian English and Indian English was enough to cause higher transfer in Indian English from Glaswegian English. However, language systems are complex, and though Indian English is a dialect of English, it is still strongly influenced by the Indian indigenous and native languages in its phonology (Bansal, 1990; Maxwell & Fletcher, 2009). Therefore, Indian English may objectively be more distant from Glaswegian English or be at a similar distance from it as Hindi on a phonological basis than what systemic typology may dictate.

A second way to characterize language distance is 'Psychotypology' or perceived language distance which was introduced by Kellerman (1977, 1979). It refers to the distance between two linguistic varieties or items as perceived by the speaker/learner, regardless of the systemic distance between them. This measure is found to be the most useful in explaining cross-linguistic influences (De Angelis, 2007). L2 speech perception models like the Speech Learning Model (SLM; Flege, 1995b), revised Speech Learning Model (SLM-r; Flege & Bohn, 2021), Second Language Linguistic Perception Model (L2LP) (Escudero, 2005; van Leussen & Escudero, 2015), Perceptual Assimilation Model (PAM, Best, 1995; PAM-L2, Best & Tyler, 2007) rely on this idea of perceptual similarity and dissimilarity between L1-L2 phones as a crucial measure for categorisation of L2 categories and cross-linguistic influences. However, there is no accepted metric that suggests how to measure this perceptual distance between L1-L2 sound categories (Schmidt, 1996; Yang, Chen, & Xiao, 2022). So then, various types of perceptual identification and discrimination tasks have been employed to identify cross-linguistic similarity between L1-L2 phonetic categories (Best & Tyler, 2007; Flege, 1991, 2003; Nishi, Strange, Akahane-Yamada, Kubo, & Trent-Brown, 2008; Strange & Shafer, 2008).

For example, Yang et al. (2022) adopted and integrated three methods to predict cross-linguistic similarity between Russian and Mandarin stops to examine acquisition of L2 Russian stops by L1 Mandarin speakers: IPA comparison (Flege, 1995b), feature redeployment, acoustic differences. Russian contrasts voiced and voiceless stops, whereas Mandarin does not, and shows voiceless unaspirated and aspirated stops. Based on this and the conclusion of IPA comparison, feature redeployment and acoustic difference between Russian and Mandarin stop system, the authors hypothesised that Russian voiced stops, which according to the SLM, may be categorised as 'new' L2 categories by L1 Mandarin learners, will be more easily acquired than Russian voiceless unaspirated stops that are ‘similar’ or even ‘identical’. They tested this prediction with a perceptual assimilation task and a perceptual discrimination task in which L1 Mandarin speakers with lower and higher proficiency in Russian participated. The results from both these tasks suggested that both Russian voiced *and* voiceless stops were perceived as equally similar to Mandarin voiceless unaspirated stops by both groups of Mandarin speakers. This was supported by the results from the production task which found that Mandarin-Russian speakers produced Russian voiced *and* voiceless stops with the same VOT as that of Mandarin voiceless unaspirated stops. So, while the results from the perception and production tasks aligned, they did not support the prediction of the three methods which were concluded to be unreliable measures of cross-linguistic similarity as compared to perceptual tasks.

The purpose of the present chapter is to test this notion: Is Indian English perceived to be more similar phonetically to Glaswegian English as compared to Hindi? To this end, an XAB similarity judgement task was used where stimuli were presented in the form of syllables in order to elicit responses purely based on phonetic similarity - void of any linguistic context like syntax or lexicon.

2.3 Methodology

The aim of this task was for the participants to decide which native variety (Indian English or Hindi) was more similar to Glaswegian English (GE). They were presented three sounds in every trial in the order of X, A and B. The ‘X’ sound was always a GE sound. The sounds ‘A’ and ‘B’ were either Indian English (IE) or Hindi. The participants could respond in two ways: if they perceived the ‘A’ sound to be more similar to ‘X’, they pressed the ‘a’ key; if they perceived the ‘B’ sound to be more similar to ‘X’, they pressed the ‘b’ key.

2.3.1 Target Sounds

Eight sounds from the Glaswegian English (GE) phonology were selected to be examined for their similarity to Indian English (IE) and Hindi. They were used as the ‘X’ target sounds. These consisted of seven consonants /p b t d k ɡ ɫ/ and one vowel /ʉ/. In relation to these GE sounds, multiple IE and Hindi sounds were selected based on phonetic and acoustic similarities. From the IE phonology, a total of nine sounds were chosen: seven consonants/p b ʈ ɖ k ɡ l/ and two vowels /u ʊ/. Almost double the number of these sounds were selected from the Hindi phonology: seventeen consonants /p pʰ b bʰ ʈ ʈʰ ɖ ɖʰ t̪ t̪ʰ d̪ d̪ʰ k kʰ ɡ ɡʰ l/ and two vowels /u ʊ/.

Each GE target sound was matched with its closest IE and Hindi counterparts based on three conditions: Place of Articulation, Aspiration and Voicing Contrast. In the first condition ‘Place of Articulation’, each GE sound was matched with IE and Hindi sounds that had the same or closest place of articulation. The ‘Aspiration’ condition only applies to the six stops /p b t d k g/ and does not include the lateral and the vowel. Here, each GE sound was matched with IE and Hindi sounds that were aspirated. However, as IE stops are not aspirated (not even as allophonic realizations) (Gargesh, 2008), unaspirated IE counterparts were used for IE in this condition. The final ‘Voicing Contrast’ condition also applies only to the six stops. Here, each GE sound was matched with the IE and Hindi sounds that had the same place of articulation, but opposite unaspirated and aspirated voicing specification. Table 1 categorises these sounds in the three languages based on their closest counterpart for each stimulus condition.

Table 2.1: Target sounds categorised according to the Stimulus Type of Place of Articulation, Aspiration and Voicing Contrast

Stimulus Type	Glaswegian English (X)	Indian English	Hindi
Place of Articulation	/p/	/p/	/p/
	/b/	/b/	/b/
	/t/	/ʈ/	/ʈ t̪/
	/d/	/ɖ/	/ɖ d̪/
	/k/	/k/	/k/
	/g/	/g/	/g/
	/ɫ/	/l/	/l/
	/ʉ/	/u/ /ʊ/	/u/ /ʊ/
Aspiration	/p/	/p/	/p^{h}/
	/b/	/b/	/b^{h}/
	/t/	/ʈ/	/ʈ^{h} t̪^{h}/
	/d/	/ɖ/	/ɖ^{h} d̪^{h}/
	/k/	/k/	/k^{h}/
	/g/	/g/	/g^{h}/
Voicing Contrast	/p/	/b/	/b b^{h}/
	/b/	/p/	/p p^{h}/
	/t/	/ɖ/	/ɖ ɖ^{h} d̪ d̪^{h}/
	/d/	/ʈ/	/ʈ ʈ^{h} t̪ t̪^{h}/
	/k/	/g/	/g g^{h}/
	/g/	/k/	/k k^{h}/

In addition to these target sounds, other sounds were also included to be used as fillers (in the filler trials). In Glaswegian English, there were eight filler consonants /s z r v l f ʃ w/ and six filler vowels /i ɪ ɔ o ɛ a̠[1]/ (FLEECE, KIT, COT, GOAT, DRESS, TRAP) (cf. Wells, 1982). IE had the same eight filler consonants, but in this phonology /v/ and /w/ are sometimes used

[1] In Glaswegian English, both TRAP and PALM vowels have the same realisation (Stuart-Smith, 1999).

interchangeably (Gargesh, 2008). Furthermore, seven filler vowels were included from the IE phonology: /iː ɪ ɔ o e æ aː/ (FLEECE, KIT, COT, GOAT, FACE, TRAP, BATH). In Hindi, there were seven filler consonants /l p^h s z r ʋ f/ and six filler vowels /iː ɪ ə e ɛ ɔ/.

2.3.2 X, A, B Stimuli

The sound stimuli presented as X, A and B were in the form of monosyllables. All target consonants were presented in a **C**V syllable. The target consonant always occurred in the syllable-initial position and was followed by the vowel /a/ (realised as /a̠/ in GE and /aː/[2] in Hindi and IE). This is how filler consonants were presented as well.

All target vowels occurred medially in a C**V**C syllable, where the onset consonant was /s/ and the coda consonant was /p/. For filler vowels, two combinations of onset and coda consonants were used: /v/ and /p/, and /b/ and /p/. Two such syllable lists were created; one in English (Appendix C; also shown in Table 2) and one in Hindi (Appendix D). Each syllable was then embedded in their respective carrier sentences: '*Say* (the syllable) *again*' for English and '*/kəha:* (the syllable) *a:pne/*' for Hindi. The Hindi carrier sentence can be translated as "Did you say (the syllable)?" (literal translation– Said (the syllable) you?). Furthermore, all stimuli syllables were non-words (at least in spelling).

Table 2 presents the syllables embedded in the carrier sentences (for English) and the target sounds that were elicited from the corresponding target syllable from the GE and IE speakers.

[2]Based on Sailaja (2012)

Table 2.2: Table showing the stimuli sentences and the target sounds (consonants and vowels) elicited from them in Glaswegian English and Indian English

Sound Type	Syllable-Sentence List	Consonant Elicited		Vowel Elicited	
		Glaswegian English	Indian English	Glaswegian English	Indian English
Target	Say pa again.	/p/	/p/		
	Say ba again.	/b/	/b/		
	Say ta again.	/t/	/ʈ/		
	Say da again.	/d/	/ɖ/		
	Say ka again.	/k/	/k/		
	Say ga again.	/g/	/g/		
	Say la again.	/ɫ/	/l/		
	Say soop again. (GOOSE)			/ʉ/	/u/
	Say sup again. (FOOT) (Only in IE)			-	ʊ
Filler	Say sha again.	/ʃ/	/ʃ/		
	Say fa again	/f/	/f/		
	Say ra again.	/r/	/r/		
	Say va again.	/v/	/v/		
	Say sa again.	/s/	/s/		
	Say wa again.	/w/	/w/		
	Say za again.	/z/	/z/		
	Say beap again. (FLEECE)			/ɨ/	/i:/
	Say bip again. (KIT)			/ɪ/	/ɪ/
	Say bawp again. (THOUGHT)			/ɔ/	/ɔ/
	Say bope again. (GOAT)			/o/	/o/
	Say vep again. (DRESS)			/ɛ/	/e[a]/
	Say vap again. (TRAP)			/a̠/	/æ/
	Say vaap again. (PALM) (Only in Indian English)				/a:/

[a]The realisation for the DRESS vowel in Indian English can be [e] or [ɛ] (Gargesh, 2008). However, the Indian English speaker in this data produced it as [e]. The same can be said for the THOUGHT vowel. It can be realised as [ɔ] or [ɒ] and even [o] depending upon where the speaker is from in India (Gargesh, 2008). The Indian English speaker in this dataset produced it as [ɔ].

Hindi has a one-to-one correspondence between its letters and the phonemes that they represent. Therefore, the Hindi syllable-sentence list has not been included here to indicate which sounds were elicited from the corresponding syllable. Instead, Appendix D presents the IPA transcription for the Hindi syllable-sentence list.

2.3.3 Experimental Speakers

Four speakers were recorded reading the syllable-sentence lists. Three of these speakers consisted of one female native speaker each of Glasgow Standard English, Indian English and Hindi. As this project was carried out during the COVID-19, only one speaker was recruited for each linguistic variety. The GE and IE speakers read the list of syllable-sentences in English. They are the same age (Table 2.3). The Hindi speaker read the list of syllable-sentences in Hindi and is two years older than the English speakers. This Hindi speaker also speaks IE, but self-reported using Hindi more than IE on a daily basis. None of these three speakers has travelled or lived abroad. In addition to these three speakers, I recorded myself (a native speaker of Hindi and IE who has been in contact with GE for nearly four years) to provide the invariant frame which would remain constant across X, A and B monosyllables in each trial. It is onto this frame that the target sound would be spliced or attached to (explained in detail in §2.5). I recorded myself speaking the English syllable-sentence list. As the invariant frame remained constant across X, A and B stimuli, participant's responses were expected to be based on the target stimuli, without any interference from the invariant frame.

Table 2.3 shows the profiles of these four experimental speakers.

Table 2.3: Profiles of Experimental Speakers

Speakers	**Gender**	**Age**	**Location**
Glaswegian English	Female	25	Glasgow, Scotland
Hindi	Female	27	Udaipur, India
Indian English	Female	25	Udaipur, India
Neutral/Invariant Frame	Female	25	Glasgow

2.3.4 Recording Equipment

All speakers were recorded in quiet rooms (without face masks) on a Zoom H4N recorder with an external Beyerdynamic Opus 55.09 headset microphone over the months of January and February, 2021.

2.3.5 Stimuli Extraction and Manipulation (Splicing)

The recorded sentence list data from the four experimental speakers was converted to monosyllabic stimuli in two steps: annotation and splicing. First, these audio files were annotated in PRAAT (Boersma & Weenink, 2019). Each sound file was hand-segmented by a careful examination of the waveform and the spectrogram. Two tiers were created– 'word' and 'phone'.

For all consonants, the entire duration of the target syllable was coded as the syllable-orthography in the ‘word’ tier. This is shown for the syllable ‘ba’ in Figure 2.1.

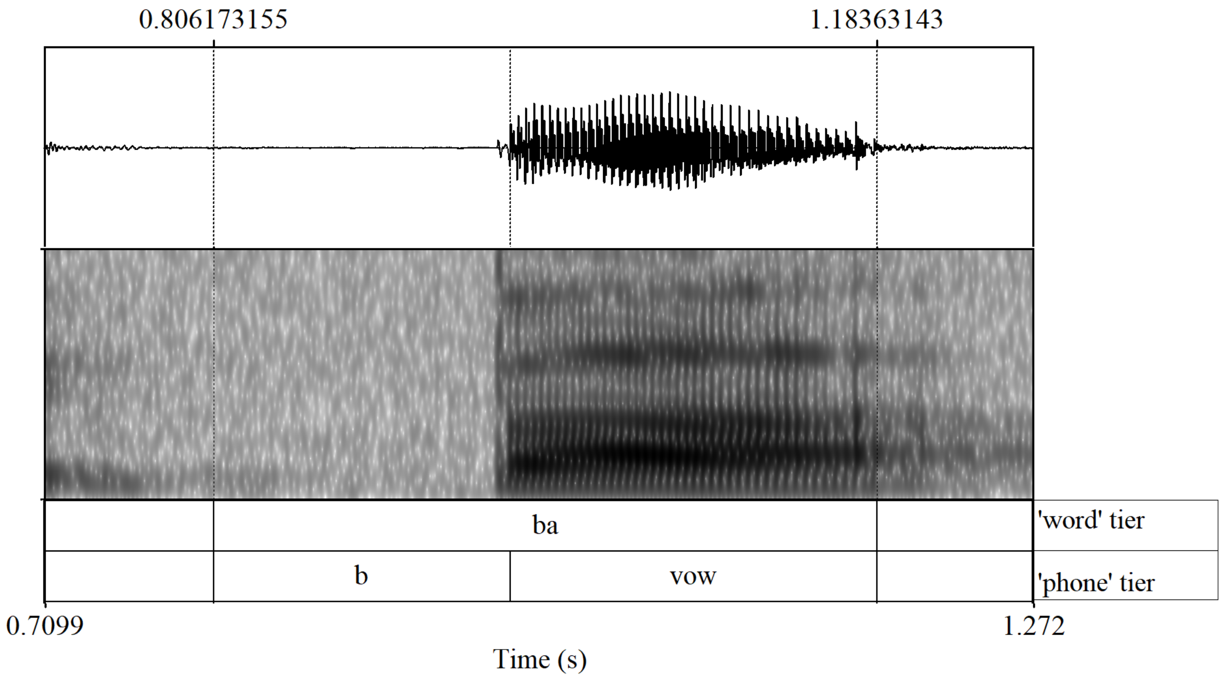


Figure 2.1: Annotation of the syllable ‘ba’ spoken by the Glaswegian English speaker

This syllable was further segmented into its constituent sounds in the ‘phone’ tier. The first boundary was placed at the end of the F1 of the preceding vowel in the word ‘say’ at the zero crossing (at the beginning of stop closure). The second boundary was placed at the beginning of the formants of the following vowel as seen in the spectrogram and beginning of periodicity in the waveform. The third boundary was placed at the zero crossing of the end of the steady state of the vowel. The consonant was labelled as ‘b’. The entire duration of the following vowel was labelled as ‘vow’ in the ‘phone’ tier.

For all vowels, the entire target syllable was segmented and labelled as the syllable orthography in the ‘word’ tier. This is shown for the syllable ‘soop’ in Figure 2.2.

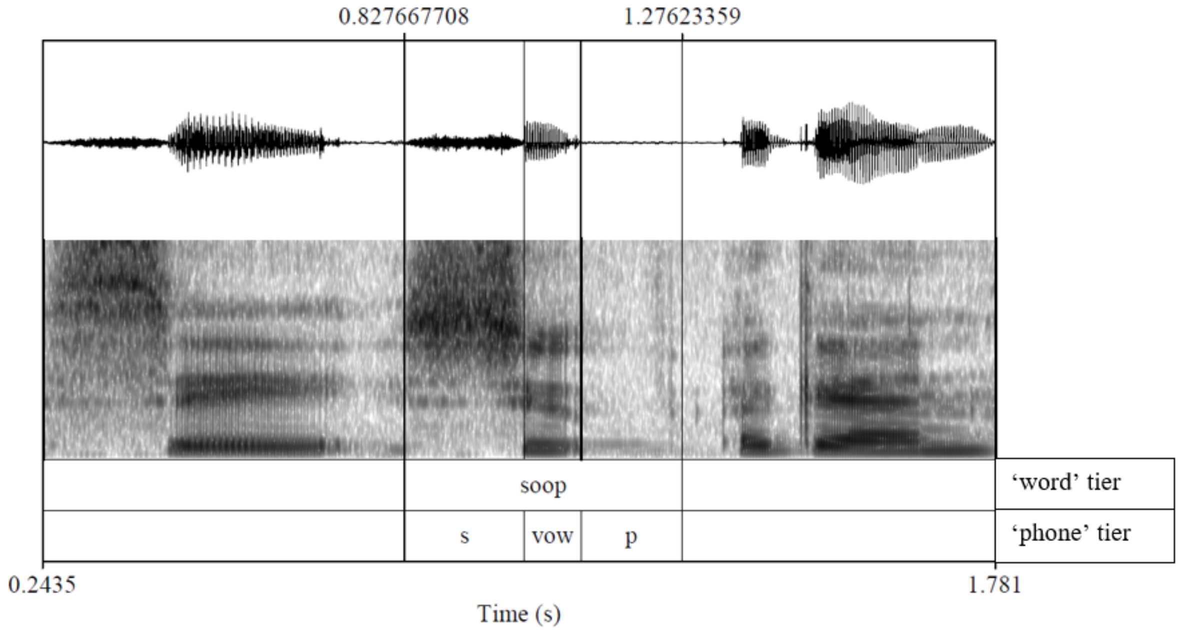


Figure 2.2: Annotation of the syllable ‘soop’ spoken by the Glaswegian English speaker

The syllable was then segmented into its constituent consonants and target vowel in the ‘phone’ tier. The first boundary was placed at the beginning of frication for the consonant /s/ at zero crossing, and the second boundary was placed at the end of frication for the same consonant at zero crossing. The entire duration of the onset consonant /s/ was labelled as ‘s’. The third boundary was placed at the zero crossing of the end of the steady state of the vowel. The entire duration of the target vowel was labelled ‘vow’. The fourth boundary was placed at the end of the burst of the coda stop /p/ at zero crossing. The entire duration of the coda consonant was labelled ‘p’.

All audio files, for every one of the four experimental speakers, were annotated in the same manner.

Second, two PRAAT scripts were written: script one for consonant syllables and script two for vowel syllables. The first script (for consonant syllables) extracted the target consonants separately from the three experimental speakers and the non-target vowel from the neutral speaker. It then spliced the initial consonants from the experimental speakers to the invariant vowel provided by the neutral speaker and saved the new spliced audios as the stimuli. For example, in the syllable /ba/, /b/ from the speech of all three native speakers was extracted and spliced to the /a/ of the neutral speaker, to create three new files ‘ba’ corresponding to the three languages. In this way, the non-target sound in the consonant syllable remained constant for all three sounds X, A and B, as shown in Figure 2.3.

The second script (for vowel syllables) extracted the target medial vowels from the three experimental speakers, and onset and coda consonants from the neutral speaker. The medial vowel from the experimental speakers was then spliced between the invariant consonant frame provided by the neutral speaker. Thus, three new files were created and saved corresponding to the three languages. For example, the vowel /u/ was extracted from the files of the three native experimental speakers and spliced between the flanking /s/ and /p/ consonants extracted from the neutral speaker. In this way, it was only the target vowel that varied across X, A and B, as the non-target consonant frame was kept constant.

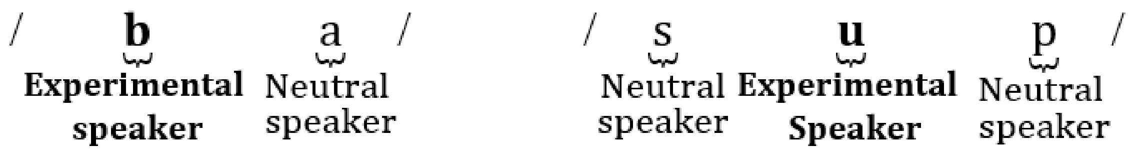


Figure 2.3: In the spliced files, the non-target sounds in the syllables were provided by the neutral speaker and remained constant in the stimuli

Splicing one speaker's consonants onto another speaker's vowel can have implications in terms of spectrotemporal continuity, related to issues such as mismatch in speaker characteristics, perceptual discrepancies, articulatory inconsistencies and prosodic incongruities. However, in the present study, splicing generated natural sounding stimuli without any artifacts, as was established by listening to each audio file. Additionally, this technique was applied to make sure that the responses made by the participants were based on perceived similarity or difference in the target consonants and vowels. The non-target sound in the syllable remained constant across X, A and B and therefore could not contribute to the differences that the participants picked on to make their response. Thus, using this technique, three types of monosyllabic stimuli were created: one set each for GE, IE and Hindi.

2.3.6 Experiment Design and Procedure

Hindi and IE were counterbalanced across A and B stimuli in blocks. In each experimental list, one block contained trials in which Hindi was presented as the A stimulus and IE as the B stimuli (Format 1), while the other block contained trials in which IE was presented as the A stimulus and Hindi presented as the B stimulus (Format 2). Figure 2.4 visualises these two formats. The order of the blocks was also counterbalanced across two experimental lists, such that half of the participants completed the format 1 block first, while the other half of the participants completed the format 2 block first.

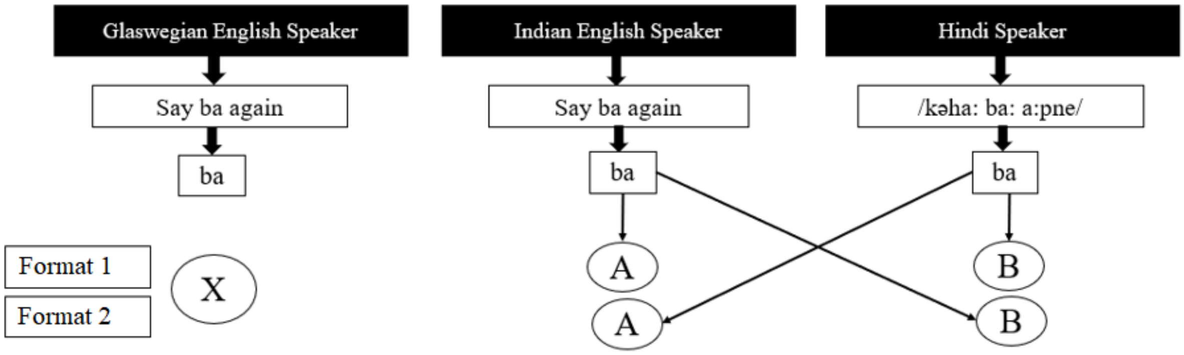


Figure 2.4: Two formats for presenting each trial

Therefore, in every trial, all three sounds were different, and all the three linguistic varieties (Glaswegian English, Indian English and Hindi) occurred once.

There was a total of 116 trials per participant divided into two blocks: 58 trials in each block. Out of these 58 trials, 37 were critical and 21 were filler trials. Each trial only occurred once in the two formats. Other than this, the trials were not repeated to reduce the total duration of this task. Only one break was inserted in the task: at the end of block one and before the beginning of the block two. In each trial, the X, A, B stimuli were played automatically with an inter-stimulus interval (ISI) of 450 milliseconds. They could not be played again and were only heard once. It took approximately fifteen minutes to finish the task.

Table 2.4 presents the combinations of GE, IE and Hindi monosyllables that occurred as X, A, B stimuli in the block one, which consisted of Format 1 trials where IE was presented as 'A' sound and Hindi was presented as 'B' sound. The final column in this table presents the total number that each trial was presented for in the entire task (in block 1 and 2) for each Stimulus Type within each target category (p, b, t, d, k, g, l, u).

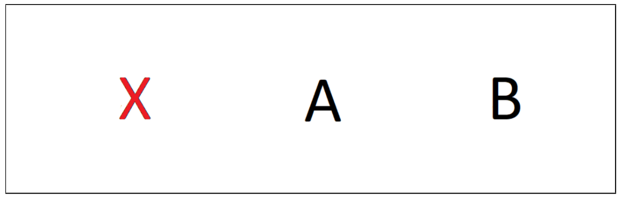
Stimulus Type	**Glaswegian English (X)**	**Indian English (A)**	**Hindi (B)**	**Total number of trials in both blocks**
Place of Articulation	p	p	p	1*2 = 2
Aspiration		p	p^h	1*2 = 2
Voicing Contrast		b	b	2*2 = 4
		b	b^h	
Place of Articulation	b	b	b	1*2 = 2
Aspiration		b	b^h	1*2 = 2
Voicing Contrast		p	p	2*2 = 4
		p	p^h	
Place of Articulation		ʈ	ʈ	2 * 2 = 4

t

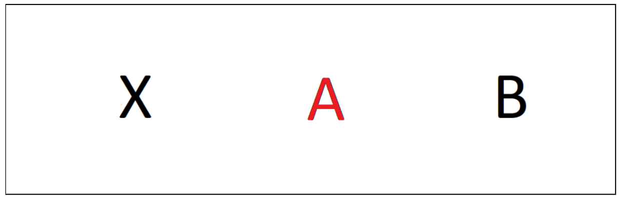
		ʈ	t̪	
Aspiration		ʈ	ʈʰ	2 * 2 = 4
		ʈ	t̪ʰ	
Voicing Contrast		ɖ	ɖ	4 * 2 = 8
		ɖ	ɖʰ	
		ɖ	d̪	
		ɖ	d̪ʰ	
Place of Articulation	ɖ	ɖ	ɖ	2 * 2 = 4
		ɖ	d̪	
Aspiration		ɖ	ɖʰ	2 * 2 = 4
		ɖ	d̪ʰ	
Voicing Contrast		ʈ	ʈ	4 * 2 = 8
		ʈ	ʈʰ	
		ʈ	t̪	
		ʈ	t̪ʰ	
Place of Articulation	k	k	k	1*2 = 2
Aspiration		k	kʰ	1*2 = 2
Voicing Contrast		g	g	2*2 = 4
		g	gʰ	
Place of Articulation	g	g	g	1*2 = 2
Aspiration		g	gʰ	1*2 = 2
Voicing Contrast		k	k	2*2 = 4
		k	kʰ	
Place of Articulation	ɫ	l	l	1*2 = 2
Place of Articulation	ʉ	u	u	4 * 2 = 8
		ʊ	ʊ	
		u	ʊ	
		ʊ	u	

Table 2.4: The combinations of GE, IE and Hindi syllables presented as X, A, B sounds in each trial based on Stimulus Type and target category (X)

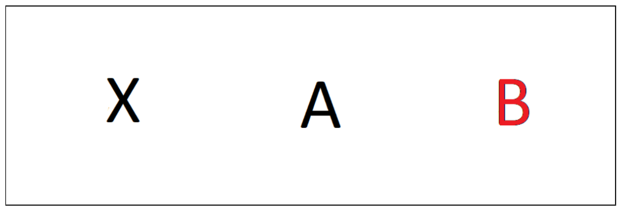
The experiment started with eliciting their consent to participate in the task, which was followed by an instruction to put on their headphones/earphones. They were then informed that in each trial they will be presented with three sounds X, A and B. They had to listen to them carefully and decide which sound (A or B) was the most similar to X. They had to press the key ‘a’ for A and ‘b’ for B. In every trial, three letters (X, A, B) were shown on the screen. The letter changed colour as its corresponding sound was played, to indicate which sound was playing (as shown in Figure 5 (a), (b), (c)).



(a) ‘X’ (always GE) sound being played



(b) ‘A’ sound being played



(c) ‘B’ sound being played

Figure 2.5: Panels (a), (b) and (c) show how the letters X, A, B changed colours to indicate to the participants which sound was playing in each trial

Four practice trials preceded the main trials. This XAB Similarity Judgement Task was created on Gorilla Experiment Builder (`www.gorilla.sc`). Two separate links to the task were generated: one for each group of participants that participated in this task and are introduced in the following sub-section.

2.3.7 Participants/Listeners

Two groups of participants of mixed sex and age participated in the XAB perception task: Scottish native speakers of GE who reside in Glasgow (‘Glaswegians’), and Indian native speakers of Hindi and IE who reside in non-Southern states of India (‘Indians’). The Glaswegian group consisted of 49 participants and the Indian group consisted of 48 participants. Glaswegians were recruited by posting on the University of Glasgow mailing lists and social media groups like Facebook, Reddit and Yammer. They were also recruited from the University of Glasgow campus. Indians were recruited by the method of snowballing. I contacted my acquaintances, who spread the call for participation among their acquaintances.

Data collection was online. The University of Glasgow College of Arts Ethics Committee granted the ethical clearance for data collection using this task, which was designed and hosted on the GDPR-compliant software Gorilla Experiment Builder (`https://app.gorilla`

`.sc)`. The participants were sent the instructions and the link to the task in an online correspondence. They then opened the link on their personal computers/laptops using any internet browser. They were required to have a stable internet connection to participate.

2.3.8 Data Analysis

All analyses for this task was subjected to binomial logistic regression using the `glm()` function (when random effects were not included) and `glmer()` function (when random effects were included) in the package `lme4` (version 1.1.29) (Bates, Mächler, Bolker, & Walker, 2015) in R (version 3.6.3) (R Core Team, 2020). Eight separate binomial logistic regression models were fitted for each of the eight Glaswegian English targets: word-initial /p/, /b/, /t/, /d/, /k/, /g/, /l/ and word-medial /u/. Each model's fit was evaluated with a log-likelihood ratio test that compared the full model with interaction terms against the simpler model, without the interaction terms. The following are the variables relevant to this analysis:

1. **Dependent Variable:**

   (a) **Response Language:** The native language which was chosen as being more similar to Glaswegian English. This factor consisted of two levels: Hindi, Indian English.

   In each model, the Response Language variable coded Hindi as 1 and Indian English (IE) as 0. This means that a positive coefficient for a predictor indicates increased log-odds of selecting Hindi, while a negative coefficient indicates decreased log odds of selecting Hindi (and hence increased log odds of selecting IE). A coefficient of 0 indicates equal likelihood of selecting either IE or Hindi as the Response Language.

2. **Independent Variables:**

   (a) **For fixed effects:**

      i. **Group:** The group that any given participant belonged to. This factor consisted of two levels: Glaswegian/Indian. It was effect-coded, with weights of .5 for Glaswegian and -.5 for Indian. Thus, positive coefficients for Group mean that Glaswegians are more likely to choose Hindi, while negative coefficients mean Indians are more likely to choose Hindi.

      ii. **Stimulus Type:** The type of phonetic feature a set of trials contrasted. This factor is only applicable to stops and has three levels: Place of Articulation, Aspiration, Voicing Contrast. This variable was treatment-coded with the reference level of 'Place of Articulation'.

   (b) **For random effects:**

i. **Participant:** Identifier code for the 97 participants (49 Glaswegians and 48 Indians).

The above variable codings ensured that the intercept of the model represented the grand mean of the two levels in Group for the Stimulus Type 'Place of Articulation'. This was done for ease of interpretation so that the coefficient for Group represents the difference between Glaswegians and Indians, while the interaction terms describe the difference in that Group effect across different levels of Stimulus Type. Therefore, if the intercept itself (or the null model) is greater than 0 it reveals an overall tendency to associate the respective Glaswegian English category with the corresponding Hindi category, and if it is less than 0 it reveals an overall tendency to associate the respective Glaswegian English category with the corresponding Indian English category.

The goodness of fit of the logistic regression models was assessed using ROC curves and Nagelkerke-R2 (Field, Miles, & Field, 2012). The ROC curve measures the discriminative-ability of the model. AUC is the area under the curve. Higher AUC indicates better ability of the model at accurately classifying the outcomes. The Concordance Index is numerically equal to the AUC (Austin & Steyerberg, 2012; Bobbitt, 2023; Royston & Altman, 2010; Shipe, Deppen, Farjah, & Grogan, 2019) and ranges from 0.5 to 1. A value of or below 0.5 indicates that the discriminative-ability of the model is no better than chance, whereas a value of 1 indicates perfect discriminative-ability of the model (Bobbitt, 2023; Royston & Altman, 2010; Shipe et al., 2019). The ROC curve and concordance index were generated using the `pROC()` function in the package `pROC` (version 1.18.0) (Robin et al., 2011). Nagelkerke-R2 was generated using the code provided in Field et al. (2012:334).

2.4 Results

The following sub-sections separately discuss the model specifications and results for each one of the eight Glaswegian English target sounds.

2.4.1 Glaswegian English /l/

For this target, there were two responses per participant. Therefore, 98 responses were made by Glaswegians and 96 by Indians. In total, there were 194 responses.

Table 2.5 presents the results summary for the logistic regression model and reports the coefficient and standard errors. The model assessed the effect of Group on Response Language. A random intercept for Participant was not included due to the observance of singular fit indicating that the model was overfitted with the inclusion of random effects.

Including Group as a predictor did not significantly improve the fit of the model $(X^2(1) = .206, p = .64)$. Furthermore, the area under the ROC curve in Figure 2.6 shows that the model has almost no discriminatory power (Concordance Index C = .516). Also, Nagelkerke pseudo-R2 (R2 = .001) indicates that the model has almost no predictive power.

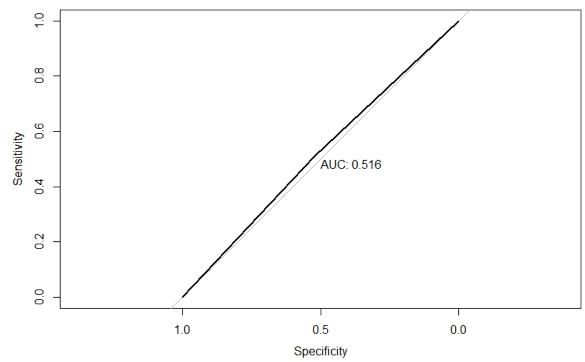


Figure 2.6: Area under the ROC curve for responses to Glaswegian English /l/

Table 2.5: Model summary for responses to Glaswegian English /l/

	Dependent variable:
	Response Language
Intercept	0.271 (0.145)
Group Effect	−0.132 (0.290)
Observations	194
Log Likelihood	−132.620
Akaike Inf. Crit.	269.240
Note:	*p<0.05; **p<0.01; ***p<0.001

Figure 2.7 visualises the effect of Group in Table 2.5, where the error bars represent 95% confidence intervals.

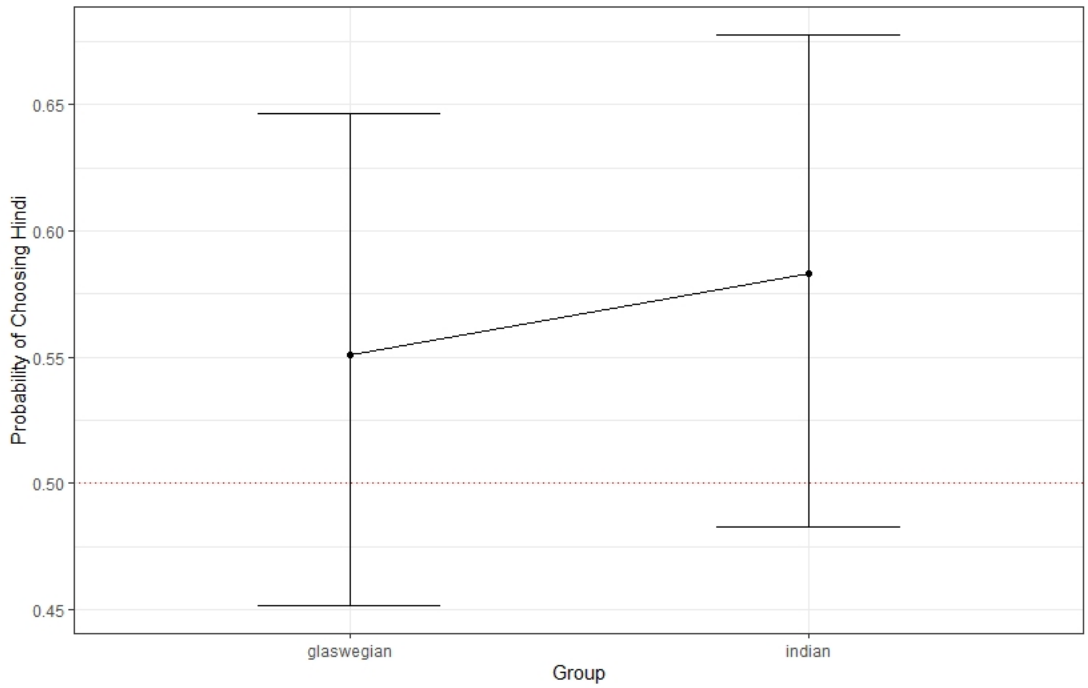


Figure 2.7: Model effects plot of Group for Glaswegian /l/. The y-axis represents probability.

In Table 2.5, the intercept represents the grand mean of the log−odds of Glaswegians and Indians. It was not significantly different from 0 ($\beta = 0.27, p = .062$). This represents equal likelihood of choosing Hindi or IE. Additionally, the Group effect was also not significant ($\beta = -.132, p = .65$). To sum up, both Glaswegians and Indians were equally likely to choose Hindi or IE as more similar to Glaswegian English (GE) /l/. This can also be seen in Figure 2.7 which depicts the probability of choosing Hindi. Here, the probability for both Glaswegians and Indians hovers around .5.

2.4.2 Glaswegian English /u/

There were four stimulus sets constructed for this target, which, when repeated in the two formats across both blocks, yielded eight responses for each participant. Therefore, 392 responses were made by Glaswegians and 384 by Indians. In total, there were 776 responses.

Table 2.6 presents the results summary for the logistic regression model and reports the coefficient and standard errors. The model assessed the effect of Group on Response Language. A random intercept for Participant was not included due to the observance of singular fit indicating that the model was overfitted.

Including Group as a predictor significantly improved the fit of the model ($X^2(1) = 7.13, p = .007$). The area under the ROC curve (Figure 2.8) shows that the model has almost no discriminatory power (Concordance index C = .548). Also, Nagelkerke pseudo-R2 (R2= .012) indicates that the model has almost no predictive power.

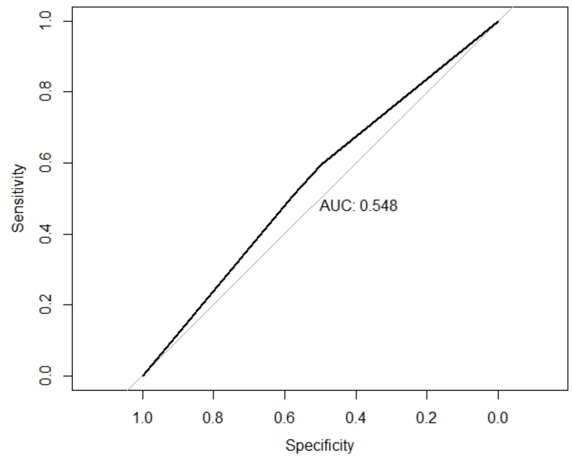


Figure 2.8: Area under the ROC curve for responses to Glaswegian English /u/

Table 2.6: Model summary for responses to Glaswegian English /u/

	Dependent variable:
	Response Language
Intercept	0.080 (0.072)
Group Effect	−0.385** (0.144)
Observations	776
Log Likelihood	−533.733
Akaike Inf. Crit.	1,071.466
Note:	*p<0.05; **p<0.01; ***p<0.001

Figure 2.9 presents the effect of Group in Table 2.6, where the error bars represent 95% confidence intervals.

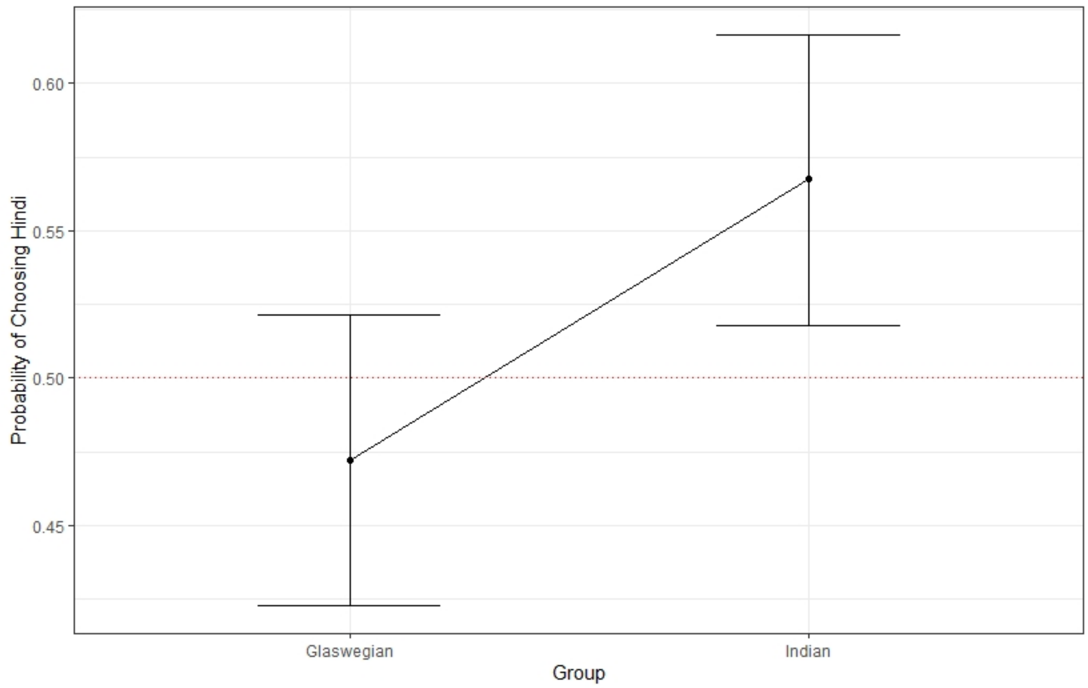


Figure 2.9: Model effects plot of Group for Glaswegian /u/. The y-axis represents probability.

In Table 2.6, the intercept represents the grand mean of the log−odds of Glaswegians and Indians. It was not significantly different from 0 ($\beta = 0.08, p = .267$). This represents an equal likelihood of choosing IE or Hindi in response to GE /u/. However, there was a significant Group effect ($\beta = -0.38, p = .008$) because with the effect-coded weight of -0.5 for Indians, a negative coefficient meant that Indians have a higher likelihood of choosing Hindi compared to Glaswegians. This is depicted in Figure 2.9 which shows the probability of choosing Hindi.

2.4.3 Glaswegian English /p/

There were two responses each for Place of Articulation and Aspiration Stimulus Type, but four responses for Voicing Contrast Stimulus Type. Therefore, there were 8 responses per participant. Thus, 392 responses were made by Glaswegians and 384 by Indians. In total, there were 776 responses. The Place of Articulation condition compared GE /p/ with IE /p/ and Hindi /p/. The Aspiration condition compared GE /p/ with IE /p/ and Hindi /p^h/. The Voicing Contrast condition compared (1) GE /p/ with IE /b/ and Hindi /b/, and (2) GE /p/ with IE /b/ and Hindi /b^h/.

A logistic mixed model was fitted to predict Response Language as a function of Group (Glaswegian/ Indian) and Stimulus Type (Place of Articulation/ Aspiration/ Voicing Contrast), and the interaction between them. A random intercept was included for Participant. Table 2.7 presents the model summary and reports the coefficients and standard errors.

The simple effects of Group and Stimulus Type did not improve the fit of the model over a null model when added separately (Group: $(X^2(1) = .19, p = .66)$; Stimulus Type: $(X^2(2) = 2.65, p = .26)$. Furthermore, adding the interaction term between Group and Stimulus Type significantly improved the fit of the model over and above the model with just main effects $(X^2(2) = 7.3, p = .02)$, but not over a null model $(X^2(5) = 10.14, p = .07)$.

Table 2.7 shows the final intercept-only null model. The area under the ROC curve in Figure 2.10 shows that this model had weak discriminatory power (Concordance index C = .647). Nevertheless, Nagelkerke pseudo-R2 (R2 = .12) indicates that the model had very weak predictive power.

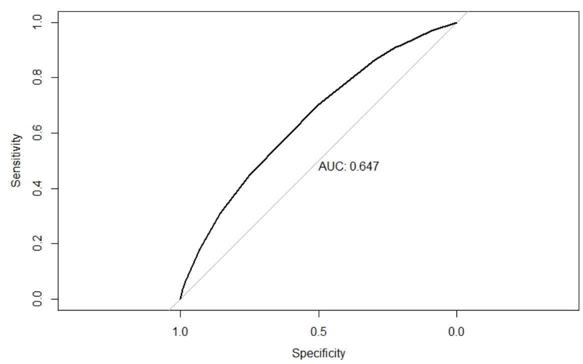


Figure 2.10: Area under the ROC curve for responses to Glaswegian English /p/

Table 2.7: Model summary for responses to Glaswegian English /p/

	Dependent variable:
	Response Language
Intercept	−0.021 (0.075)
Observations	776
Log Likelihood	−537.742
Akaike Inf. Crit.	1,079.483
Bayesian Inf. Crit.	1,088.792
Note:	*p<0.05; **p<0.01; ***p<0.001

Table 2.7 shows that the intercept is not significantly different from 0 and represents equal likelihood of choosing Hindi or IE $(\beta = -.021, p = .77)$.

2.4.4 Glaswegian English /b/

There were two responses each for Place of Articulation and Aspiration Stimulus Type, but four responses for Voicing Contrast Stimulus Type. Therefore, there were 8 responses per participant. Based on this, 392 responses were made by Glaswegians and 384 by Indians. In total, there were 776 responses. The Place of Articulation condition compared GE /b/ with IE /b/ and Hindi /b/. The Aspiration condition compared GE /b/ with IE /b/ and Hindi /b^h/. The Voicing Contrast condition compared (1) GE /b/ with IE /p/ and Hindi /p/, and (2) GE /b/ with IE /p/ and Hindi /p^h/.

A logistic mixed model was fitted to predict Response Language as a function of Group (Glaswegian/ Indian) and Stimulus Type (Place of Articulation/ Aspiration/ Voicing Contrast) and the interaction between them. The model also included a random intercept for Participant. Table 2.8 presents the results summary for this model and reports the coefficient, standard errors and indicates their significance.

The simple effects of Group and Stimulus Type significantly improved the fit of the model over a null model when added separately (Group: $(X^2(1) = 4.27, p = .03)$; Stimulus Type: $(X^2(2) = 24.77, p < .001)$. Adding the interaction term between Group and Stimulus Type did not improve the fit of the model over a model with just the main effects $(X^2(2) = 2.92, p = .23)$.

The area under the ROC curve (Figure 2.11) shows that the model had almost acceptable discriminatory power (Concordance index C = .642). Nagelkerke pseudo-R^2 ($R^2 = .06$) indicates that the model had almost no predictive power.

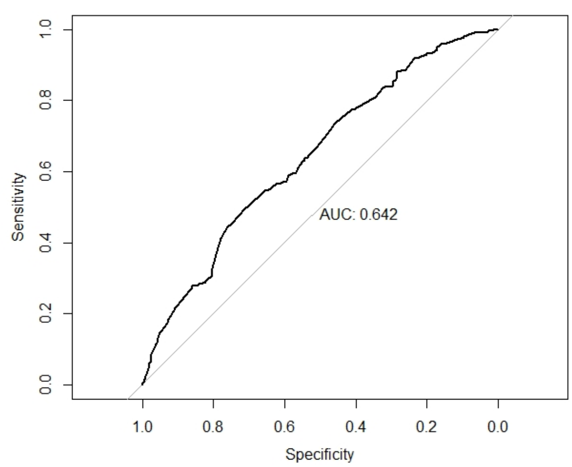
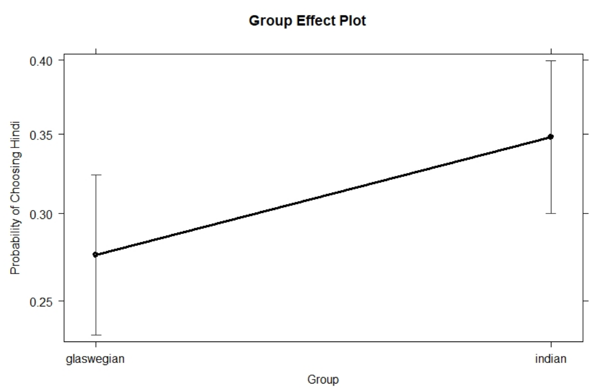


Figure 2.11: Area under the ROC curve for responses to Glaswegian English /b/

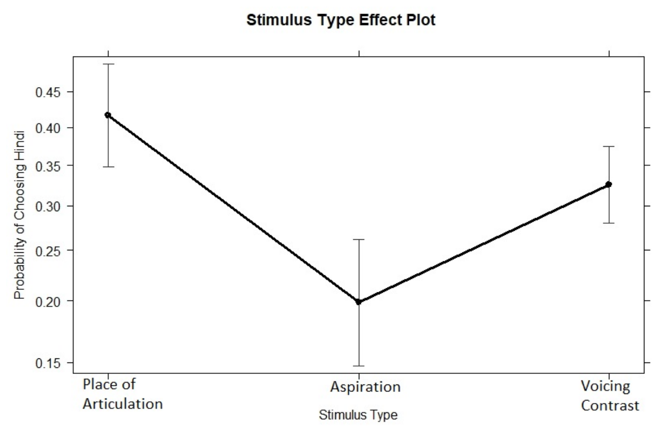
Table 2.8: Model summary for responses to Glaswegian English /b/

	Dependent variable:
	Response Language
Intercept	-0.336^{*} (0.148)
Stimulus Type Aspiration	-1.057^{***} (0.232)
Stimulus Type Voicing Contrast	-0.392^{*} (0.183)
Group Effect	-0.338^{*} (0.157)
Observations	776
Log Likelihood	-472.122
Akaike Inf. Crit.	954.244
Bayesian Inf. Crit.	977.515
Note:	*p<0.05; **p<0.01; ***p<0.001

Figures 2.12a and 2.12b show the effects of Group and Stimulus Type in Table 2.8. In these, the error bars represent 95% confidence intervals



(a) Effect of Group



(b) Effect of Stimulus Type

Figure 2.12: Significant effects of Group and Stimulus Type for responses to Glaswegian English /b/ in Table 2.8. The y-axis represents probability.

The intercept for the model for /b/ (Table 2.8) represents the grand mean of the log-odds of Glaswegians and Indians for the Stimulus Type Place of Articulation. It is significantly different from 0 and the negative log-odds indicate a stronger preference of IE over Hindi ($\beta = -0.33, p = 0.003$), as seen in Figure 2.12b. The simple effect of Stimulus Type Aspiration is significantly lower than the intercept ($\beta = -1.06, p < .001$). This represents a stronger preference of choosing IE over Hindi for Aspiration, relative to the Place of Articulation. Finally, the simple effect of Stimulus Type Voicing Contrast was also significantly less than the intercept ($\beta = -0.39, p = 0.03$). This, again, represents a stronger preference of choosing IE over Hindi for Voicing Contrast, relative to the Place of Articulation. (Figure 2.12b).

The Group effect was significantly different from 0 ($\beta = 0.34, p = .032$). As compared to Glaswegians, Indians had a higher likelihood of choosing Hindi over IE; however, the probability of choosing Hindi over IE was still below .5, as shown in Figure 2.12a.

2.4.5 Glaswegian English /t/

There were four responses each for Place of Articulation and Aspiration Stimulus Type, and eight responses for Voicing Contrast Stimulus Type. Therefore, there were 16 responses per participant. Based on this, 784 responses were made by Glaswegians and 768 by Indians. In total, there were 1552 responses.

The Place of Articulation condition compared (1) GE /t/ with IE /ʈ/ and Hindi /ʈ/, and (2) GE /t/ with IE /ʈ/ and Hindi /t̪/. The Aspiration condition compared (1) GE /t/ with IE /ʈ/ and Hindi /ʈʰ/, and (2) GE /t/ with IE /ʈ/ and Hindi /t̪ʰ/. The Voicing Contrast condition compared (1) GE /t/ with IE /ɖ/ and Hindi /ɖ/, (2) GE /t/ with IE /ɖ/ and Hindi /ɖʰ/, (3) GE /t/ with IE /ɖ/ and Hindi /d̪/, (2) GE /t/ with IE /ɖ/ and Hindi /d̪ʰ/.

A logistic mixed model was fitted to predict Response Language as a function of Group (Glaswegian/ Indian) and Stimulus Type (Place of Articulation/ Aspiration/ Voicing Contrast) (treatment-coded) and the interaction between them. A random intercept was included for Participant. Table 2.9 presents the model summary and reports the coefficients and standard errors.

The simple effects of Group and Stimulus Type significantly improved the fit of the model over a null model when added separately (Group: ($X^2(1) = 20.14, p < .001$); Stimulus Type: ($X^2(2) = 143, p < .001$). Furthermore, adding the interaction term between Group and Stimulus Type significantly improved the fit of the model over and above the model with just main effects ($X^2(2) = 14.3, p < .001$).

Furthermore, the area under the ROC curve (Figure 2.13) shows that the model had acceptable discriminatory power (Concordance index C = .708). Nagelkerke pseudo-R^2 ($R^2 = .017$) indicates that the model had almost no predictive power.

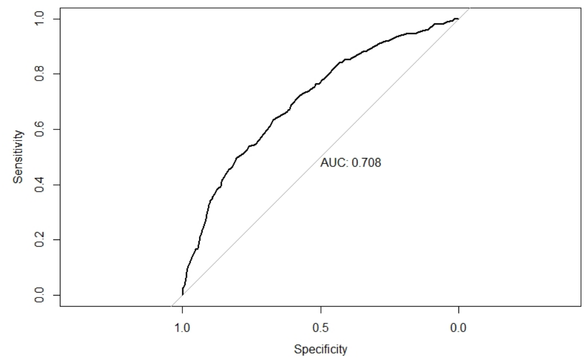


Figure 2.13: Area under the ROC curve for responses to Glaswegian English /t/

Table 2.9: Model summary for responses to Glaswegian English /t/

	Dependent variable:
	Response Language
Intercept	-0.802^{***} (0.122)
Stimulus Type Aspiration	1.534^{***} (0.160)
Stimulus Type Voicing Contrast	0.155 (0.139)
Group Effect	-1.218^{***} (0.232)
Group Effect:Stimulus Type Aspiration	1.085^{***} (0.318)
Group Effect:Stimulus Type Voicing Contrast	0.853^{**} (0.277)
Observations	1,552
Log Likelihood	−971.376
Akaike Inf. Crit.	1,956.753
Bayesian Inf. Crit.	1,994.184
Note:	*p<0.05; **p<0.01; ***p<0.001

Figure 2.14 visualises the interaction between Group and Stimulus Type in model 2.9 for Glaswegian English /t/. In these, the error bars represent 95% confidence intervals

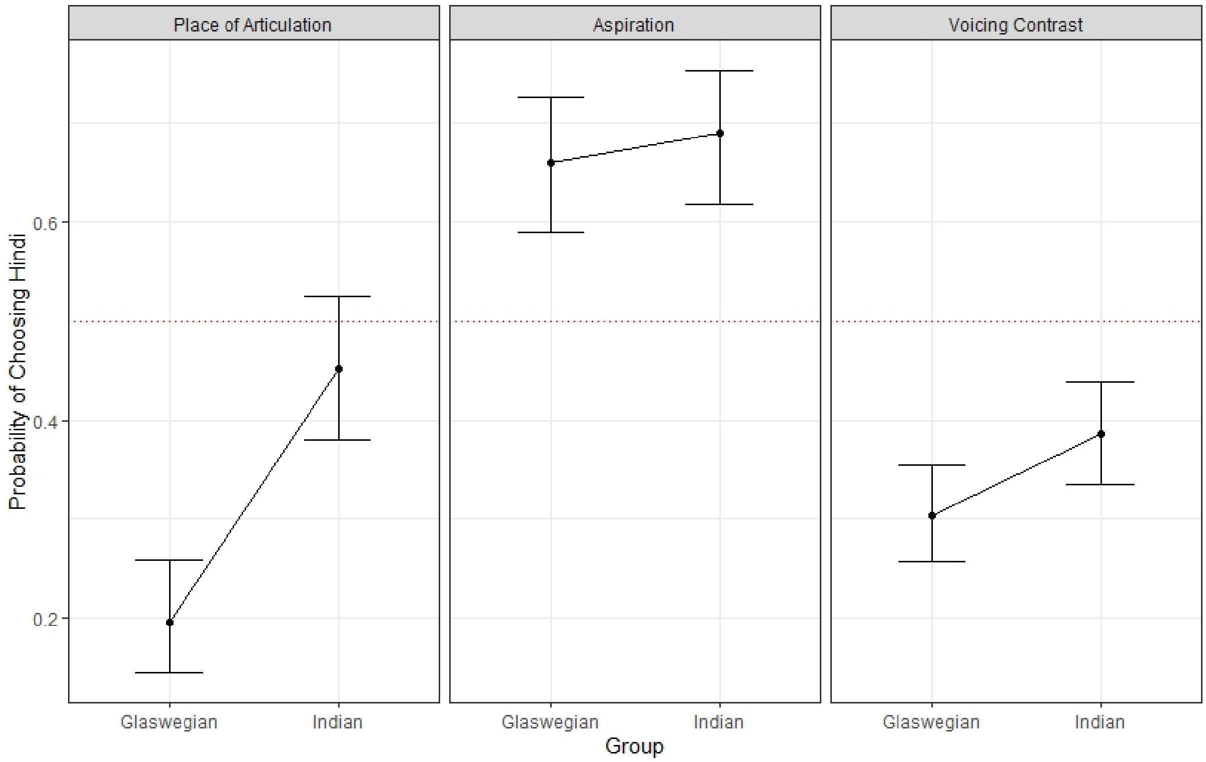


Figure 2.14: The interaction between Group and Stimulus Type for responses to Glaswegian English /t/ in Table 2.9. The y-axis represents probability.

In this model (Table 2.9), the intercept represents the grand mean of the log-odds of Glaswegians and Indians for the Stimulus Type Place of Articulation for /t/, which is significantly different from 0 with negative log-odds ($\beta = -.802, p < .001$). This represents a stronger preference of IE over Hindi for the Stimulus Type Place of Articulation averaged across the two groups. Also, the simple effect of Stimulus Type Aspiration was significantly different from the intercept ($\beta = 1.534, p < .001$) with positive log-odds. This represents a stronger preference of Hindi over IE for Aspiration compared to Place of Articulation when averaged across the two groups. As the positive magnitude of the coefficient for Aspiration is almost double the negative magnitude of the coefficient for Place of Articulation, this has the effect of reversing the preference for IE seen for PoA, such that it is now Hindi that is actively preferred (as shown in the middle panel of Figure 2.14). The simple effect of the Stimulus Type Voicing Contrast, however, was not significantly different from Place of Articulation ($\beta = 0.155, p < .264$) and represented a stronger preference of IE over Hindi.

The effect of Group for the Stimulus Type Place of Articulation was significantly different from 0 ($\beta = -1.218, p < .001$). The negative coefficient shows that Glaswegians had a stronger preference for IE over Hindi as compared to Indians. This can be seen in Figure 2.14 (left-most panel)[3]. So, in this case, I conclude that Glaswegians had a stronger preference for IE over

[3]The addition of various insignificant effects might result in sub-group estimates being significantly different from 0 in the plots, but it cannot be concluded that this difference is significant without re-leveling and refitting the

Hindi, as compared to Indians who were equally likely to choose Hindi or IE.

Additionally, the effect of Group for the Stimulus Type Aspiration was significantly smaller than the Group effect for Place of Articulation ($\beta = 1.085, p < .001$), as seen in Figure 2.14 (middle panel). Finally, the effect of Group for the Stimulus Type Voicing Contrast was also significantly smaller than the Group effect for Place of Articulation ($\beta = .853, p < .001$), as shown in Figure 2.14 (right-most panel).

2.4.6 Glaswegian English /d/

There were four responses each for Place of Articulation and Aspiration Stimulus Type, and eight responses for Voicing Contrast Stimulus Type. Therefore, there were 16 responses per participant. Thus, 784 responses were made by Glaswegians and 768 by Indians. In total, there were 1552 responses.

The Place of Articulation condition compared (1) GE /d/ with IE /ɖ/ and Hindi /ɖ/, and (2) GE /d/ with IE /ɖ/ and Hindi /d̪/. The Aspiration condition compared (1) GE /d/ with IE /ɖ/ and Hindi /ɖʰ/, and (2) GE /d/ with IE /ɖ/ and Hindi /d̪ʰ/. The Voicing Contrast condition compared (1) GE /d/ with IE /ʈ/ and Hindi /ʈ/, (2) GE /d/ with IE /ʈ/ and Hindi /ʈʰ/, (3) GE /d/ with IE /ʈ/ and Hindi /t̪/, (2) GE /d/ with IE /ʈ/ and Hindi /t̪ʰ/.

A logistic mixed model was fitted to predict Response Language as a function of Group (Glaswegian/ Indian) and Stimulus Type (Place of Articulation/ Aspiration/ Voicing Contrast) and the interaction between them. A random intercept was included for Participant. Table 2.10 presents the model summary and reports the coefficients and standard errors.

The simple effects of Group and Stimulus Type significantly improved the fit of the model over a null model when added separately (Group: ($X^2(1) = 5.8, p > .01$); Stimulus Type: ($X^2(2) = 91.7, p > .001$). Furthermore, adding the interaction term between Group and Stimulus Type significantly improved the fit of the model over and above the model with just main effects ($X^2(2) = 8.1, p = .01$), and over a null model as well ($X^2(5) = 106, p > .001$).

The area under the ROC curve in Figure 2.15 shows that the model had acceptable discriminatory power (Concordance index C = .685). Nagelkerke pseudo-R^2 ($R^2 = .079$) indicates that the model had almost no predictive power.

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model, and that would introduce multiple comparison issues (Schad, Vasishth, Hohenstein, & Kliegl, 2020)

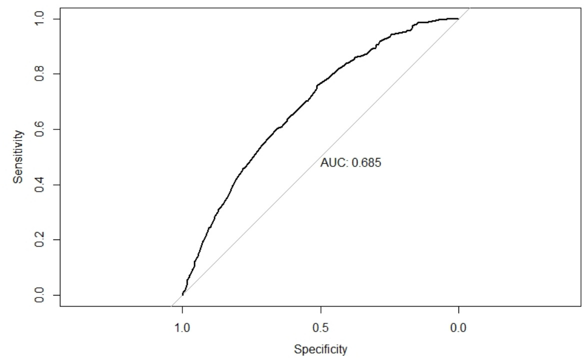


Figure 2.15: Area under the ROC curve for responses to Glaswegian English /d/

Table 2.10: Model summary for responses to Glaswegian English /d/

	Dependent variable:
	Response Language
Intercept	−0.179 (0.113)
Stimulus Type Aspiration	-1.362^{***} (0.172)
Stimulus Type Voicing Contrast	−0.097 (0.127)
Group Effect	−0.403 (0.207)
Group Effect:Stimulus Type Aspiration	−0.434 (0.343)
Group Effect:Stimulus Type Voicing Contrast	0.386 (0.254)
Observations	1,552
Log Likelihood	−975.262
Akaike Inf. Crit.	1,964.524
Bayesian Inf. Crit.	2,001.955
Note:	*p<0.05; **p<0.01; ***p<0.001

Figure 2.16 visualises the interaction between Group and Stimulus Type in Table 2.10, where the error bars represent 95% confidence intervals.

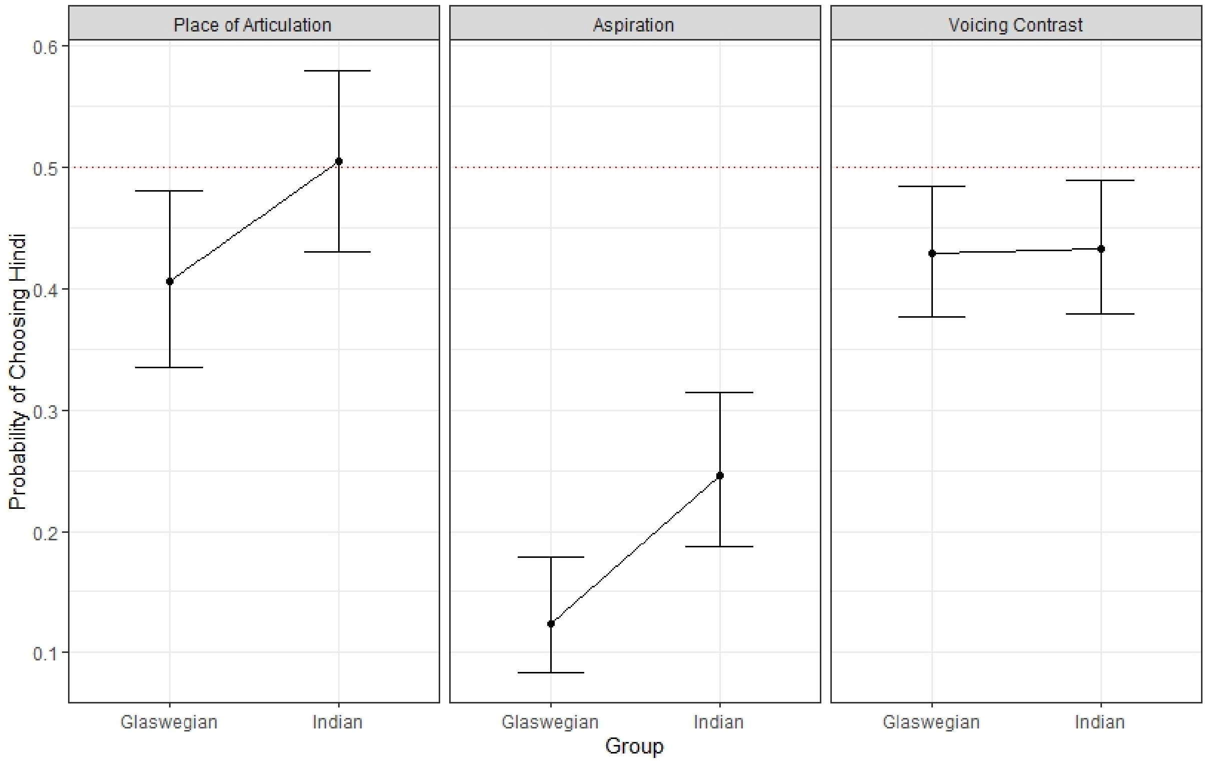


Figure 2.16: The effect of the interaction between Group and Stimulus Type on responses to Glaswegian English /d/ in Table 2.10. The y-axis represents probability.

In this model (Table 2.10), the intercept represents the grand mean of the log-odds for the two levels in Group for the Stimulus Type Place of Articulation. It was not significantly different from 0 ($\beta = -.179, p = .11$). This represents a similar likelihood of choosing Hindi or IE when averaged across the two groups. The simple effect of the Stimulus Type Aspiration was significantly different from Place of Articulation ($\beta = -1.362, p < .001$) with negative log-odds. In other words, when averaged across the two groups, there was stronger preference for IE over Hindi for the Stimulus Type Aspiration. By contrast, the simple effect of the Stimulus Type Voicing Contrast was not significantly different relative to Place of Articulation ($\beta = -.097, p = .44$).

Furthermore, the Group effect for the Stimulus Type Place of Articulation was not significantly different from 0 ($\beta = -.403, p = .052$). Therefore, both groups were similarly likely to choose Hindi or IE. This can be seen in Figure 2.16, where the probability for choosing Hindi over IE hovers around .5. The estimates for the effect of Group were not significantly different across the other Stimulus Types (Stimulus Type Aspiration: ($\beta = -.434, p = .2$); Stimulus Type Voicing Contrast: ($\beta = .386, p = .12$)).

2.4.7 Glaswegian English /k/

There were two responses each for Place of Articulation and Aspiration Stimulus Type, but four responses for Voicing Contrast Stimulus Type.Therefore, there were 8 responses per participant. Thus, 392 responses were made by Glaswegians and 384 by Indians. In total, there were 776 responses. The Place of Articulation condition compared GE /k/ with IE /k/ and Hindi /k/. The Aspiration condition compared GE /k/ with IE /k/ and Hindi /k^h/. The Voicing Contrast condition compared (1) GE /k/ with IE /g/ and Hindi /g/, and (2) GE /g/ with IE /g/ and Hindi /g^h/.

A logistic mixed model was fitted to predict Response Language as a function of Group (Glaswegian/ Indian) and Stimulus Type (Place of Articulation/ Aspiration/ Voicing Contrast) and the interaction between them. A random intercept of Participant was not included due to issues of singular fit indicating that the model was overfitted. Table 2.11 presents the model summary and reports the coefficients and standard errors.

The simple effects of Group and Stimulus Type did not improve the fit of the model over a null model when added separately (Group: $(X^2(1) = 3.51, p = 0.6)$; Stimulus Type: $(X^2(2) = 4.05, p = .13)$). However, when added together along with an interaction between them, the fit of the model significantly improved over a null model $(X^2(5) = 18.27, p = .002)$.

The area under the ROC curve in Figure 2.17 showed that the model had weak discriminatory power (Concordance index C = .583). Nagelkerke pseudo-R^2 $(R^2 = .031)$ indicates that the model had almost no predictive power.

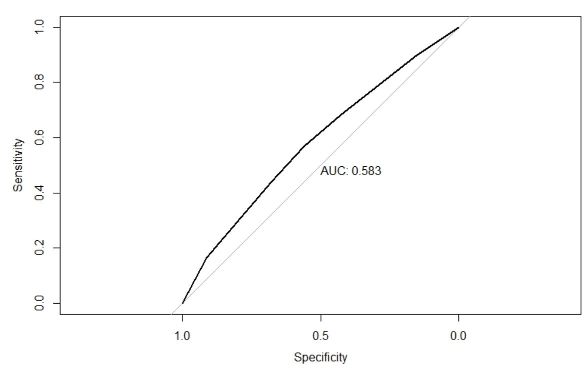


Figure 2.17: Area under the ROC curve for responses to Glaswegian English /k/

Table 2.11: Model summary for responses to Glaswegian English /k/

	Dependent variable:
	Response Language
Intercept	−0.208 (0.145)
Stimulus Type Aspiration	0.397 (0.207)
Stimulus Type Voicing Contrast	0.112 (0.178)
Group Effect	−0.498 (0.291)
Group Effect:Stimulus Type Aspiration	1.295** (0.414)
Group Effect:Stimulus Type Voicing Contrast	0.894* (0.356)
Observations	776
Log Likelihood	−528.489
Akaike Inf. Crit.	1,068.977
Note:	*p<0.05; **p<0.01; ***p<0.001

Figure 2.18 visualises the interaction between Group and Stimulus Type in model 2.11, where the error bars represent 95% confidence intervals.

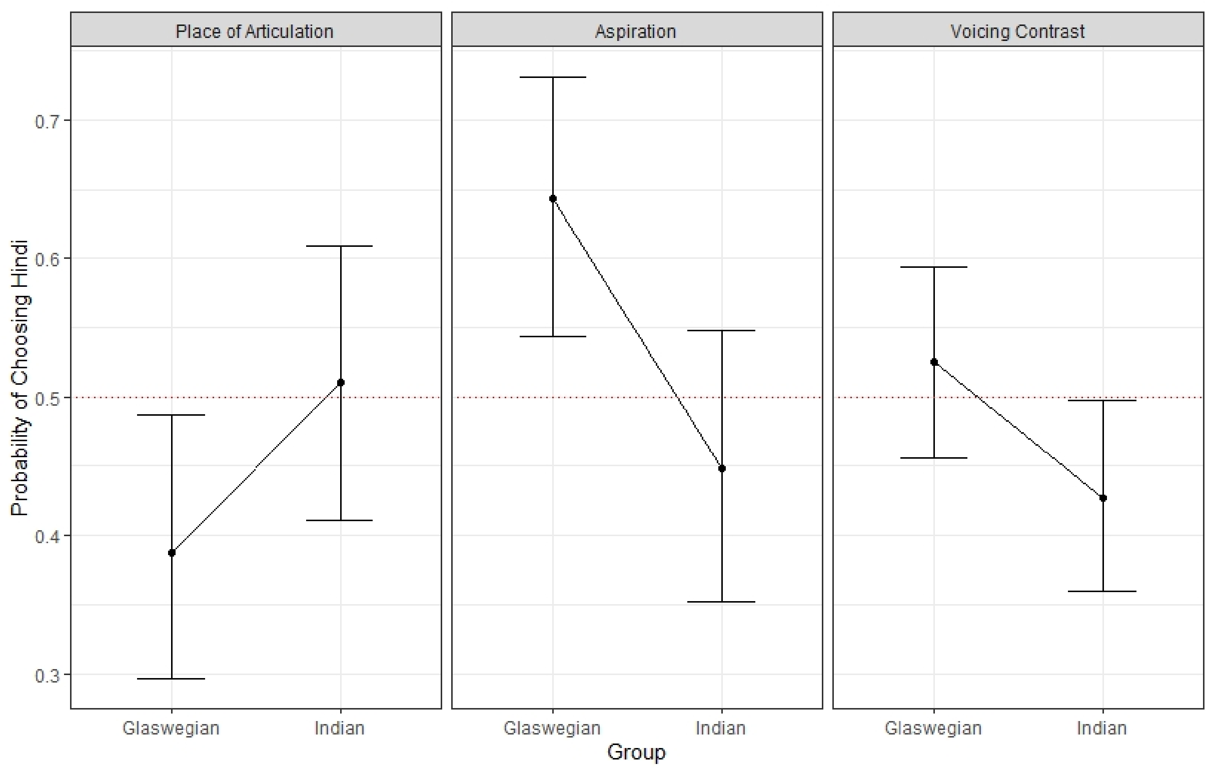


Figure 2.18: The effect of the interaction between Group and Stimulus Type on responses to Glaswegian English /k/ in Table 2.11. The y-axis represents probability.

The intercept in this model (Table 2.11) represents the grand mean of the log-odds for the two levels in Group for the Stimulus Type Place of Articulation, but it is not significantly different from 0 ($\beta = -.208, p = .15$). This represents that when averaged across Group, the likelihood of choosing Hindi or IE was equal for the Stimulus Type Place of Articulation. Also, the simple effects of the Stimulus Types Aspiration ($\beta = .397, p = .055$) and Voicing Contrast ($\beta = .112, p = .52$) were not significantly different from the Place of Articulation. Therefore, for Aspiration as well as Voicing Contrast, there was an equal likelihood of choosing Hindi or IE in response to GE when averaged across Group.

Furthermore, the Group effect for the Stimulus Type Place of Articulation was also not significantly different from 0 ($\beta = -.498, p = .08$). Therefore, both groups were similarly likely to choose IE or Hindi for Place of Articulation. Figure 2.18 (left-most panel) depicts this as the probability for choosing Hindi over IE, which hovers around .5 for Glaswegians and Indians. By contrast, Group effect for the Stimulus Type Aspiration was significantly larger from the Group effect for Place of Articulation ($\beta = 1.295, p < .001$). The positive coefficient indicates that for Aspiration, Glaswegians had stronger preference for Hindi as compared to Indians. This is shown in Figure 2.18 (middle panel), where the probability of choosing Hindi for Glaswegians is above .5, whereas it hovers around .5 for Indians. Finally, the effect of Group for the Stimulus Type Voicing Contrast was also significantly larger than the group effect for Place of Articulation ($\beta = .894, p = .01$). The positive coefficient represents that Glaswegians had a higher likelihood of choosing Hindi as compared to Indians. This can be seen in Figure 2.18 (right-most panel).

2.4.8 Glaswegian English /g/

There were two responses each for Place of Articulation and Aspiration Stimulus Type, but four responses for Voicing Contrast Stimulus Type.Therefore, there were 8 responses per participant. Thus, 392 responses were made by Glaswegians and 384 by Indians. In total, there were 776 responses. The Place of Articulation condition compared GE /g/ with IE /g/ and Hindi /g/. The Aspiration condition compared GE /g/ with IE /g/ and Hindi /g^{h}/. The Voicing Contrast condition compared (1) GE /g/ with IE /k/ and Hindi /k/, and (2) GE /g/ with IE /k/ and Hindi /k^{h}/.

A logistic mixed model was fitted to predict Response Language as a function of Group (Glaswegian/ Indian) and Stimulus Type (Place of Articulation/ Aspiration/ Voicing Contrast) and the interaction between them.The random intercept of Participant was not included due to observance of singular fit which indicated an overfitted model. Table 2.12 presents the model summary and reports the coefficients and standard errors.

The simple effects of Group and Stimulus Type significantly improved the fit of the model over a null model when added separately (Group: ($X^2(1) = 9.07, p = .002$); Stimulus Type: ($X^2(2) = 27.19, p < .001$). Furthermore, adding the interaction term between Group and Stimulus Type significantly improved the fit of the model over and above the model with just main effects ($X^2(2) = 11.22, p = .003$).

The area under the ROC curve in Figure 2.19 shows that the model had weak discriminatory power (Concordance index C = .616). Nagelkerke pseudo-R^2 ($R^2 = .083$) indicates that the model had almost no predictive power.

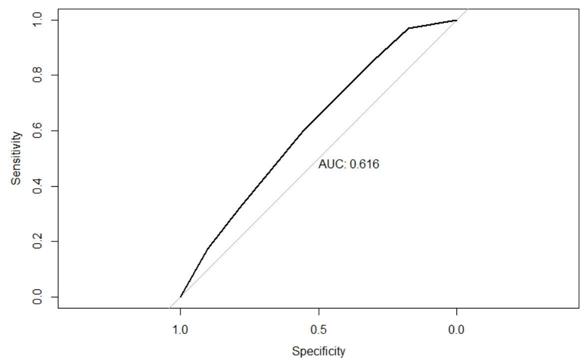


Figure 2.19: Area under the ROC curve for responses to Glaswegian English /g/

Table 2.12: Model summary for responses to Glaswegian English /g/

	Dependent variable:
	Response Language
Intercept	−0.249 (0.145)
Stimulus Type Aspiration	-1.332^{***} (0.259)
Stimulus Type Voicing Contrast	−0.312 (0.180)
Group Effect	−0.331 (0.290)
Group Effect:Stimulus Type Aspiration	-1.349^{**} (0.518)
Group Effect:Stimulus Type Voicing Contrast	0.142 (0.359)
Observations	776
Log Likelihood	−474.307
Akaike Inf. Crit.	960.614
Note:	*p<0.05; **p<0.01; ***p<0.001

Figure 2.20 visualises the interaction between Group and Stimulus Type in Table 2.12, where the error bars represent 95% confidence intervals.

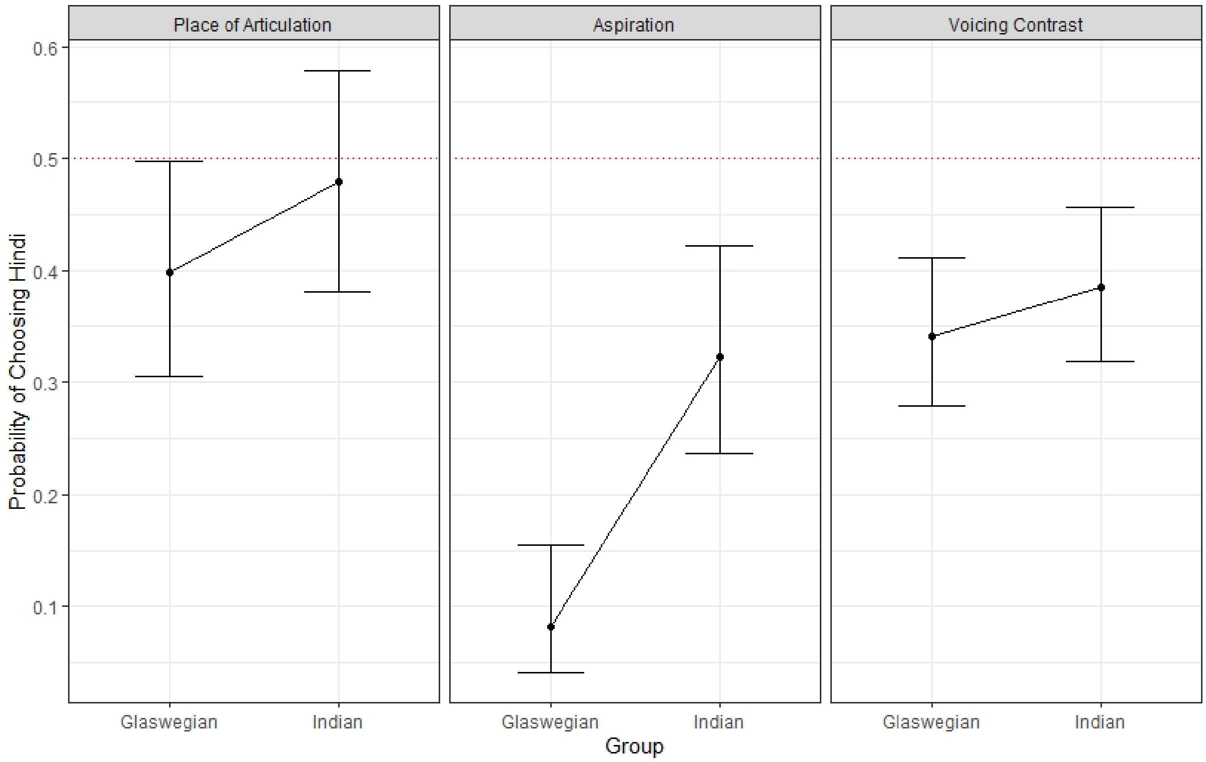


Figure 2.20: The effect of the interaction between Group and Stimulus Type on responses to Glaswegian English /g/ in Table 2.12. The y-axis represents probability.

The intercept for this model (Table 2.12) represents the grand mean of the log-odds for the two levels in Group for the Stimulus Type Place of Articulation. However, it is not significantly different from 0 ($\beta = -.249, p = .08$). This represents a similar likelihood of choosing IE or Hindi for the Stimulus Type Place of Articulation when averaged across Group. The simple effect of Stimulus Type Aspiration, on the other hand, was significantly different from Place of Articulation ($\beta = -1.332, p < .001$) with negative log-odds. This is to say that there was a stronger preference for IE over Hindi for the Stimulus Type Aspiration when averaged across the two groups. However, the simple effect of Stimulus Type Voicing Contrast was not significantly different relative to Place of Articulation ($\beta = -.312, p < .08$)[4].

Additionally, the effect of Group for the Stimulus Type Place of Articulation was not significantly different from 0 ($\beta = -.331, p = .25$). Both groups were similarly likely to choose IE or Hindi. This can also be seen in Figure 2.20 which depicts the probability for choosing Hindi over IE. In the left-most panel for Place of Articulation, the probability for both Glaswegians and Indians hovers around .5. However, the Group effect for the Stimulus Type Aspiration was significantly larger than the Group effect for Place of Articulation ($\beta = -1.349, p = .009$). The

[4]Since there was an insignificant negative coefficient for Place of Articulation, and an insignificant negative coefficient for Voicing Contrast, then, added together, those might result in the apparent overall preference for IE for Voicing Contrast. However, since models were not coded to test the effect of Voicing Contrast against 0, it cannot be concluded that this difference is significant without re-leveling and refitting the model, and that would introduce multiple comparison issues (Schad et al., 2020).

negative coefficient indicates that Glaswegians had a stronger preference for IE over Hindi as compared to Indians. Figure 2.20 shows this in the middle panel for Aspiration. Finally, the group effect for the Stimulus Type Voicing Contrast was not significantly larger from the Group effect for Place of Articulation ($\beta = .142, p = .69$).

2.5 Discussion

The purpose of the XAB Similarity Judgement Task was to determine whether IE is perceptually more similar to GE than Hindi. The findings have been summarised in Table 2.13.

Glaswegian English Sound	**Stimulus Type**	**Indians**	**Glaswegians**
/l/	-	Hindi = IE	Hindi = IE
/u/	-	Hindi >IE	Hindi = IE
/b/	PoA	Inconclusive	Inconclusive
	Aspiration	Inconclusive	Inconclusive
	Voicing Contrast	Inconclusive	Inconclusive
/d/	PoA	IE = Hindi	IE = Hindi
	Aspiration	IE >Hindi	IE >Hindi
	Voicing Contrast	IE = Hindi	IE = Hindi
/g/	PoA	IE = Hindi	IE = Hindi
	Aspiration	IE >Hindi	IE >Hindi
	Voicing Contrast	IE = Hindi	IE = Hindi
/p/	PoA	Inconclusive	Inconclusive
	Aspiration	Inconclusive	Inconclusive
	Voicing Contrast	Inconclusive	Inconclusive
/t/	PoA	IE = Hindi	IE >Hindi
	Aspiration	Hindi >IE	Hindi >IE
	Voicing Contrast	IE >Hindi	IE >Hindi
/k/	PoA	IE = Hindi	IE = Hindi
	Aspiration	IE = Hindi	Hindi >IE
	Voicing Contrast	IE = Hindi	Hindi >IE

Table 2.13: Table summarising which native language (Hindi or IE) was perceived to be perceptually more similar to GE by sound, and according to the two participant groups of Glaswegians and Indians

1. **Word-initial /l/:** Both groups (Indians and Glaswegians) had equal likelihood of choosing Hindi and IE as equally likely to GE. That is, both Hindi and IE were perceived to be equally perceptually similar to GE. Therefore, for this category, it is not expected that IE will receive more transfer from GE compared to Hindi.

2. **Word-medial /u/**: Indians had a higher likelihood of choosing Hindi as more similar to GE than IE, whereas Glaswegians had equal likelihood of choosing both Hindi or IE as more similar to GE. So, according to Indians, Hindi is more similar to GE, but according to Glaswegians both Hindi and IE are equally similar to IE. Importantly, the Hindi and IE options provided for this category included the GOOSE and FOOT vowels. Due to this, it cannot be said for sure if it was the GOOSE vowel or the FOOT vowel that contributed to the Indian results, or Glaswegian results for that matter. Nonetheless, as both options (GOOSE and FOOT) were available in both Hindi and IE, it was still the Hindi option that was perceived as perceptually more similar to GE. Based on this, more transfer from GE may be expected into Hindi than IE, based on the judgement from Indians.

3. **Word-initial /b/:** For this category, the results did not give information about the judgement of the two groups for each stimulus type. However, in general, both groups had a higher likelihood of perceiving IE as more similar to GE, than Hindi. While this is not very helpful, this may reflect higher perceptual similarity between GE and IE, and therefore, more transfer to IE than Hindi.

4. **Word-initial /d/:** For the Stimulus Type Place of Articulation and Voicing Contrast, both groups judged neither Hindi or IE as more similar to GE than the other. For Aspiration, however, both groups similarly judged IE as more similar to GE than Hindi. Like IE, GE word-initial /d/ is not aspirated. However, the Hindi option presented for the Aspiration trial was aspirated /d/ [d^h]. Therefore, this result seems to indicate higher sensitivity to cross-linguistic differences in VOT patterns in both groups rather than higher perceptual similarity across these native and host varieties. Based on these results for this category, it is not expected that IE will receive more transfer from GE as compared to Hindi according to either group.

   However, there is an aspect of this task which complicates the above conclusion. For this GE category, there was only one IE option ([ɖ]), but two Hindi options ([ɖ] and [d̪]), as shown in Table 2.4. So, the groups' responses could be subject to whether IE was judged as more similar to GE in relation to both Hindi [ɖ] *and* Hindi [d̪], or in relation to either Hindi [ɖ] or Hindi [d̪]. That is, it is possible for the results to be different if the Hindi options [ɖ] and [d̪] are analysed separately. So, the results for this category may be a consequence of this incongruency in number of options for each language instead of indicating higher perceptual similarity.

5. **Word-initial /g/:** The results for this category are the same as for /d/. For Stimulus Type Place of Articulation and Voicing Contrast, both groups similarly perceived Hindi and IE as equally similar to GE - neither native language being more similar to the other. For Aspiration, both groups chose IE as more similar to GE than Hindi, but Glaswegians more so than Indians. Thus, in line with the findings for /d/ for this Stimulus Type, both groups successfully matched the VOT patterns for this stop as well: unaspirated word-initial /g/ in IE with the unaspirated word-initial /g/ in GE. However, similar to /d/, it is not expected that IE will receive more transfer from GE as compared to Hindi.

6. **Word-initial /p/:** The results were inconclusive for this category.

7. **Word-initial /t/:** For the Stimulus Type Place of Articulation, Glaswegians judged IE as more similar to GE, but Indians judged both languages to be equally similar to GE. For Voicing Contrast, both groups judged IE as more similar to GE than Hindi. For Aspiration, both groups judged Hindi as more similar to GE than IE. This makes sense because the Hindi option provided for this stimuli type was aspirated /t/ [t^h] and the Glaswegian English option for this stimuli type, word-initial /t/, also has an aspirated realisation. This judgement from both groups indicates their higher sensitivity to VOT differences across the varieties (as it also did for word-initial /d/ and /g/), instead of perceptual similarity across the native and host varieties. In conclusion, based on the judgements for Place of Articulation and Voicing Contrast, IE may be expected to exhibit more transfer from GE than Hindi according to Glaswegians as well as Indians.

   But similar to /d/, in this case as well, there was one IE option, but two Hindi options ([ʈ] and [t̪], as seen in Table 2.4. These were not analysed separately and may have contributed to the results.

8. **Word-initial /k/:** For the Stimulus Type Place of Articulation, both groups were equally likely to judge neither Hindi nor IE as more similar to GE than the other. For the Stimulus Type Aspiration, Glaswegians had a stronger preference for Hindi as being more perceptually similar to GE. However, for Indians, the probability of choosing Hindi was lower than Glaswegians (.45 – even below .5). Like /t/, the voiceless stop /k/ is unaspirated in word-initial position in IE but aspirated in GE. The Hindi option provided for this Aspiration Stimulus Type trial was aspirated /k/ [k^h]. While Glaswegians successfully matched the aspirated categories, Indians did not. However, for word-initial /t/, both groups successfully chose Hindi as more similar to GE for this particular Stimulus Type. For Voicing

> Contrast, Glaswegians considered Hindi to be more similar to GE than IE but Indians considered both languages as equally similar for this stimulus type. So, while these results are quite divided, based on the judgements of Glaswegians, Hindi may be expected to undergo more transfer from GE. However, both /p/ and /k/ will not be examined in the speech production task to contain the extent of this thesis. So, unlike other phones, it won't be possible to observe whether the perceptual judgements aligned with the production results for these two voiceless stops.

For the stops, the Stimulus Type Place of Articulation represents the whole combination of cues associated with the respective phone category. The Stimulus Type Aspiration primarily represents the feature of positive VOT among other characteristics. The Stimulus Type Voicing Contrast primarily represents the contrast between voiced and voiceless stops for the same place of articulation (for example, VOT, pre-voicing, Relative Burst Intensity, closure duration, F0 contour, etc.).

The above findings highlight that across sounds as well as languages, there does not seem to be a specific pattern with respect to perceptual similarity, but a lot of variability. A more specific finding is that for some categories and stimuli type, the two groups differed in their judgement. This is the case for GE GOOSE vowel and GE /k/ for Aspiration and Voicing Contrast. While Indians judged Hindi GOOSE as more similar to the corresponding GE category, Glaswegians judged both Hindi and IE GOOSE counterparts as equally similar to the corresponding GE category. For Voicing Contrast, while Indians judged Hindi and IE /k/ as equally similar to the corresponding GE category, Glaswegians perceived Hindi /k/ as more perceptually similar to the corresponding GE category. This disagreement in judgement according to the two groups may reflect differences in how different features or cues are weighted ('cue weighting') in the native languages of either group (Flege & Bohn, 2021; Hauser, 2021), which has been shown by multiple studies. For example, native English monolinguals are known to use VOT as the primary cue when categorising word-initial stops as phonologically voiced or voiceless, making lesser use of F0 onset frequency (Whalen, Abramson, Lisker, & Mody, 1993), whereas in Korean, F0 is often the primary cue and VOT is often (but not always) a secondary cue. Similarly, in case of vowels, Flege and Bohn (2021:19-20) argue that English listeners use both spectral cues and duration to categorise English vowels – but greater weight is given to spectral cues than temporal cues (Nishi et al., 2008). In Swedish, however, for the categorisation of certain vowels, temporal cues are given greater weight than spectral cues. Similarly, S. Kim, Kim, and Cho (2018) showed that native English speakers made greater use of spectral than temporal cues in classifying English vowels whereas the reverse held true for the native Korean speakers. Interestingly, native Korean speakers made greater use of spectral cues over the course of the longitudinal study which indicates adaptation to the native English pattern of cue-weighting. This also shows that language users can shift their cue-weighting patterns with experience and training in a language with different weighting patterns (Francis, Kaganovich, & Driscoll-Huber, 2008; Lehet & Holt, 2017; Schertz, Cho, Lotto, & Warner, 2016). Using the ‘full-access hypothesis’, SLM-r argues that even late L2 learners have full-access to cues in the L2, that are not exploited in their L1 (Flege & Bohn, 2021). For example, Kong and Yoon (2013) showed that the Korean students that were more experienced in English reduced the use of F0, the primary cue in Korean, when perceiving stops in English, where F0 is a secondary cue. However, in case of the present study, due to the nature of this XAB judgement task, it is not possible to determine which perceptual cue the participants across the two groups were giving greater weight to to make their judgement. Therefore, it cannot be clearly said as to which cue is perceptually more similar across the native and host varieties here, based on which a specific prediction for transfer cannot be made.

Additionally, research also suggests that cue-weighting may not only differ across speakers with different native languages, but even individual speakers of the same L1 may also weight their L1 acoustic cues differently (Schmidt, 1996). Schmidt (1996) found that individual L1 Korean listeners differed in their judgement of how similar Korean and English consonants were. When listeners had enough acoustic cues to base their judgement on, their responses were quite consistent as a group. However, when there was a conflict between Korean and English cues, listeners selected cues or a set of cues to base their judgement on. This is how Schmidt (1996) explains the perception of English /θ/ as having a fricative element by some, a labial element by others, and a dental element by the rest of the Korean listeners. Similarly, it is possible that Indians weighted the cues of their Hindi or Indian English categories differently when their L1 cues conflicted with those of the corresponding Glaswegian English category. This could also be the case for Glaswegians.

The results of this task could also be influenced by its limitations. One such limitation is that only one speaker of each linguistic variety was recruited to provide the audio stimuli. This is potentially problematic for Hindi, Indian English and Glaswegian English as one speaker does not represent the actual population, especially when so much variability exists in these languages, especially in the case of Hindi and Indian English (Gargesh, 2008). The same can be the case for Indians who participated as listeners in this similarity judgement task, who must exhibit much inter-speaker variability based on the region of India that they live in and regional languages that they speak. This experiment did not collect this data from the participants to be able to account for this. While Hauser (2021) confirms that pre-voicing is a primary cue with higher weighting in Hindi, not much research exists on Indian English to confirm if Indian speakers do in fact show biases in cue-weighting.

In conclusion, the present chapter indicates that IE and GE are, in fact, not as perceptually similar as we might expect even though they are typologically more proximate as compared to Hindi and GE which are typologically more distant. This is the case when the target categories are presented to listeners in nonsensical monosyllables. The SLM and SLM-r (Flege, 1995b; Flege & Bohn, 2021) predict that perceptually similar L1-L2 categories are more susceptible to link together as diaphones and undergo transfer.

Thus, it seems that based on the present results, more transfer cannot be expected in Glaswasian Indian English, in general, as compared to their Hindi. However, predictions regarding the implications of this differential perceptual similarity across Hindi and Indian English across groups can still be made regarding backward transfer effects on these individual sound categories in production.

With respect to Indians' perceptual judgement, it appears that higher transfer from GE can be predicted to Hindi /u/ and IE /b/ and /t/. With respect to Glaswegians' perceptual judgement, it appears that higher transfer from GE can be predicted to IE /b/ and /t/. However, these predictions are quite tentative and may be subject to differences such as in cue weighting across the two participant groups and group members. Therefore, it remains to be seen in the next chapter if these predictions are confirmed in the speech production task.

Chapter 3

Speech Production Task

3.1 Introduction

Chapter 1 summarised the substantial evidence for phonological backward transfer and L1 phonetic accommodation in multiple language pairs and various speech communities. The discussion highlighted the various mechanisms which could lead second language acquisition and contact with another dialect to influence the phonology of speakers' native language or dialect. The previous chapter was directed at identifying whether for a given set of categories, Indian English was perceptually more similar to Glaswegian English than Hindi, for which mixed results were found. Now, it is the aim of the present study to examine whether backward transfer in production is different across languages and dialects, based on the situation of language contact between Hindi, Indian English and Glaswegian English exhibited by the bilingual Indian migrant community in Glasgow (Glaswasians). In that respect, the present chapter seeks to answer the following questions:

1. In Glaswasians, is there backward transfer of Glaswegian English on their native varieties of Indian English and Hindi in production?
2. Will Indian English receive more transfer from Glaswegian English as compared to Hindi?

Regarding the first research question, the predictions are based on the Speech Learning Model (SLM; Flege, 1995b) and revised Speech Learning Model (SLM-r; Flege & Bohn, 2021). The SLM and SLM-r (Flege, 1995b; Flege & Bohn, 2021) argue that L1 and L2 sounds exist in the same phonetic space, which allows them to interact and mutually influence each other. From the perspective of backward transfer, this interaction may result in changes due to the influence of the L2, which may manifest as assimilation or dissimilation. In the case of 'assimilation', Glaswasian native categories will become more Glaswegian-like, and in the case of 'dissimilation', Glaswasian native categories will exaggerate the native characteristics in order to contrast them from the similar Glaswegian categories. However, the native categories may also remain uninfluenced in face of Glaswegian English and resist assimilation or dissimilation. The specific predictions for each target phone category are laid out in detail later in their specific sections.

The motivation for the second question comes from the idea that mutually intelligible and structurally similar varieties influence each other (Rothman, 2010, 2013, 2015; Trudgill, 1986). Therefore, there may be more evidence of backward transfer of GE to IE, another variety of the same language, than to Hindi, a different language altogether. Along with this general idea, the predictions for this are also guided by the results of the XAB similarity judgement task (Chapter 2). The SLM and SLM-r (Flege, 1995b; Flege & Bohn, 2021) argue that perceptually similar L1-L2 categories are more susceptible to transfer effects. Therefore, if there is indeed more perceptual similarity between Glaswegian English and Indian English categories than between Glaswegian English and Hindi categories, then Indian English would be expected to undergo more transfer from Glaswegian English. However, the results from Chapter 2 do not indicate straightforward higher perceptual similarity between Indian English and Glaswegian English for all the phone categories and stimuli type (Place of Articulation, Aspiration and Voicing Contrast) that were examined. The results from the XAB task were divided such that of all the categories (/u/, /l/, /p/, /t/, /k/, /b/, /d/, /g/), on the one hand, only Indian English /b/ and /t/ were judged by both participant groups of the XAB task (Glaswegians and Indians) as perceptually more similar to the corresponding Glaswegian English categories. On the other hand, Hindi GOOSE vowel and /k/ was judged as more similar to the corresponding Glaswegian English category, and only by Indians. So, it is difficult to estimate the weight of this result in relation to backward transfer in Glaswasians. For the rest of the categories, both Indian English and Hindi were equally likely or unlikely to be judged as similar to Glaswegian English (for example, /l/, /d/, /g/) and the results were inconclusive for /p/. Therefore, it will be very interesting to examine if in the present task, Glaswasian production mirrors this pattern of perceptual similarity found in the XAB similarity judgement task by the two control groups.

Thus, the present chapter is aimed at better understanding the process of backward transfer in production: broadly, to determine whether these processes (assimilation, dissimilation, no change) are consistent across phonetic categories and their respective cues, and if a mutually intelligible variety can be expected to undergo more transfer than an entirely different language.

These questions were answered by carrying out a speech production task, which is the focus of the present chapter. Speech data was collected from three speaker groups - one experimental group (Glaswasians) and two control groups (‘Glaswegians’ and ‘Indians’) (§3.2.1). This data was then subjected to acoustic analysis and compared across groups. Backward transfer was examined in multiple sound categories for multiple cues: (1) word-initial lateral /l/ for F2-F1 difference, (2) word-initial voiceless stop /t/ for voice onset time (VOT), (3) word-initial voiced stops /b d g/ for VOT, voicing during closure (VCD) and relative burst intensity (RBI), and (4) word-medial GOOSE vowel for F1, F2, F3.

3.2 Methodology

3.2.1 Participants

Three groups of adult speakers were recruited for this study; one experimental group (Glaswasians) and two control groups (Glaswegians and Indians).

3.2.1.1 Experimental Group

3.2.1.1.1 Glasgow-Indians ('Glaswasians')

Thirty-eight Glaswasians were recruited: 7 males and 31 females. These Glaswasians are first-generation immigrant Indians in Glasgow. They had been living in Glasgow for at least three years at the time of data collection. Additionally, they speak Hindi and Indian English as their native languages and acquired both before coming to Glasgow.

These participants migrated from central, northern, north-western, western and eastern regions of India (as shown in Figure 3.1). Table 3.1 shows the Indian states where these Glaswasians used to reside prior to migrating to Glasgow.

Indian States of Residence	**Number of Glaswasians**
Uttarakhand	2
Punjab	11
Bihar	2
Uttar Pradesh	4
Bengal	1
Rajasthan	3
Gujarat	3
Madhya Pradesh	1
Maharashtra	7
New Delhi	4
Total	**38**

Table 3.1: Indian states of residence of Glaswasians prior to migration to Glasgow

Each of these states is represented by at least one dominant regional language (Bhatia, 2008), which these participants speak along with Hindi. These languages are: Garhwali, Punjabi, Bhojpuri, Bengali, Rajasthani, Malvi, Gujarati and Marathi.

The diversity of Indian immigrants in Glasgow meant that it was not possible to restrict all participants to those with identical regional language backgrounds. Therefore, I ensured that the Glaswasians' regional languages were, at a minimum, from the Indo-Aryan subgroup. This was done because the sound categories selected for investigation were those anticipated to be phonologically and phonetically similar to each across these Indo-Aryan regional languages. Only recruiting speakers of Indo-Aryan languages also made it possible to minimize the possibility of uncontrolled transfer effects from more dissimilar languages, such as the Dravidian languages spoken in South India.

The participants belong to a large age range (*min.* = 21, *max.* = 83, *mean* = 46.02, *SD* = 17.59; as age was one of the variables examined for its effect on backward transfer in the present study), but importantly, all are adults. Nine of these are elderly above the age of 67 and they did not participate in the psychometric tasks (in Chapter IV). The Glaswasians' reported occupations are HR consultant, restaurant manager, IT analyst, software engineer, restaurant owner, property manager/language interpreter, business analyst, software engineer, IT, accountant, business owner, researcher, analyst, research support staff, full-time PhD student, Bachelors' student, laboratory assistant, beautician, and the nine elderly Glaswasians had retired from their jobs. Furthermore, of the total (non-elderly) twenty-three females, five of them are homemakers, two of them are students at the University and the rest are all working professionals. All seven males are working professionals. While this may give an indication about the gender roles now, these are not as strictly defined as they were for the first immigrants back in 1920s. Previously, the arrival of women back in 1900s was as dependents. They were restricted to the domestic sphere, whereas the men worked and interacted with the host society. Today, women are arriving on their own and the majority of them are working professionals. Moreover, even as homemakers, they are involved in the upbringing of their young children in Glasgow, which involves interacting with the host community.

The Glasgow Hindu Temple was targeted for data collection and advertisements were shared on social media platforms related to it. Also, there are multiple groups on Facebook and Whatsapp created specifically for members of this community. Advertisements were shared on these platforms, in addition to reaching out to Indian societies at the University of Glasgow and the University of Strathclyde. Members of the community that I was previously acquainted with were also contacted.

Figure 3.1: The map of India showing the states in India where Glaswasians migrated from (Google Maps, 2023)

3.2.1.2 Control Groups

To determine backward transfer in Glaswasians, two control groups were recruited for comparison. These groups provided the baselines of the native realisations in Glaswegian English, and Indian English and Hindi.

3.2.1.2.1 Glaswegians

In Glasgow, two varieties of English are spoken: Glasgow Standard English (GSE), which is the Glaswegian form of Standard Scottish English (SSE), spoken by most middle class speakers, and Glasgow Vernacular (GV), spoken by most working class speakers (Stuart-Smith, 1999). Socially-stratified differences exist between these two varieties. For example, the GOOSE vowel is fronter in GV than in GSE (Stuart-Smith, 1999). In the current study, however, the recruited 'Glaswegians' comprised speakers of GSE only, which controls for this variation based on social class (Stuart-Smith, 1999).

In the present study, Glaswegian English acts as the 'host' language and dialect of English that the Glaswasians are dominantly exposed to after arriving in Glasgow. Thirty-four speakers of Glaswegian English were recruited: 10 males, 2 non-binary and 22 females. These participants belong to a large age range (*min.* = 18, *max.* = 69, *mean* = 32.3, *SD* = 14.4), and all are adults. The majority of these participants are monolinguals ($n = 26$) and have never lived abroad for a short or long term ($n = 27$).

Glaswegians were recruited by advertising on various University of Glasgow-related mailing lists, and posting on social media platforms like Facebook and Yammer.

3.2.1.2.2 Indians

'Indians' comprised native speakers of Hindi and Indian English, which is the variety of English which is spoken in India. These speakers use Hindi and Indian English to communicate in their daily life, and they have never had any contact with Glaswegian English. Thirty-one Indians were recruited: 12 males and 19 females. Furthermore, these participants belonged to a large age range (*min.* = 18, *max.* = 62, *mean* = 31.32, *SD* = 9.76), and all are adults. They reside in central, northern, north-western, western regions of India (as shown in Figure 3.2). Table 3.2 shows Indian states where these Indian participants reside. Each state is represented by a dominant regional language and like Glaswasians, participants in this group also speak these regional languages as their native language along with Hindi. These languages are: Punjabi, Haryanvi, Rajasthani, Malvi, Gujarati, Odia, Sindhi, Konkani and Marathi. In addition to this, some participants may also speak more than one regional Indo-Aryan language (usually due to situations of internal migration within India).

Indian States of Residence	**Number of Indians**
Uttarakhand	2
Punjab	1
Haryana	1
Rajasthan	7

Indian States of Residence	**Number of Indians**
Gujarat	15
Madhya Pradesh	2
Maharashtra	1
New Delhi	2
Total	**31**

Table 3.2: Indian states of residence of Indians

Importantly, Indian English is a blanket term that is used to cover the variation that exists in the English that is spoken in India (Gargesh, 2008). The source of this variation is the fact that the English spoken in any region of India is strongly influenced by the regional languages spoken in that area. These regional linguistic differences contribute to regional phonological variation in English spoken in India. Therefore, there may be subtle phonological differences in the IE spoken by Indian speakers. However, as a response to this complex case of linguistic contact, I ensured that, like with Glaswasians, only those speakers were recruited who spoke Indo-Aryan regional languages and the phonetic features under investigation were expected to show minimal differences as a result of regional L3 Indic language background.

Additionally, there is an inconsistency in the number of speakers within the Glaswasian and Indian groups who reside or used to reside in the same Indian states (Table 3.3) and speak the same regional languages. Initially, I planned that the demographics of each Glaswasian speaker would be matched with the demographics of one speaker from each control group to form a triad of speakers with similar demographics, for comparison across groups. For example, a Glaswasian speaker of age 34, gender female, who migrated from Rajasthan and spoke Rajasthani as a regional language, was to be matched with an Indian control speaker with the same profile (age 34, gender female, resides in Rajasthan, speaks Rajasthani as a regional language) and a Glaswegian control speaker with a similar profile (age 34, gender female). This was planned to control for demographics-based variation and transfer effects. However, due to the COVID-19 pandemic, data collection had to be shifted online and due to constraints related to time and recruiting participants, this approach was dropped.

Figure 3.2: The map of India showing the states in which 'Indians' reside (Google Maps, 2023)

Table 3.3: Number of Glaswasian and Indian speakers originating from a given Indian state

Indian State	**Total in Glaswasian Group**	**Total in Indian Group**
Bihar	2	-
Bengal	1	-
Gujarat	3	15
Haryana	-	1
Madhya Pradesh	1	2
Maharashtra	7	1
New Delhi	4	2
Punjab	11	1
Rajasthan	3	7
Uttarakhand	2	2
Uttar Pradesh	4	-
Total	38	31

3.2.2 Target Phone Categories

Multiple phone categories (and one or more phonetic features for each phone category) were examined in the present study. These are:

1. **Word-initial lateral /l/:**
    (a) F2-F1 difference
2. **Word-medial GOOSE vowel /u/:**
    (a) F1
    (b) F2
    (c) F3
3. **Word-initial voiced stops /b d g/:**
    (a) Voice Onset Time (VOT)
    (b) Voicing During Closure (VDC)
    (c) Relative Burst Intensity (RBI)
4. **Word-initial voiceless stop /t/:**
    (a) VOT

The following sub-sections discuss each phonetic category and respective phonetic features separately with respect to their articulatory and acoustic background, realisations in Glaswegian English (GE), Indian English (IE) and Hindi, and previous research on the phone category and feature as observed in the South-Asian population in the UK. Finally, I offer predictions for each phone category and phonetic feature in relation to the possibilities of assimilation or dissimilation as proposed by the Speech Learning Model (SLM; Flege, 1995b) and revised Speech Learning Model (SLM-r; Flege & Bohn, 2021).

3.2.2.1 Word-initial Lateral /l/

3.2.2.1.1 Articulatory and Acoustic Background

The two allophones of the alveolar lateral relevant to this study are ‘clear’ and ‘dark’ /l/. When the tip/blade of the tongue touches the alveolar ridge and the tongue body is also raised, the sound produced is a ‘clear’ or ‘light’ alveolar /l/ (Hayward, 2000; Ladefoged & Johnson, 2014; Recasens, 2004). The lateral /l/ is ‘dark’ when for the same primary articulation, the tongue body is raised towards the velum, that is, it is velarized [ɫ] (Hayward, 2000; Ladefoged & Johnson, 2014; Recasens, 2004; Simonet, 2010). Dark /l/ typically shows a lower second formant (F2) (Hayward, 2000; Recasens, 2004) and higher first formant (F1) as compared to clear /l/ which has higher F2 and lower F1. In terms of F2-F1 difference then, darker /l/ should have smaller F2-F1 difference as compared to clearer /l/, which should have larger F2-F1 difference.

3.2.2.1.2 Realisation of /l/ across GE, IE and Hindi

In Glasgow Standard English (GSE), which is the variety used by the Glaswegians in the present study, the lateral is realised as [ɫ] in all word positions (Stuart-Smith, 2004; Wells, 1982), but it is comparatively less dark than the realisation in Glasgow Vernacular (GV) (Stuart-Smith, 1999). In any case, the dark /l/ in GSE has been shown to have a very low F2 (Stuart-Smith, Timmins, & Alam, 2011), and therefore, I anticipate Glaswegians to show a small F2-F1 difference. However, Hindi and IE only have clear /l/ in all word-positions (Gargesh, 2008; Wells, 1982), and therefore, both are expected to have larger F2-F1 difference than GE.

3.2.2.1.3 Previous Research on /l/ in British-Asians in the UK

Some previous research exists on /l/ in ethnic accents of second, third and further generations of speakers of heritage languages in the UK. Stuart-Smith et al. (2011) examined the quality of word-initial /l/ in second-generation English-dominant Punjabi bilingual and English-dominant Punjabi/Urdu trilingual Glaswasians. They found that the Glaswasian word-initial /l/ was acoustically clearer than Glaswegian word-initial /l/ but still much darker than other varieties of English (like RP). This was evidence of the integration of Glaswegian and Indian-heritage phonetic features being exploited as hybrid identity markers for second-generation Glaswasians, as opposed to instances of transfer. Furthermore, Kirkham (2017) compared the characteristics of /l/ in second-generation British-Asian English and Anglo-British English adolescents in Sheffield. He also found that in Asian-English, /l/ was clearer in word-initial and medial position and darker in word-final position.

There is one study that examined /l/ in first-generation heritage speakers directly. McCarthy, Evans, and Mahon (2011) carried out auditory and acoustic investigation of /l/ in first- and second- generation members of the London-Bengali community who originated in Bangladesh and speak Sylheti as their heritage language. Within first-generation speakers, they separately examined early and late arrivals in London; ‘early’ arrivals migrated to London before the age of 16, whereas ‘late’ arrivals migrated to London after the age of 16. Both groups acquired English after migrating to London. The authors found that second-generation speakers of Sylheti and SSBE controls had darker and more retracted variants of /l/ as compared to both first-generation groups and Sylheti controls. Interestingly, early first-generation /l/ was not different from late first-generation /l/ and Sylheti control /l/ - they all showed clearer /l/.

In sum, some research exists on South-Asian ethnolinguistic minorities in the UK on /l/ (also Kirkham & McCarthy, 2021 on English-Sylheti bilingual children), but it is focused on this feature as an ethnolectal marker in second, third and so on generations. Whatever is known about first-generation speakers is either as a kind of by-product of this focus on 2$^{\text{nd}}$ and 3$^{\text{rd}}$ generation speakers, or is rather sparse. Furthermore, the kind of transfer in McCarthy’s (2011) first-generation speakers would be very different from the backward transfer in first-generation Glaswasians in the present study. McCarthy’s (2011) first-generation speakers continued learning English as a second language after arriving in London, whereas the first-generation Glaswasians in the present study finished acquiring English before migrating to the host country, often simultaneously with Hindi, and also learnt it from their original community. Therefore, in my M.Sc. thesis (Shaktawat, 2018a), I examined first-generation Glasgow-Indians (‘Glaswasians’; drawn from the same community as the present study) for their production of /l/ to examine backward transfer from Glaswegian English on their native dialect and language, Indian English and Hindi. F2-F1 difference was examined. I found that in English, Glaswasians had smaller F2-F1 difference as compared to the Indian control group. This smaller F2-F1 difference is representative of darker /l/ which is found in Glaswegian English. Therefore, in English, Glaswasian /l/ became more Glaswegian-like or underwent assimilation. On the other hand, in Hindi, Glaswasians developed larger F2-F1 difference, hence clearer /l/, than Indian controls. Thus, Glaswasians exaggerated the native characteristic of clarity in /l/ so much, that it became non-native like, or underwent dissimilation.

The present study will allow to investigate if this pattern is repeated with a different and larger group of Glaswasians. Also, Glaswegians have also been added as a second control group to provide the baselines for GE /l/.

3.2.2.1.4 Specific predictions for backward transfer for word-initial /l/

In the current study, which analyses word-initial /l/, in the case of assimilation, for their Hindi and IE, Glaswasians will show darker /l/ than Indians (in direction of Glaswegian English). Since dark /l/ has higher F1 and lower F2 than clear /l/, assimilation to dark /l/ will emerge in the form of a smaller F2-F1 difference in Glaswasians compared to Indians. In the case of dissimilation, Glaswasians will show clearer /l/ than Indians by exhibiting larger F2-F1 difference than Indians in order to dissimilate or contrast it from the darker /l/ in Glaswegian English. Finally, if there is no backward transfer, then Glaswasians will have the same F2-F1 difference as Indians because the category will remain uninfluenced.

As per the results of the XAB task, both Indian English and Hindi /l/ were judged as equally perceptually similar to Glaswegian English /l/ by both Glaswegians and Indians. Therefore, both Indian English and Hindi are predicted to be equally susceptible to transfer from Glaswegian English, and are expected to show similar direction and amount of transfer from GE in F2-F1 difference.

3.2.2.2 Word-medial GOOSE Vowel

What is important to the present discussion is that Scottish English only has GOOSE vowel in its inventory which is realised as [ʉ] (Stuart-Smith, 1999, 2004), whereas Indian English (IE) typically shows both GOOSE and FOOT in its inventory which are realised as /u/ and /ʊ/ respectively (Gargesh, 2008). Hindi also maintains a phonemic contrast between /u/ and /ʊ/ (Ohala, 1994). It is the GOOSE vowel that is of concern in the present study, not FOOT.

3.2.2.2.1 Articulatory and Acoustic Background

Vowels are sonorants that are produced when air from the lungs flows out without any obstruction (Hayward, 2000; Ladefoged & Johnson, 2014; Ogden, 2017). The Source-Filter theory (Hayward, 2000) explains that the complex waves generated due to the action of the vibrating vocal folds are shaped by the vocal tract which acts as the filter. There is a different vocal tract configuration each with a characteristic resonance curve and resonance for every vowel sound which lends each vowel its particular quality and distinguishes it from others (Hayward, 2000). Vowels are defined with respect to three dimensions: the position of the highest point of the tongue, the height to which it is raised and the shape of the lips with respect to rounding, that is, rounded or un-rounded (Ogden, 2017). As the present study is concerned with the GOOSE vowel, with respect to the above three dimensions, depending upon regional variation, this vowel is defined as high, (fairly) back and rounded.

In terms of acoustics of vowels, according to Ogden (2017), a simple correspondence is said to exist between tongue height, and frontness and backness, and the relative positions of the formants F1 and F2. That is, F2 is positively correlated with auditory frontness and backness, and F1 is inversely correlated with auditory vowel height. However, research on vocal tract modelling, articulatory and acoustic comparisons of the GOOSE vowel has shown that F1 and (especially) F2 (Fant, 2004) is also influenced by position of the lips (Lawson, Stuart-Smith, & Rodger, 2019; B. E. F. Lindblom & Sundberg, 1971; Stevens, 2000; Stevens & House, 1955). Furthermore, much research has found that different vocal tract configurations can be employed to produce the formant frequencies associated with the GOOSE vowel (Harrington, Kleber, & Reubold, 2011; Lawson et al., 2019; Stevens & House, 1955). For example, Lawson et al. (2019) found high F2 values in both Anglo-English and Scottish English suggesting acoustically fronter GOOSE vowels. However, the former achieved this by a backer tongue-body position and lip protrusion, while the latter by smaller degree of lip-protrusion and fronter tongue-body position. In conclusion, a safer assumption can be made about the inverse correlation between F1 and tongue-body height as compared to that for F2 and tongue-body frontness.

The case for F3 is similar to that of F2. It is generally assumed that F3 is indicative of the shape of the lips (lip rounding) (Fant, 1971; Stevens, 2000), that is, lip rounding lowers the F3. However, this is not as straightforward because the influence of lip rounding varies also according to where in the vocal tract the primary constriction is (B. E. F. Lindblom & Sundberg, 1971). Thus, it seems unlikely that lip rounding has a corresponding independent acoustic dimension (Hayward, 2000).

3.2.2.2.2 Realisation of GOOSE across GE, IE and Hindi

The GOOSE vowel in IE as well as Hindi is realised as a high, fully-back vowel with well-rounded lips (Gargesh, 2008; Maxwell & Fletcher, 2009; Wiltshire & Harnsberger, 2006). Biswas, Sahu, Bhowmick, and Chandra (2014) reported the average F1 and F2 frequencies of Hindi GOOSE vowel as 190, and 817 Hz respectively.

According to Lawson et al. (2019), Stuart-Smith (2004) and Wells (1982), Scottish English GOOSE vowel is realised as a mid-high, central-front vowel [ʉ], with weakly-protruded or neutral lip position and a fronted tongue body. Importantly, in the GSE variety of Glaswegian English, which is of concern here, GOOSE has a backer realisation than in the GV variety. Ferragne and Pellegrino (2010) reported the median F1 and F2 values of the GOOSE vowel in GE as 345 and 1751 Hz respectively.

The differences in reported F1 and F2 values across Hindi (Biswas et al., 2014) and GE (Ferragne & Pellegrino, 2010) seem to confirm the differences in vowel height and frontness/backness across these varieties. F1 is higher in GE as reported by Ferragne and Pellegrino (2010) (345 Hz) compared to the F1 reported by Biswas et al. (2014) in Hindi (190 Hz). In light of the inverse relationship between height and F1, Hindi GOOSE indeed seems to have a higher realisation than GE GOOSE. Not only this, F2 in GE as reported by Ferragne and Pellegrino (2010) (1751 Hz) is higher than the F2 reported by Biswas et al. (2014) in Hindi (817 Hz). In light of the positive relationship between F2 and frontness and backness, the higher F2 in GE seems to confirm the fronted realisation in GE as compared to a backer realisation in Hindi.

3.2.2.2.3 Previous Research on GOOSE in British-Asians in the UK

As was the case with /l/, most research on GOOSE in British-Asians has been in relation to its use as an ethnolectal marker in second, third and so forth generations (Alam, 2015; Evans, Mistry, & Moreiras, 2007; McCarthy, Evans, & Mahon, 2013; McCarthy et al., 2011).

The GOOSE vowel was another phone category that I examined in my M.Sc. thesis on first-generation immigrant bilingual Indians in Glasgow (Shaktawat, 2018a). Three features were examined: F1, F2, F3. Glaswasians were found to have higher F1 and so a more open vowel than Indian controls, but only in Hindi. This was interpreted as indicative of dissimilation in Hindi /u/ in Glaswasians. However, there was no difference in English /u/ for F1. For F2, Glaswasians were found to have higher F2, therefore, a fronter vowel than Indian controls in Hindi as well as English. This was taken as an instance of assimilation of F2, in the form of vowel fronting, in both languages. Finally, for F3, Glaswasians had higher F3 than Indian controls in both Hindi and English which was taken as instance of assimilation in Glaswasian /u/ for F3 in both languages.

The current study will investigate if the above patterns of backward transfer in Shaktawat (2018a) were stable enough to be replicated with a different and larger group of first-generation Glaswasians, and with an additional control group, Glaswegians.

3.2.2.2.4 Specific predictions for backward transfer for word-medial GOOSE

As mentioned above, GE GOOSE has a mid-high realisation, whereas in Hindi and IE, GOOSE is realised as a high vowel. Lowered F1 indicates higher tongue-body position (a closer vowel), whilst larger F1 values are related to lower tongue-body position (a more open vowel). So, the difference between the control groups should be visible in higher F1 in Glaswegians and lower F1 in Indians. In the case of assimilation, Glaswasians will have Glaswegian-like lower vowel height reflected in higher F1 than Indian controls. In the case of dissimilation, Glaswasians will have higher vowel height reflected in lower F1 than Indian controls. If there is no transfer, then Glaswasians will have similar F1 values as Indian controls.

Furthermore, GE GOOSE has a fronter realisation (comparatively backer in GSE than GV) than Hindi and IE, in which GOOSE has a fully-back realisation. Higher F2 indicates fronter realisation, whereas lower F2 is indicative of a backer realisation. So, the difference between the control groups should be visible in higher F2 in Glaswegians and lower F2 in Indians. In the case of assimilation, Glaswasians will have Glaswegian-like fronted realisation reflected in higher F2 than Indian controls. In the case of dissimilation, Glaswasians will have a backer realisation reflected in lower F2 than Indian controls. If there is no transfer, then Glaswasians will have similar F2 values as Indian controls.

Only a general prediction has been made for F3 in relation to the possibilities of transfer. In case of assimilation, Glaswasians will have Glaswegian-like F3 values, significantly different from the Indian control. In case of dissimilation, Glaswasians will have more extreme F3 values than Indians, in the opposite direction from Glaswegians. If there is no transfer, then Glaswasians will have similar F3 values as the Indian control group.

As informed by the results of the XAB similarity judgement task (Chapter 2), Indian English GOOSE vowel was not found to be perceptually more similar than Hindi GOOSE to the corresponding Glaswegian English category by either Glaswegians or Indians. Instead, of these two groups, Indians found Hindi GOOSE to be perceptually more similar to the corresponding Glaswegian English category, whereas Glaswegians found Hindi and Indian English categories to be equally similar. In this light, Hindi GOOSE vowel may show higher transfer effects, but Indian English GOOSE vowel is certainly not expected to show higher transfer effects than Hindi.

3.2.2.3 Word-initial Voiced Stops /b d g/

In relation to the voiced stops /b d g/, this study examined three measures: Voice Onset Time (VOT), Voicing During Closure (VDC) and Relative Burst Intensity (RBI). Based on previous research, these measures are known to differ cross-linguistically across these three word-initial voiced stops in Hindi, Indian English (L1s) and Glaswegian English (L2), and therefore will be informative in examining the backward transfer of Glaswegian English on Hindi and Indian English. Additionally, these measures are also useful in distinguishing various places of articulation of the respective stops.

3.2.2.3.1 Articulatory and Acoustic Background

The voiced stops /b d g/ are present in all three linguistic varieties of concern here, but as part of different stop series, as discussed in §3.2.2.3.2.

These stops or ‘plosives’ are produced with a complete closure in the oral tract (at bilabial place of articulation for /b/, coronal place of articulation for /d/ and dorsal place of articulation for /g/) with the velum raised to prevent the air from flowing out through the nasal cavity (Ladefoged & Johnson, 2014; Ogden, 2017). There are three phases associated with the production of a stop: the closure phase, the hold phase and release (Ogden, 2017). During the closure phase, the two articulators are brought together to form a closure which prevents the air from flowing out through the vocal tract. This is followed by the hold phase, during which the pressure of the trapped air builds up due to the complete closure of the vocal tract, which is then released during the release phase with an audible burst as the pressure of the trapped air is higher than that of the air outside (Ogden, 2017).

Previous research has reported some cues to distinguish between these three voiced stops /b d g/ according to their places of articulation. Three such cues have been selected for examination in the present study because they are also known to differ cross-linguistically across the linguistic varieties of relevance here, that is, Glaswegian English, Indian English, Hindi (discussed in detail in §3.2.2.3.2).

The first cue is called Voice Onset Time (VOT) which has primarily and prominently been used to distinguish between these voiced stops not only within languages, but also cross-linguistically (Lisker, 1986; Lisker & Abramson, 1964). VOT is defined as the duration from the release of the stop closure to the onset of voicing for the following segment. Positive VOT is a measure of the delay in voicing onset after the release of the closure and the beginning of the following vowel. Stops with positive VOT are said to show voicing 'lag' and have a VOT value greater than zero (Davis, 1994; Lisker & Abramson, 1964). Voiced stops (which are of concern in this section) are known to exhibit a 'short lag', characterised by a small delay between the burst release and onset of voicing (typically found in English voiced stops or voiceless unaspirated stops). Furthermore, VOT in voiced stops has been found to differ by place of articulation to reflect the following pattern: labial < coronal < dorsal, such that VOT values increase as the place of articulation moves further back (Cho & Ladefoged, 1999; Chodroff & Wilson, 2018; Docherty, 1992; Sonderegger, Stuart-Smith, Knowles, Macdonald, & Rathcke, 2020; Stuart-Smith, Sonderegger, Rathcke, & Macdonald, 2015).

The second cue of concern to the present study, which is also known to vary by place of articulation in these voiced stops is Voicing During Closure (VDC). It is also important to the present study because it is known to differ cross-linguistically across Glaswegian English and the native varieties (Indian English and Hindi) (Davis, 1994; Hauser, 2021; Sonderegger et al., 2020; Stuart-Smith et al., 2015) (discussed in detail in §3.2.2.3.2). In addition to having a positive short-lag VOT, voiced stops are sometimes also characterised by presence of full or partial voicing during the closure phase (Hayward, 2000; Ladefoged & Johnson, 2014; Ogden, 2017). The duration between the initiation of voicing *during* the closure phase of the stop and the release of the burst is called Negative VOT or 'voicing lead' (Davis, 1994; Lisker & Abramson, 1964). VDC is related to pre-voicing, but unlike pre-voicing, it is measured in relation to the duration of the closure, represented in terms of percentage, or as binary categorisations (Davidson, 2016; Sonderegger et al., 2020). It is VDC which is the measure relevant to the present study. VDC across /b d g/ is also known to vary by place of articulation such that full VDC (continuous voicing throughout the entire duration of the stop closure) is more likely in labial than velar stops (Hussain, 2018; Sonderegger et al., 2020).

The final cue of concern to the present study is Relative Burst Intensity (RBI; Kirkham, 2011; Stoel-Gammon, Williams, & Buder, 1994; Sundara, 2005; Sundara, Polka, & Baum, 2006) which is also helpful not only in distinguishing /b d g/ by their place of articulation (Repp, 1984) but is also known to vary cross-linguistically (Jongman, Blumstein, & Lahiri, 1985; Stoel-Gammon et al., 1994; Sundara, 2005) (discussed in detail in §3.2.2.3.2 with reference to GE, IE and Hindi). RBI is the spectral amplitude, or loudness, of the stop burst, calculated relative to the intensity of the following vowel (Sundara, 2005; Sundara et al., 2006). RBI in voiced stops has also been shown to distinguish the different places of articulation (Bush, Stevens, & Blumstein, 1976; Jongman et al., 1985; Ohde & Stevens, 1983; Repp, 1984). Sundara (2005) highlights a relationship between VOT and burst intensity based on the aerodynamic consequences of a stop closure. Specifically, stops with longer closure duration will also have a greater build-up of oral pressure, which results in louder bursts. Thus, in context of the present study, a pattern for RBI can be expected across /b d g/ such that /b/ has higher RBI than /d/ and /g/ which have comparatively smaller closure duration (Repp, 1984).

3.2.2.3.2 Realisation of /b d g/ across GE, IE and Hindi

The voiced stops /b d g/ are present in the phonological systems of all three varieties of concern here, but differ substantially with respect to their role in the phonological stop series of each variety.

On the one hand, GE has a two-way voicing contrast at three places of articulation: bilabial (/p b/), denti-alveolar (/t d/) and velar (/k g/) (Stuart-Smith, 2004). On the other hand, Hindi has a four-way system of contrast at four places of articulation: bilabial (/p p^{h} b b^{h}/), dental (t̪ t̪^{h} d̪ d̪^{h}/), retroflex (/ ʈ ʈ^{h} ɖ ɖ^{h}/) and velar (/k k^{h} g g^{h}/) (Davis, 1994; Ohala, 2014b; Singh & Tiwari, 2016). Like GE, IE also has a two-way voicing contrast at three places of articulation, but as it is influenced by Hindi (and other Indian regional languages), the denti-alveolar stops are replaced by retroflex stops (Gargesh, 2008). So then, what is recognised as a denti-alveolar voiced or voiceless stop in GE, is realised as a retroflex voiced or voiceless stop in IE ([ʈ] or [ɖ]). The present study, however, is concerned with possible transfer related to fine phonetic detail in these three word-initial voiced stops /b d g/ for three measures: Voice Onset Time (VOT), Voicing During Closure (VDC) and Relative Burst Intensity (RBI).

1. **Voice Onset Time (VOT)**:

   Table 3.4 presents previous findings on short-lag positive VOT in Glaswegian English and other Indic languages including Hindi.

Study	**Speech Type**	**Language**	**Stop/s**	**Short-lag Positive VOT**
Stuart-Smith et al. (2015)	Spontaneous	Glaswegian English	/b d g/	15.5 ms
			/b/	10 ms
			/d/	20 ms (approx.)
			/g/	30 ms (approx.)
Sonderegger et al. (2020)	Spontaneous	Glaswegian English	/b d g/	18 ms

Davis (1994)	Isolated Words	Hindi	/g/	11.58 ms
Schertz and Khan (2020)	Isolated Words	Hindi/Urdu	/b/	∼12.5 ms (approx.)
Dmitrieva and Dutta (2020)	Isolated words	Marathi	/g/	29.8 ms
Poon and Mateer (1985)	Isolated words	Nepali	/b/	5.99 ms
			/g/	26.79 ms

Table 3.4: Short-lag positive 'VOT' across Glaswegian English and Indic languages including Hindi

Stuart-Smith et al. (2015) examined short-lag positive VOT in voiced and voiceless word-initial stops in the Glasgow Vernacular (GV) accent of Glaswegian English. The voiced stops averaged at 15.5 ms of VOT: 10 ms in /b/, approximately 20 ms in /d/ and approximately 30 ms in /g/. In another study (Sonderegger et al., 2020), the mean VOT for Glaswegian English voiced stops was reported to be 18 ms. Importantly, the accent of Glaswegian English that the recruited Glaswegians in the present study speak is Glasgow Standard English (GSE) which is known to exhibit longer VOT than GV (Stuart-Smith, 1999). Therefore, the GE VOT values in the present study may be longer in comparison with Stuart-Smith et al. (2015) and Sonderegger et al. (2020).

Based on her examination of Hindi velar stops, Davis (1994) reported that all four Hindi velar stops (/k k^h g g^h/) could be distinguished from each other based on differences in 'lag' time alone. The average short-lag VOT for /g/ was reported as 11.58 ms, which is smaller than the VOT reported by Stuart-Smith et al. (2015) for /g/. This could indicate differences in VOT across Glaswegian English and Hindi, at least for /g/. This difference in VOT for /g/ between Glaswegian English and Hindi is exaggerated if one considers that Stuart-Smith et al. (2015) and Sonderegger et al. (2020) reported values for spontaneous speech which could have further shortened their VOT (Kessinger & Blumstein, 1998; Stuart-Smith et al., 2015). More recently, Schertz and Khan (2020) reported short-lag VOT for /b/ in speakers of Urdu/Hindi to be around 12.5 ms. Remember that VOT values are known to increase as the place of articulation moves further back (Cho & Ladefoged, 1999). So, when the reported VOT for Hindi /b/ (Schertz & Khan, 2020) and /g/ by Davis (1994) are compared, this pattern is opposite. Considering that the VOT for /g/ was reported in 1994 (Davis, 1994), it is possible that it has since undergone change and become longer as indicated by the available VOT for /g/, not in Hindi, but another similar Indo-Aryan language spoken in India, Marathi (29.8 ms; Dmitrieva & Dutta, 2020).

Not much research has reported short-lag VOT values in Indian English. However, previous research agrees that it is strongly influenced by the Indic languages (Gargesh, 2008; Sirsa & Redford, 2013; Wells, 1982). Therefore, one can expect short-lag VOT across Indian English /b d g/ to be similar to that of Hindi /b d g/, and therefore shorter than VOT across Glaswegian English /b d g/.

2. **Voicing During Closure (VDC)**:

   In addition to VOT, Sonderegger et al. (2020) also examined 'Voicing During Closure' (VDC) in spontaneous speech of Glasgow Vernacular (GV) speakers. The authors reported that 56.8 % of word-initial voiced stops did not have any VDC, and partial and full VDC was found for 12.6 % and 30.6 % of voiced stops, respectively.

   Word-initial Hindi voiced stops, on the contrary, are reported to be fully voiced during the stop closure (Davis, 1994; Lisker & Abramson, 1964; Pruitt, Jenkins, & Strange, 2006; Schertz & Khan, 2020) and have been shown to exhibit much less variability for the same (Hauser, 2021). Hauser (2021) found that with respect to the three categorisations of VDC ('none', 'partial' and 'full' voicing during closure), all Hindi speakers consistently had 'full' VDC for the majority of phonologically voiced stops across the three places of articulation as compared to speakers of American English who were more likely to exhibit much variability and 'partial' VDC.

   Compared to VDC, much more research exists on voicing lead or pre-voicing (voicing that starts during the closure and continues until the release burst) on Hindi and Indian English stops. While pre-voicing as a measure has not been examined in the present study, the evidence on it supports that Indic voiced stops are highly pre-voiced as well. This is shown in Table 3.5.

Study	**Speech Type**	**Language**	**Stop/s**	**Pre-voicing**
Lisker and Abramson (1964)	(Isolated Words/ Within Sentences)	Hindi	/b/	-85 ms/-89 ms
			/d/	-76 ms/-74 ms
			/g/	-63 ms/-47 ms
Benguerel and Bhatia (1980)	CV Syllabic Utterance	Hindi	/b/	-136.67 ms
			/g/	-133.33 ms
Poon and Mateer (1985)	Isolated Words	Nepali	/b/	-78.51 ms
			/g/	-67.55 ms
Shimizu (1989)	Monosyllabic Isolated Words	Hindi	/b/	-96 ms
			/g/	-121 ms
Davis (1994)	Isolated Words	Hindi	/g/	-89.3ms
Hussain (2018)	Nonsense CV Words	Punjabi	/b/	-106 ms
			/d/	-109 ms

			/g/	-95 ms
		Urdu	/b/	-94 ms
			/d/	-117 ms
			/g/	-85 ms
Dmitrieva and Dutta (2020)	Isolated Words	Marathi	/g/	-87.9 ms
Wiltshire and Harnsberger (2006)	(Isolated Words, Within Sentences)	Gujarati English	/b/	-86 ms
		Tamil English	/b/	-97 ms
Wiltshire and Sarmah (2021)	Wordlist	Assamese English	/b d g/	-100 ms

Table 3.5: Pre-voicing across Glaswegian English, varieties of Indian English and Indic languages including Hindi

In the studies on pre-voicing, the influence of Indic languages on Indian English pre-voicing patterns is visible as IE voiced stops show pre-voicing patterns similar to other Indic voiced stops (Wiltshire & Harnsberger, 2006; Wiltshire & Sarmah, 2021).

3. **Relative Burst Intensity (RBI)**:

Finally, the last cue to be examined in the voiced stops is Relative Burst Intensity (RBI). In a small-scale study (Shaktawat, 2018b) on 2nd and 3rd generation Pakistani heritage speakers of Punjabi and Urdu in Glasgow, I observed that native Glaswegian English speakers had less intense bursts than Glaswasians whose English was influenced by Urdu/Punjabi. This triggered my interest in examining RBI in the present study. Prior to Shaktawat (2018b), Kirkham (2011) examined RBI in British-Asians (in Sheffield) in coronal stops /t/ and /d/, where British-Asian /t/, but not /d/, was found to be have greater burst intensity than the British English counterpart.

3.2.2.3.3 Previous Research on /b d g/ in British-Asians in the UK

1. **Voice Onset Time (VOT)**:

Like /l/ and /u/, much research on voiced stops in South-Asian communities is focused on 2nd and 3rd generation speakers whose phonetic characteristics exhibit an integration of host and heritage features (Heselwood & McChrystal, 1999; Kirkham, 2011; McCarthy et al., 2013).

An investigation of L1 in 1st generation immigrants comes from Heselwood and McChrystal (1999) as a by-product of the focus on 2nd generation speakers. Additionally, this investigation focuses on pre-voicing which is a measure that is not examined in the present study. Heselwood and McChrystal (1999) examined Punjabi voiced stops, as produced by 1^{st} and 2^{nd} generation speakers of Punjabi, who acquired the language in Pakistan and Bradford respectively, and lived in Bradford (UK). The authors found that compared to 1^{st} generation adults and 2^{nd} generation adults (aged 25 and above) who showed pre-voicing in 93.5 % of the voiced tokens, 2^{nd} generation younger speakers (age 11-22) pre-voiced only 42.2 % of their stops. This decrease in pre-voicing in Punjabi voiced stops is taken as the result of influence from the majority host language in Bradford, English. However, this decrease in pre-voicing in 2^{nd} generation speakers is unlikely to be an instance of backward transfer, but that of integration of Bradford and Pakistani-heritage features to create a hybrid identity marker in younger 2^{nd} generation speakers (Alam, 2015; Stuart-Smith et al., 2015).

Another piece of research on VOT in Sylheti-English voiced stops in first-generation immigrants comes from McCarthy et al. (2013). In a study on first- and second- generation members of the London-Bengali community who originated in Bangladesh, speak Sylheti as a heritage language and acquired English after coming to London, McCarthy et al. (2013) found a general pattern for VOT in both languages with respect to transfer: across all voiced stops, first-generation early arrivals and second-generation speakers' VOT aligned with that of SSBE speakers, whereas first-generation late arrivals aligned with Sylheti controls in their VOT. This is a case of assimilation in first-generation early arrivals, but not in first-generation late arrivals. Furthermore, in first-generation early speakers, while there was an effect of SSBE on Sylheti VOT patterns, it was their English production patterns that were very similar to SSBE controls. This could indicate that for early arrivals, English underwent more transfer from SSBE than Sylheti. However, it is to be noted that the English acquired by this community was after arrival in London and from native speakers of SSBE. This is different to the case of Glaswasians in the present study, who knew English before coming to Glasgow, certainly taught by a member of the Indian community.

Finally, as part of my M.Sc. thesis (Shaktawat, 2018a), I examined pre-voicing as a cue for backward transfer from Glaswegian English to Hindi and Indian English in 1^{st} generation immigrant Indians in Glasgow. Unlike the present study, Shaktawat (2018a) examined pre-voicing, not VDC. In any case, the results indicated that Glaswasians did not differ in pre-voicing from the Indian control group for any of the three voiced stops (/b d g/) in Hindi or Indian English.

2. **Relative Burst Intensity (RBI)**: The only instance of investigation of RBI in South-Asian speakers in the UK comes from Kirkham (2011), who examined RBI in /d/ in 2^{nd} generation speakers of British-Asian English, but did not find it to be different from that in British English speakers. In addition to the observed difference between Glaswegian and

Glaswasian stops for RBI (Shaktawat, 2018b), this lack on research on RBI motivated me to also examine RBI in voiced stops /b d g/ in addition to pre-voicing for backward transfer from Glaswegian English to Hindi and Indian English in my M.Sc. thesis (Shaktawat, 2018a) in the same population of 1st generation immigrant Indians in Glasgow. The results showed that all Glaswasians produced all three stops in Hindi with significantly lower RBI than the Indian control group. Thus, Glaswasian voiced stops in Hindi had developed more Glaswegian-like quieter stop bursts, which is indicative of backward transfer in terms of assimilation. By contrast, in English, /b/ and /g/ had similar RBI as the Indian control group; /d/ however showed significantly lower RBI in Glaswasians as compared to Indians. This was, again, indicative of assimilation. Interestingly, Hindi seemed to have undergone more transfer than Indian English.

The present study provides a wonderful opportunity to examine these three measures with a bigger and different South-Asian group of 1st generation Indians in Glasgow, with baseline values from Glaswegian English guiding the interpretation.

3.2.2.3.4 Specific predictions for backward transfer for word-initial /b d g/

1. **VOT**: Based on previous research, I argue that Hindi and Indian English word-initial voiced stops /b d g/ have shorter VOT than Glaswegian English voiced stops. Therefore, in the case of assimilation, for their Hindi and Indian English, Glaswasians will show longer VOT than Indians, in direction of relatively longer (but still pretty short) Glaswegian English VOT. In the case of dissimilation, Glaswasians will show shorter VOT than Indians, in a direction opposite to Glaswegian English VOT to maintain a contrast with it. Finally, if there is no backward transfer, then Glaswasians will have similar VOT values across the word-initial voiced stops /b d g/ as Indians.

2. **Voicing During Closure (VDC)**: With respect to this measure, previous research seems to confirm that both Hindi and Indian English have fully voiced stop closures as compared to Glaswegian English (Hauser, 2021; Sonderegger et al., 2020). Therefore, in case of assimilation, Glaswasians will show lower percentage of VDC than Indians (in direction of Glaswegians). In case of dissimilation, Glaswasians will show higher percentage of VDC than Indians. If there is no transfer, then Glaswasians will have similar VDC patterns across the voiced stops as Indians.

3. **Relative Burst Intensity (RBI)**: Based on the research discussed above, Hindi and Indian English are likely to show higher RBI than Glaswegian English. Therefore, in case of assimilation, Glaswasians will show lower RBI than Indians (in direction of Glaswegians). However, in case of dissimilation, Glaswasians will show higher RBI than Indians to contrast it from the lower RBI in GE. If there is no transfer, then Glaswasians will have the same RBI as Indians.

Additionally, the results of the XAB similarity judgement task (Chapter 2) showed that, in general, only Indian English /b/ of the three voiced stops, was judged to be perceptually more similar to the Glaswegian English counterpart in general, by both Glaswegians and Indians. The other Indian English stops /d/ and /g/ were judged as equally similar to the Hindi counterparts in their perceptual similarity to Glaswegian English. Therefore, of the three Indian English voiced stops /b d g/, higher transfer from Glaswegian English is only predicted for /b/.

3.2.2.4 Word-initial Voiceless Stop /t/

In terms of voiceless stops, the present study is only concerned with /t/ and the phonetic cue of VOT.

3.2.2.4.1 Articulatory and Acoustic Background, and Realisation of /t/ across GE, IE and Hindi

As discussed in §3.2.2.3.2, /t/ has a denti-alveolar realisation in GE (Stuart-Smith et al., 2015). Hindi phonology exhibits a phonemic contrast between dental and retroflex stops (Davis, 1994; Ohala, 2014b; Singh & Tiwari, 2016), and influenced by it, a retroflex stop is used for Indian English /t/ (Awan & Stine, 2011; Gargesh, 2008; Wiltshire & Harnsberger, 2006). Ohala (1991) argued that retroflex stops are perceptually closer to alveolar stops than dental stops, which is why Indian English uses the retroflex stop in place of alveolar stop instead of a dental stop, even though Indian languages have both dental and retroflex stops.

The present study is concerned with possible transfer related to fine phonetic detail in positive VOT. In addition to short-lag VOT, positive VOT can also be ‘long lag’, characterised by a longer delay between burst release and onset of voicing (as generally found in English voiceless aspirated stops). Table 3.6 presents the findings from previous research on VOT in /t/ across Glaswegian English, Indian English and Hindi.

Study	Speech Type	Language	Stop/s	Pre-voicing
Stuart-Smith et al. (2015)	Spontaneous Speech	Glaswegian English	/p t k/	46.5 ms
			/t/	70-80 ms (approx.)
Sonderegger et al. (2020)	Spontaneous Speech	Glaswegian English	/p t k/	50 ms
Lisker and Abramson (1964)	(Isolated Words/ Within Sentences)	Hindi	/p t k/	13 ms
			/t/	9 ms
Benguerel and Bhatia (1980)	CV Syllabic Utterance	Hindi	/t/	15.24 ms
Ohala and Ohala (1992)	Wordlist	Hindi	/t/	∼10 ms

Hauser (2016)	Wordlist	Hindi	/p t k/	20.43 ms
			/t/	11.25 ms
Hussain et. al (2017)	Isolated Disyllabic Words	Punjabi	/t/	15 ms
Das and Hansen (2004)	Monosyllabic Isolated Words	Indian English	/t/	28.58 ms
Wiltshire and Harnsberger (2006)	(Isolated Words, Within Sentences)	Gujarati English	/t/	16 ms
		Tamil English	/t/	38 ms
Awan and Stine (2011)	Continuous Speech	Indian English	/t/	36.02 ms
		American English		86.63 ms

Table 3.6: Reported lag VOT across Glaswegian English, Indian English and Hindi in /t/ and /p t k/ in previous research

In word-initial position, GE /t/ is aspirated, which is reflected in longer lag/positive VOT (Sonderegger et al., 2020). Stuart-Smith et al. (2015) examined voiceless stops in GE and reported an average VOT of 46.5 ms across the voiceless stops /p t k/, where /t/ alone was found to have a VOT of approximately 60 to 70 ms. In another study (Sonderegger et al., 2020), the average VOT across GE voiceless stops was reported to be 50 ms. By contrast, in both Hindi and IE, /t/ remains unaspirated and has short-lag positive VOT. This is because aspiration is contrastive in Hindi (that is, the stops / t̪/ and /t̪^{h}/ are separate phonemes in Hindi). This short-lag nature of VOT in Hindi /t/ is confirmed by various studies over the years (Benguerel & Bhatia, 1980; Hauser, 2016; Lisker & Abramson, 1964; Ohala & Ohala, 1992) (Table 3.6), and when compared with VOT for /t/ in Glaswegian English, there is no denying that Hindi VOT for /t/ is much shorter than the VOT reported for Glaswegian English /t/ (Sonderegger et al., 2020; Stuart-Smith et al., 2015).

When compared to Hindi VOT for /t/, Indian English VOT seems longer (Awan & Stine, 2011; Das & Hansen, 2004; Wiltshire & Harnsberger, 2006) (Table 3.6), but nonetheless, much shorter than the VOT for /t/ in Glaswegian English. So, the pattern for VOT for /t/ across Glaswegian English, Indian English and Hindi appears to be *Glaswegian English* > *Indian English* > *Hindi*. Wiltshire and Harnsberger (2006) report short-lag VOT in /t/ for Gujarati English speakers (16 ms). This is attributed to the fact that in Gujarati (like Hindi), aspiration is contrastive which leads to unaspirated stops in IE. This is contrasted from Tamil English speakers for whom aspiration is not contrastive. They were found to aspirate their word-initial /t/ stop and had a VOT of 38 ms. This illustrates one of the differences between Indo-Aryan and Dravidian languages, which is why only speakers of Indo-Aryan languages were recruited in this study to avoid misinterpreting the differences between these two type of languages as transfer effects.

3.2.2.4.2 Previous Research on /t/ in British-Asians in the UK

Again, similar to the above phone categories, much research on /t/ in terms of VOT comes from studies primarily examining second and so forth generation South-Asian communities in the UK (Heselwood & McChrystal, 1999; Kirkham, 2011; McCarthy et al., 2013).

Along with the voiced stop /d/, Heselwood and McChrystal (1999) also examined the voiceless stops in Punjabi as produced by 1st and 2nd generation speakers of Punjabi. The results indicated no difference in VOT for the voiceless stops between any of the speaker groups, who rather maintained a clear-contrast between their Punjabi aspirated and unaspirated voiceless stops. This, importantly, is evidence of no backward transfer in 1st generation speakers on their L1 Punjabi VOT in /t/.

McCarthy et al. (2013) also examined VOT in voiceless stops in Sylheti and English spoken by first generation members of the London-Bengali community who originated in Bangladesh and acquired English after coming to London. The first-generation speakers were further divided into two groups: early (arrived before the age of 16) and late (arrived after the age of 16) arrivals in London. For VOT in /t/ in Sylheti, first-generation late speakers had shorter VOT like Sylheti controls, whereas first-generation early speakers had longer VOT like second-generation and native SSBE speakers. This is evidence of backward transfer (assimilation) in first-generation early speakers, but not in first-generation late speakers.

Thus, previous research has indicated instances of assimilation in first-generation speakers, which was modulated by age of entry in the host country (McCarthy et al., 2013). The present study will add to this knowledge for /t/ by examining a new ethnolinguistic minority community of first-generation Indians in Glasgow, who speak Hindi and Indian English as their native languages.

3.2.2.4.3 Specific predictions for backward transfer for word-initial /t/

With respect to previous research, one can claim comfortably that GE /t/ has longer VOT than Hindi and IE /t/. Thus, in case of assimilation, in both Hindi and Indian English, Glaswasians will show longer VOT than Indians (in direction of Glaswegians). In case of dissimilation, Glaswasians will show shorter VOT than Indians in both Hindi and Indian English, to dissimilate or contrast it from the longer VOT in Glaswegians. Finally, if there is no backward transfer, then Glaswasians will have same VOT as Indians.

Furthermore, the results of the XAB task (Chapter 2) showed that according to Glaswegians and Indians, Indian English /t/ was judged as perceptually more similar to the corresponding Glaswegian English category than Hindi /t/. Therefore, higher transfer from Glaswegian English is predicted in Indian English for VOT in /t/, which should be manifested in the form of longer VOT in Indian English than Hindi.

3.2.3 Stimuli

Glaswasians and Indians were recorded reading two sentence-lists in English and Hindi, and Glaswegians were recorded reading the sentence-list in English only (refer to Appendix E for English sentence-lists and Appendix F for Hindi sentence-lists). The carrier sentence for the English word-list was *Say* _____ *again* and for the Hindi wordlist was /kəhaː _____ aːpneʔ/. It can be translated as "Did you say _____?". The target consonants occurred in word-initial position, followed by a vowel. The target vowel occurred in word-medial position surrounded by consonants. There were ten words per target sound. The target words were a mix monosyllabic and disyllabic because there were not enough monosyllabic words, especially in Hindi (so more monosyllabic words in English than in Hindi). In English disyllabic words, the target sound always occurred in the stressed syllable. However, this was not controlled for in Hindi words. Therefore, there may be implications of the stress pattern differences for temporal measures in Hindi, that have not been taken into account. Additionally, the effects of lexical frequency have not been controlled for.

Target words were chosen to keep the contextual phonetic variability to a minimum across GE, IE and Hindi by matching the context in which the target phones occurred in English and Hindi wordlists. This applied to the vowel following the word-initial target consonants /l/ (Figure 3.3 for stimuli words by language), /b d g/ (Figure 3.5 for stimuli words by language), /t/ (Figure 3.4 for stimuli words by language). Thus, out of the 10 words for /l/, in five words, the vowel following the target is realised as the FACE vowel in English and /e/ in Hindi (Gargesh, 2008; Ohala, 2014b; Stuart-Smith, 2004). As there were not enough words in Hindi with the following vowel as /e/, a different set of vowels was used for the next 5 words such that in Hindi, the following vowel is realised as /ə/ (Ohala, 2014b), and in English, it is realised as the CUT vowel. Research on Indian English indicates that the distinction between /ə/ and /ʌ/ may not be clear. Sailaja (2012) argues that /ʌ/ is either absent or realised in variation with /ə/ in Indian English, whereas Wells (1982) reports no difference between the vowels /ə/ and /ʌ/. The CIEFL (Central Institute of English and Foreign Languages) vowel inventory of Indian English (1972) did not include /ʌ/, but /ə/ instead. For the rest of the target consonants (/t b d g/), the same vowel sets were used but with four words with /e/ or FACE vowel and six words with /ə/-/ʌ/ vowels. In the acoustic analysis, in terms of vowel height, all words with the /e/-FACE vowels were classified as 'high', and all words with /ə/-/ʌ/ were classified as 'non-high'. This is shown in Table 3.7.

Word-Initial Target	Following Vowel/ Categorised Vowel Height	Vowel Height	English Wordlist	Hindi Wordlist (With IPA)
/l/	FACE (in English) /e/ (in Hindi)	High	late	लेखन /lekʰən/
			lame	लेप /lep/
			lace	लेटना /let̪na:/
			lake	लेख /lekʰ/
			lazy	लेपना /lepna:/
	CUT (in English) /ə/ (in Hindi)	Non High	luck	लय /ləj/
			love	लघु /ləgʰʊ/
			lust	लता /lət̪a:/
			lucky	लहर /ləhər/
			luggage	लगा /ləga:/

Figure 3.3: Word stimuli for word-initial target /l/ by Language

Word-Initial Target	Following Vowel/ Categorised Vowel Height	Vowel Height	English Wordlist	Hindi Wordlist (With IPA)
/t/	FACE (in English) /e/ (in Hindi)	High	tail	टेढ़ा /t̪ed̪ʰa:/
			tape	टेका /t̪eka:/
			tame	टेकना /t̪ekna:/
			taste	टेसू /t̪esu:/
	cut (in English) /ə/ (in Hindi)	Non High	tug	टर /t̪ər/
			tuck	टसर /t̪əsər/
			tummy	टपका /t̪əpka:/
			tub	टका /t̪əka:/
			tough	टहल /t̪əhəl/
			ton	टकना /t̪əkna:/

Figure 3.4: Word stimuli for word-initial target /t/ by Language

Word-Initial Target	Following Vowel/ Categorised Vowel Height	Vowel Height	English Wordlist	Hindi Wordlist (With IPA)
/b/	FACE (in English) /e/ (in Hindi)	High	bait	बेल /bel/
			bail	बेच /beʧ/
			bake	बेटा /beʈa:/
			bane	बेर /ber/
	CUT (in English) /ə/ (in Hindi)	Non High	buck	बल /bəl/
			bun	बता /bət̪a:/
			bug	बढ़ा /bəd̪ʰa:/
			bud	बह /bəh/
			bus	बजा /bəʤa:/
			buzz	बना /bəna:/
/ɖ/	FACE (in English) /e/ (in Hindi)	High	date	डेरा /ɖera:/
			dame	डेढ़ /ɖeɖʰ:/
			days	डेचकी /ɖeʧki/
			dane	डेल /ɖel/
	CUT (in English) /ə/ (in Hindi)	Non High	duck	डस /ɖəs/
			dumb	डफली /ɖəfli:/
			dug	डटा /ɖəʈna:/
			dub	डमरू /ɖəmru:/
			dull	डर /ɖər/
			does	डगर /ɖəgər/
/g/	FACE (in English) /e/ (in Hindi)	High	gate	गेरू /geru:/
			game	गेती /get̪i:/
			gape	गेला /gela:/
			gaze	गेरुआ /gerʊa:/
	CUT (in English) /ə/ (in Hindi)	Non High	gum	गज /gəʤ/
			gun	गई /gəi:/
			gut	गरम /gərəm/
			gulf	गत /gət̪/
			gust	गति /gət̪i/
			gull	गया /gəja:/

Figure 3.5: Word stimuli for word-initial targets /b ɖ g/ by Language

For the word-medial GOOSE vowel, only the segment preceding the word-medial target was matched across Hindi and English words (see Figure 3.6 for stimuli words for this target by language). This is because it was hard to control for the preceding as well as following segment for every word across English and Hindi. In the present analysis the effect of the segment following the target vowel has not been controlled for, but it will be accounted for in later publications.

Word-Medial Target	English Wordlist	Hindi Wordlist
GOOSE (in English) /u:/(in Hindi)	boot	बूता /bu:t̪a:/
	goose	घूस /gʰu:s/
	moon	मूक /mu:k/
	choose	चूहा /ʧu:ha:/
	suit	सूखा /su:kʰa/
	loop	लूट /lu:ʈ/
	tool	टूट /tu:ʈ/
	cool	कूदा /ku:d̪a:/
	food	फूल /pʰu:l/
	doom	डूबा /ɖu:ba:/

Figure 3.6: Word stimuli for word-medial GOOSE (/u/ in Hindi) by Language

Vowel Height	Following Vowel	
	Realisation in Hindi	Realisation in English
High	/e/	FACE
Non High	/ə/	CUT

Table 3.7: Classification of vowels following the target word-initial consonants as ‘High’ or ‘Non High’

3.2.4 Task Procedure

The University of Glasgow College of Arts Ethics Committee granted the ethical clearance for data collection using this task, which was designed and hosted online on LaBB-CAT Speech Elicitation Tool (Fromont & Hay, 2012). Upon entering the link to the task in their browser, the participants were prompted to plug in their speech recording equipment (headphones or microphones or earphones), and allow the software permission to record their audio. After granting the permission and ticking informed consent box, a set of instructions were presented on the screen which directed the participants to read out the sentences showed on the screen slowly and as clearly as possible into their microphone (however, not everyone followed this instruction, resulting in some variation in speech rate). The participants then hit the ‘continue’ button to proceed to the trials. In each trial, a set of five sentences was showed on the screen at once and the participants were given thirty seconds to finish reading them out into their microphones. They had the ability to move to the next trial if they had read out all the five sentences before thirty seconds. Glaswasians and Indians were first presented the English sentence-list, followed by the Hindi sentence-list. Glaswegians were only presented the English sentence-list. On the last trial, participants had to press on ‘Finish’ to end the task and upload the audio files to LaBB-CAT.

In recent years, there has been much discussion around the quality of speech data collected remotely over various online platforms using various recording devices, particularly in relation to the reliability of acoustic measures for comparison across speakers. Sanker et al. (2021) summarise two different sources of variation in remotely recorded audio. First is acoustic signal manipulation. This includes compressing audio files for space-effective storage (Rathcke, Stuart-Smith, Torsney, & Harrington, 2017; Sanker et al., 2021), presence of non-speech artifacts in the recordings and differences in sampling rate. Sanker et al. (2021) reported audio compression to be influencing duration and formant measures. Other research has also reported effects of file compression on spectral properties (De Decker & Nycz, 2011; Rozborski, 2007; Van Son, 2005), and F1 and F2 measures in vowels (De Decker & Nycz, 2011) in video and audio recordings. LaBB-CAT's Elicit Speech Tool records all audio as 16kHz mono WAV files. Therefore, all recordings have the same sampling rate, and all remain uncompressed. So, compression is unlikely to be a big issue in the present study.

The second source of variation involves differences in types of recording devices or conditions related to issues of shielding, ambient noise and microphone placement. Much research has shown that increased noise levels can make the formants appear less clearly defined or faint and also interfere with spectral characteristics (De Decker & Nycz, 2011; Rathcke et al., 2017; Sanker et al., 2021; Svec & Granqvist, 2010). LaBB-CAT itself does not control for such factors, and no special processing has been carried out to try to rectify these. Therefore, there may be variability in the quality of recordings as participants in this study have used their own devices and microphones, which have different frequency responses, and were placed at varying distances, and recordings were made in different setups for each participant. Such interference can ultimately lead to discrepancies in formant extraction (Rathcke et al., 2017). To a certain extent, some of this extra variation, will be taken care of in the statistical modelling (by adding a random intercept for Speaker). There were also multiple instances of non-speech click-like artifacts that could have been caused by equipment noise or poor shielding. These were especially problematic when directly imposed on the part of the audio signal that was being measured, for example, on the burst of the stop which was used to measure burst intensity. Such tokens were discarded from the analysis.

Additionally, although their results suggest relatively little overall difference between recording devices (such as Zoom H4N recorder, Mac computer, iPad, iPhone and android phone) for most measurements, Sanker et al. (2021) reported that the F2 measures especially for /u/ were very high for some device conditions. Therefore, there may be implications for F2 measurements of the GOOSE vowel in this study, though the extent of it may not be as wide. This is because, the majority of Glaswasian participants used a computer equipped with an external audio recording device (n = 35), whereas two Glaswasians used android mobile phones and one used an iPhone (based on the data collected by the online platform Gorilla Experiment Builder). Though all Indians and Glaswegians were also advised to use their computers, there is no way to quantify how many participants used which device for these two control groups since they did not use Gorilla Experiment Builder as none of their tasks were hosted on it. Furthermore, as Sanker et al. (2021) only examined vowels, it is not clear if F2 measures of other types of segments such as laterals may also be susceptible to this device-related variability.

Another measure that is susceptible to these effects is burst intensity. Even though burst intensity of the stop in this study is calculated relative to the following vowel, this does not resolve across-speaker differences that may be caused by differing noise levels. In such cases, all tokens with high noise levels were discarded from the analysis.

In conclusion, while there is a possibility of remote audio recording affecting the quality of speech data, it was taken care of to certain extents by the means discussed above. Additionally, tokens with suspiciously high or low formant values, as provided by the PRAAT script, were hand-corrected for F1 and F2 in /l/, and F1, F2, F3 in /u/.

3.2.5 Data Analysis

The recorded speech data was acoustically analysed in two steps. First the audio files were annotated in PRAAT (Boersma and Weenink, 2020) with segment boundaries positioned according to acoustic landmarks on both waveform and spectrogram as described in the section below. After this, a PRAAT script was run on these annotations to extract the chosen phonetic measures for each phone: (1) F1, F2, F3 for vowel /u/, (2) F1 and F2 for /l/ and the difference between them (F2-F1), (3) Voice Onset Time (VOT), Voicing During Closure (VDC) and Relative Burst Intensity (RBI) for the voiced stops /b d g/, and (4) VOT for the voiceless stop /t/. After extracting the above data, it was subjected to statistical analysis in R (Version 3.6.3; R Core Team, 2020) in R Studio (Version 2023.03.0; Posit team, 2023).

3.2.5.1 Annotation: PRAAT

Each target was hand-segmented by a careful examination of the waveform and the spectrogram, following the standard phonetic protocols for each segment (Turk, Nakai, & Sugahara, 2006). Four tiers were created– ‘word’, ‘phone’ and ‘feature’ and ‘voicing’, which were used according to the relevant phonetic category and acoustic feature.

3.2.5.1.1 Word-initial lateral /l/: F2-F1 Difference

For /l/, the onset/offset of the lateral was marked by the beginning/ending of a visually steady F2 (after Carter & Local, 2007 and Nance, 2013). The entire duration of the steady state of the lateral was coded as ‘l’ in the ‘phone’ tier (Figure 3.7). For each token, the script was designed to capture the value of formants F1 and F2 at three time points: (1) 25 percent into the lateral, (2) 50 percent into the lateral, and (3) 75 percent into the lateral. Using these values at three time points, mean F1 and F2 values for that token were calculated. Finally, F2-F1 difference for that token was calculated in two steps. First, mean F2-F1 difference was determined at three points (25 percent, 50 percent, 75 percent into the lateral) using the mean F1 and F2 formant values determined above at the three time points. Second, using these three mean F2-F1 difference values at the three time points, a final mean **F2-F1 Difference** value was calculated, which forms the dependent variable for this phone category of /l/. Suspiciously high or low F1, F2, F2-F1 difference values (as suggested by previous literature) were manually checked and hand-corrected.

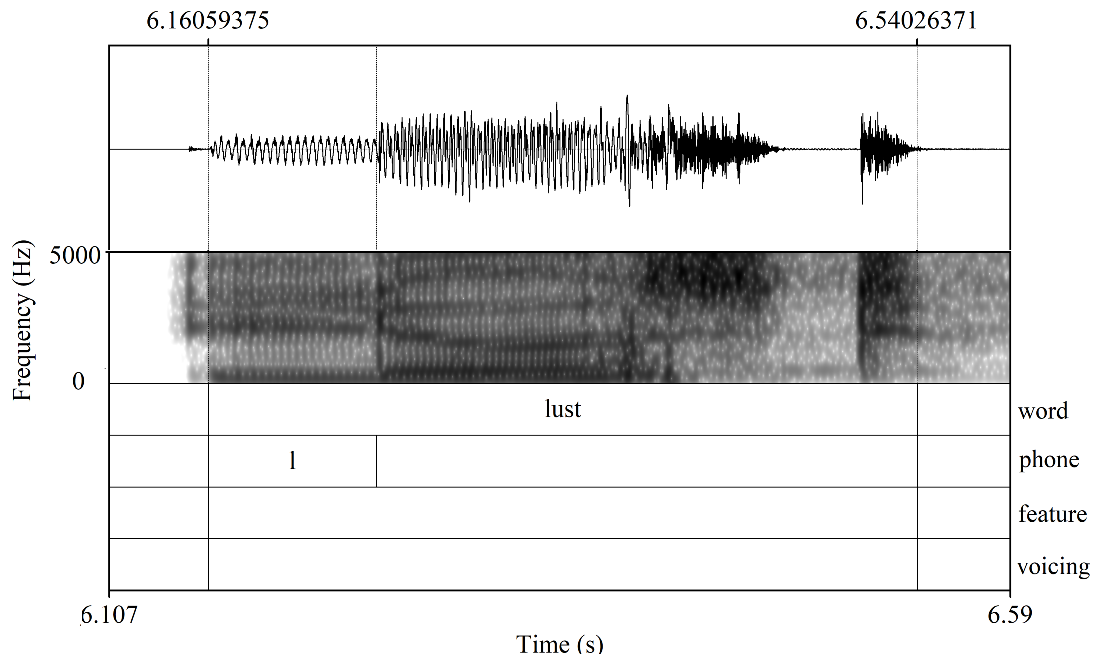


Figure 3.7: Annotation of word-initial /l/ in the word ‘lust’ as spoken by a female speaker from the ‘Indian’ control group

3.2.5.1.2 Word-medial GOOSE Vowel: F1, F2, F3

Similar to /l/, the onset/offset of the vowel was marked by the beginning/ending of a visually steady F2 (after Turk et al., 2006). For the script to be able to estimate F1, F2 and F3 for the vowel, the entire steady state of the vowel was segmented and coded as ‘u’ in the ‘phone’ tier as shown in Figure 3.8. The script was designed to capture the value of formants F1, F2 and F3 at three time points: (1) 25 percent into the vowel, (2) 50 percent into the vowel, and (3) 75 percent into the vowel. Using these values at three time points, mean F1, F2 and F3 values were calculated. Ideally, these values should have been normalised in order to account for variation in formant resonances due to differences in the dimensions of vocal tracts across speakers. In this case, bark-metric difference could have been useful, as only vowel /u/ measures were taken. However, after normalising the values with the said method using NORM: Vowel Normalisation Suite (`http://lingtools.uoregon.edu/norm/norm1.php`), for some unknown reason, the normalised values were reversed in scale to the raw values. This was the case when the bark-metric difference normalisation formula was applied using the website as well as manually. On finding this unreliable, the normalised data was discarded and raw **F1, F2, F3** values were used as the three dependent variables in case of this phone category (/u/). Suspiciously high or low F1, F2, F3 values were manually checked and hand-corrected.

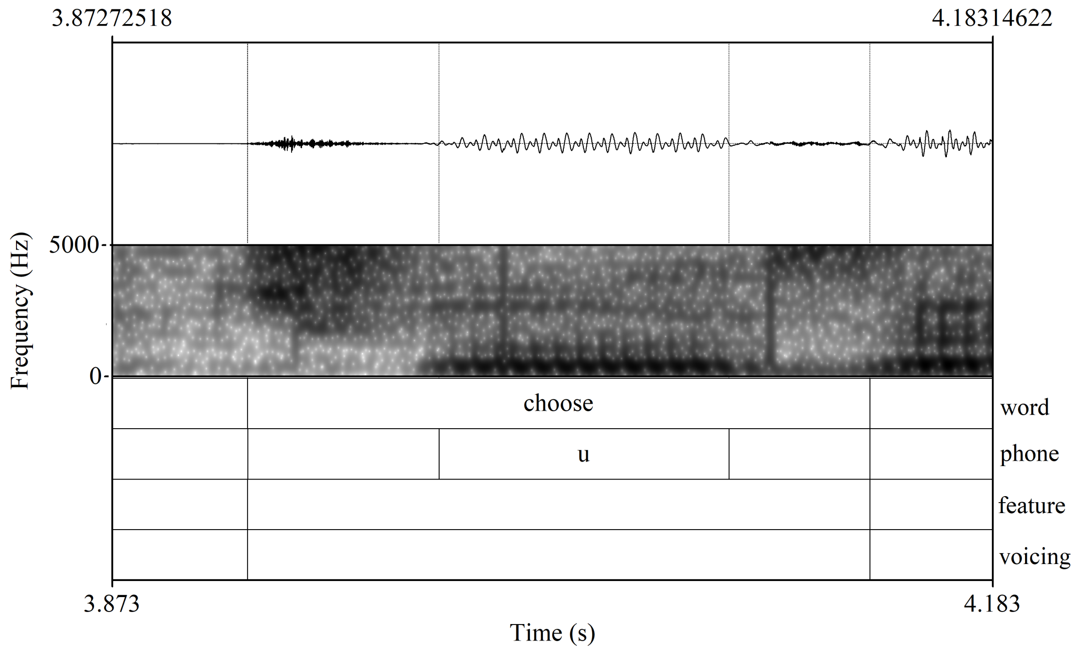


Figure 3.8: Annotation of word-medial /u/ in the word ‘choose’ as spoken by a male speaker from the ‘Indian’ control group

3.2.5.1.3 Word-initial voiced stops /b d g/: VOT, VDC, RBI

As suggested by Turk et al. (2006), the boundary for the onset of the closure of the voiced stop was placed at the offset of the visibly steady F2 of the preceding vowel. The entire steady duration of the vowel following the stop, identified by the onset/offset of the visually steady F2 of the vowel, was labelled as ‘vow’ in the ‘phone’ tier. Then the respective phone was labelled as ‘b’ or ‘g’ or ‘d’ in the ‘phone’ tier. The boundaries that were placed to extract each of the three cues (VOT, VDC and RBI), are described below separately. Figure 3.9 depicts an example of the annotation for voiced stops.

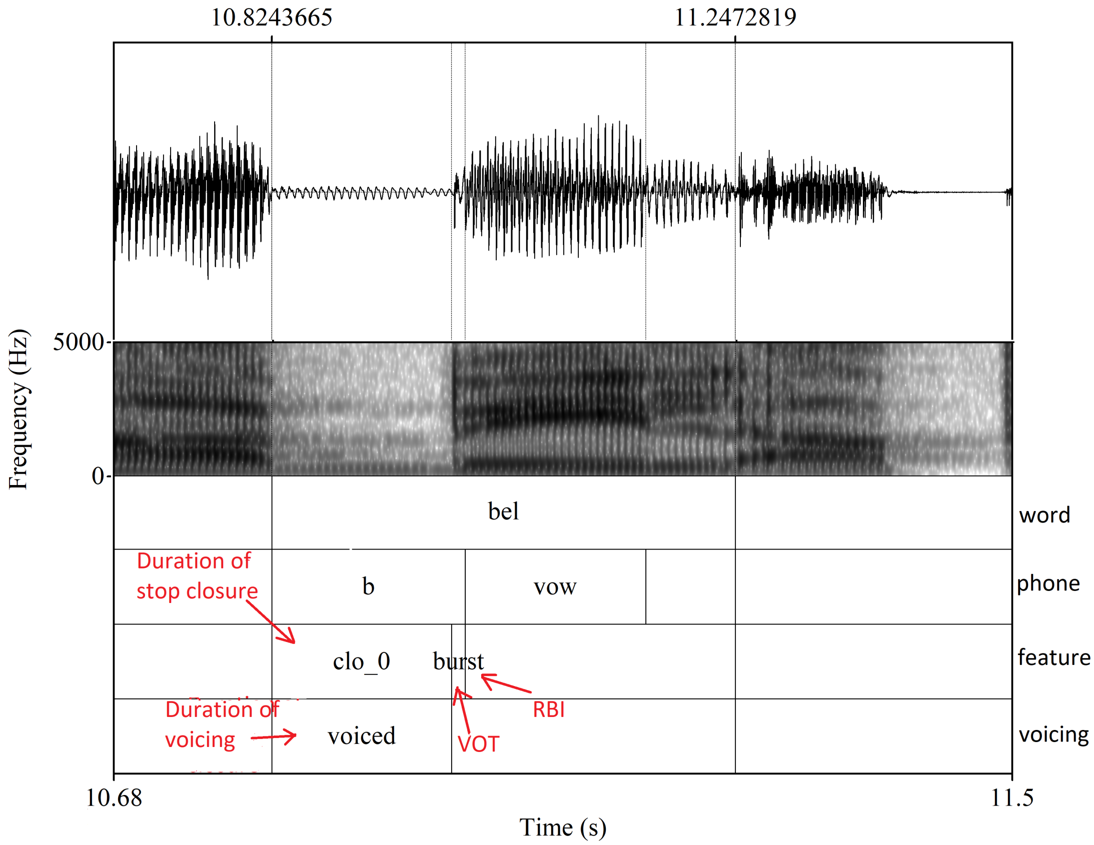


Figure 3.9: Annotation of word-initial /b/ in the Hindi word 'bel' (meaning *vine*) as spoken by a male speaker from the control group 'Indian'

- **Voice Onset Time (VOT):** VOT was measured as the duration from the onset of the release of the stop closure to the onset of voicing in the following vowel (Cho & Ladefoged, 1999). For cases where there were multiple bursts, the onset of first burst was marked as the onset of release of the stop closure. This measure of VOT reflects the duration of the burst (Stuart-Smith et al., 2015) and this segment was labelled as 'burst' in the 'feature' tier in Figure 3.9.

- **Voicing During Closure (VDC):** VDC is a measure of pre-voicing, but relative to the duration of the stop closure. That is, it was calculated as the amount of voicing during closure proportional to the total duration of the closure (Sonderegger et al., 2020). For this, two measurements were extracted: (1) the entire duration of the closure of the stop (labelled as 'clo_0' in the 'feature' tier) (Figure 3.9), and (2) the duration of voicing during that closure (labelled as 'voiced' in the 'voicing' tier; shown in Figure 3.9). The duration of voicing during closure was identified by the onset/offset of the low amplitude quasi-periodic waveform during the stop closure. Finally, the percentage of VDC was calculated by dividing the duration of voicing during closure by the total duration of the stop closure, multiplied by 100.

- **Relative Burst Intensity (RBI):** As mentioned earlier, RBI is the intensity of the stop burst in decibels, calculated relative to the intensity of the following vowel (Jongman et al., 1985; Stoel-Gammon et al., 1994; Sundara, 2005). This was done in order to control for the variation based on different recording conditions and equipment. Therefore, two measurements were extracted: (1) the raw intensity of the stop burst (from the segment labelled as 'burst' in the 'feature' tier, as shown in Figure 3.9), and (2) the raw intensity of the vowel following the stop (from the segment labelled as 'vow' in the 'phone' tier in Figure 3.9). Finally, RBI was calculated by subtracting the intensity of the burst from the intensity of the following vowel (Sundara, 2005; Sundara et al., 2006). A smaller RBI value represents a louder burst.

3.2.5.1.4 Word-initial voiceless stop /t/: VOT

The voiceless stop /t/ was annotated for VOT in a similar manner to the voiced stops. The boundary for the onset of the closure of the voiceless stop was placed at the offset of the visibly steady F2 of the preceding vowel (Turk et al., 2006). The entire steady duration of the vowel following the stop, identified by the onset/offset of the visually steady F2 of the vowel, was labelled as 'vow' in the 'phone' tier. The phone was labelled as 't' in the 'phone' tier. The entire duration of the vowel following the stop was coded as 'vow' in the 'phone' tier.

For this phone category, the dependent variable was Voice Onset Time (VOT), for which two measurements were extracted separately: (1) the duration of the burst of the stop (from the segment labelled as 'burst' in the 'feature' tier; shown in Figure 3.10), and (2) duration of the aspiration of the burst (from the segment labelled as 'asp' in the 'feature' tier; shown in Figure 3.10). Finally, these two values were added to represent combined duration of the burst and aspiration which formed the dependent variable of **Voice Onset Time (VOT)** for this phone category. Please refer to Figure 3.10 for an example.

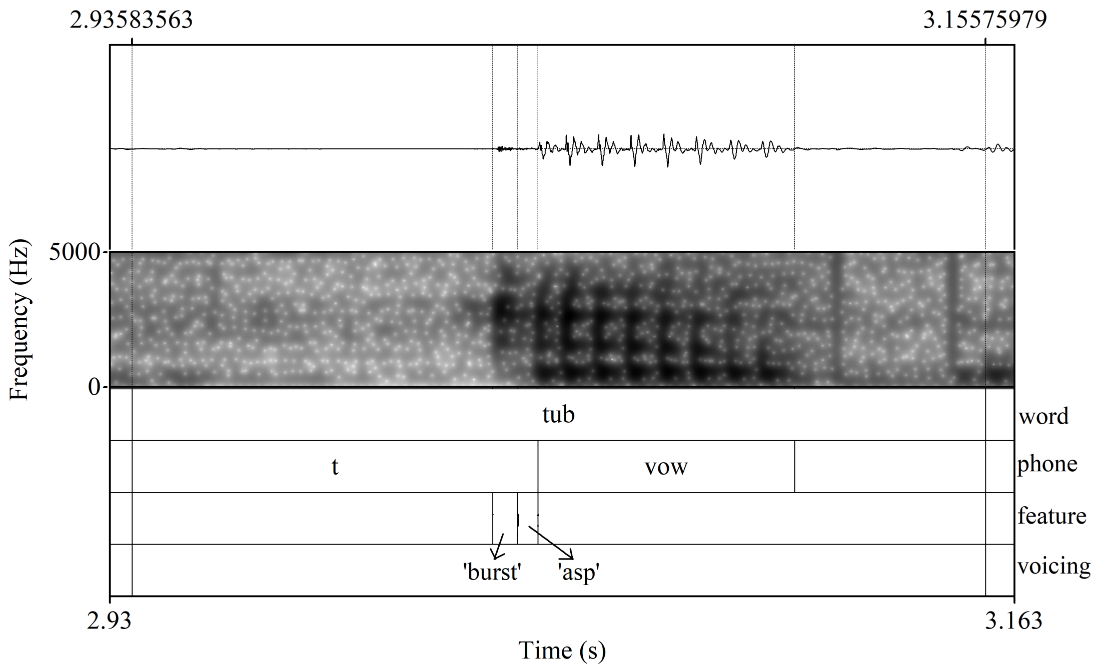


Figure 3.10: Annotation of word-initial /t/ in the word 'tub' as spoken by a male speaker from the control group 'Indian'

3.2.5.2 Statistical Analysis

Statistical analyses and visualizations were conducted in R (Version 3.6.3; R Core Team, 2020) in R Studio (Version 2023.03.0+386; Posit team, 2023). Mixed-effects linear and logistic regression analysis was used for cross-analysis across variables Group, Language and Phone (Phone only for voiced stops). This is explained in detail in the following section (§3.3).

3.3 Results

The analysis and findings presented in the current section were focused at answering the following questions:

1. In Glaswasians, is there a backward transfer of Glaswegian English on their native varieties of Indian English and Hindi?

2. Has Indian English received more transfer from Glaswegian English as compared to Hindi?

To do so, the data was selectively subjected to linear and logistic mixed effects modelling using `lmer()` and `glmer()` functions in `lme4` package (Version 1.1.29; Bates et al., 2015) in R (Version 3.6.3; R Core Team, 2020). The model summary and p-values were generated using the `summary()` function in the `lmerTest` package (Version 3.1.3; Kuznetsova, Brockhoff, & Christensen, 2017). The summary output was transferred to LATEX using `stargazer()`

function in the `stargazer` package (Version 5.2.3; Hlavac, 2022). The data was plotted using `ggplot()` function in `ggplot2` package (Version 3.3.6; Wickham, 2016) and models visualised using `allEffects()` function in the `effects` package (Version 4.2.1; J. Fox & Weisberg, 2018).

Separate analyses were conducted for each of the four phone categories: (1) lateral /l/, (2) GOOSE vowel, (3) voiced stops /b, d, g/ and (4) voiceless stop /t/. The variables relevant to this acoustic analysis are:

1. **Dependent Variables:** As one or more acoustic cues were examined within each phone category, there were multiple dependent variables. Separate analyses were carried out for each acoustic cue which formed the dependent variable for that particular analysis. Following are the dependent variables in the four phone categories:
    (a) **Lateral /l/:** F2-F1 difference
    (b) **Vowel /u/:**
        i. F1
        ii. F2
        iii. F3
    (c) **Voiced stops /b d g/:**
        i. Voice Onset Time (VOT)
        ii. Voicing During Closure (VDC)
        iii. Relative Burst Intensity (RBI)
    (d) **Voiceless stop /t/:** VOT
2. **Independent Variables:**
    (a) For Random Effects
        i. **Speaker:** Identifier code for the total 104 participants.
        ii. **Word:** The target words that functioned as stimuli that the speakers were recorded producing. There were 10 words each for each of the six phones.
    (b) For Fixed Effects
        i. Linguistic Variables:
            A. **Vowel Height:** Vowel Height specified the height of the vowel that followed the target phone. This has two levels: High (/e/) and Non-High (/ɔ/ or /ʌ/). It was treatment-coded, with the reference level of High. This variable is not applicable to the GOOSE vowel.

B. **Phone Duration:** This specified the duration of the target phone. This is the only predictor variable that is continuous in nature. Phone duration was first converted to log values, after which it was scaled and centered. In the present analysis, this variable was not applied to the voiceless and voiced stops, but it will be applied to these stops in later analysis for publication.

ii. Key Variables:

A. **Phone:** This variable specified the target phone. It is only applicable to the voiced stops and has three levels: b/ d/ g. It was treatment-coded, with the reference level of b.

B. **Language:** This variable specified the language that was examined. This has two levels: English/ Hindi. It was treatment-coded, with the reference level of English.

C. **Group:** This variable represented the group (that is, Glaswasian, Glaswegian or Indian) that any given participant belonged to. It is divided into two variables, the levels of which are determined by the stage of analysis (1 or 2) as described below.

In stage 1, Group is a binary variable with levels Indian/Glaswegian (for both control groups), and in stage 2, it is a binary variable with levels Indian/Glaswasian (for Indian control group and Glaswasian experimental group).

The variable Group was effect-coded, with weights of .5 for Glaswegian and -.5 for Indian (in stage 1; both control groups), and with weights of .5 for Glaswasian and -.5 for Indian (in stage 2; Glaswasian experimental group and Indian control group).

The analysis for each phone category and acoustic feature was carried out in two stages using two separate mixed effects models. In stage 1, only the two control groups (Glaswegian/ Indian) were compared for production in English only. This model provided the baselines for the two control groups in English (since Glaswegians do not speak Hindi). These control baseline values were used to assess the direction of transfer in Glaswasians in stage 2. In stage 2, the experimental group (Glaswasians) was compared with the Indian control group for English as well as Hindi. This analysis examined whether there was transfer in either language in Glaswasians. It also compared the amount of transfer that each language received, to determine whether one received more transfer than the other.

The variable codings ensured that the intercept of the models analysing /l/, /t/ and /u/ represents the grand mean of the two levels in Group for English in high vowels with mean Log Phone Duration (note that Log Phone Duration is not applicable to /t/). For the voiced stops, the variable codings ensured that the intercept of the model represents the grand mean of the two levels in Group for English /b/ in high vowels (Log Phone Duration is not applicable here).

In the model summaries, a Group effect will indicate that there is a difference between the relevant groups, and specifically, in stage 2 analysis of Glaswasians and Indians, this effect will indicate backward transfer. Furthermore, an interaction between Group and Language will indicate if one language is more susceptible to transfer than the other. In the analysis for voiced stops, interactions between Group and Phone or Language and Phone will indicate that different places of articulation are differentially sensitive to transfer effects.

The results for the four phone categories are presented separately in the following four subsections.

3.3.1 The Lateral: Word-initial /l/

For /l/, the dependent variable was F2-F1 difference. Glaswasians had a total of 384 and 382 tokens in English and Hindi respectively. Glaswegians had 323 tokens in English. Indians had 287 and 296 tokens in English and Hindi respectively.

Figure 3.11 visualises F2-F1 difference in /l/ for Glaswasians, Glaswegians and Indians across English and Hindi.

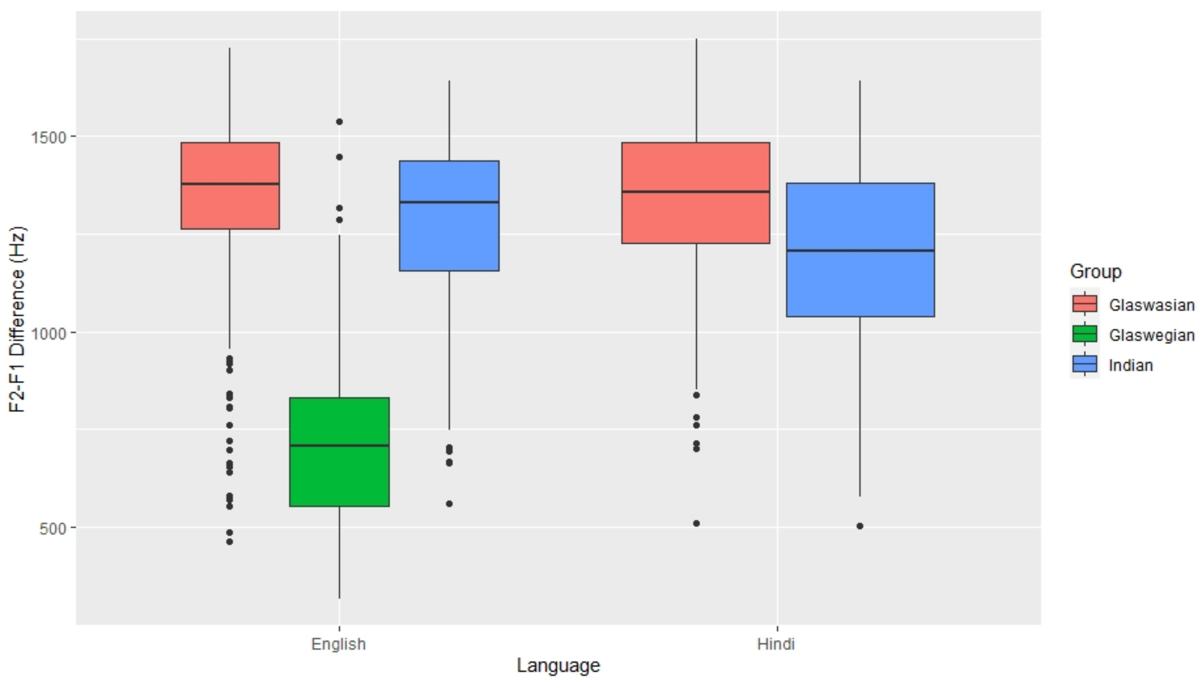
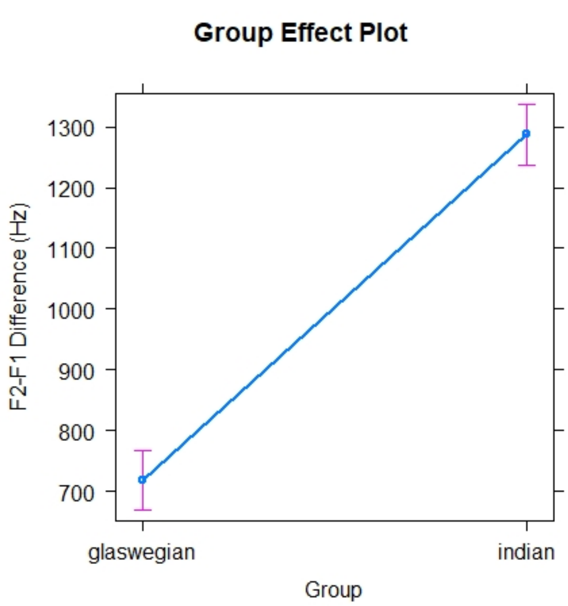


Figure 3.11: F2-F1 difference for Glaswasians, Glaswegians and Indians in word-initial /l/ in English and Hindi

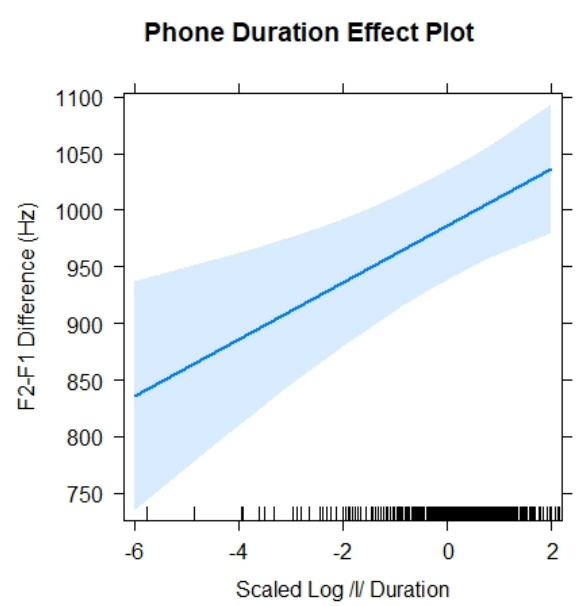
In the first stage of analysis, a linear mixed model was fitted to predict F2-F1 difference in English by fixed effects of Group (Glaswegian/ Indian), Vowel Height (High/ Non-High) and scaled Log Duration of /l/. No interaction was specified between any of these predictors. The model included a random intercept for Speaker. A random intercept for Word was not included due to the observance of singular fit indicating that the model was overfitted. Figure 3.12a visualises the effect of Group in this model. Table 3.8 presents the summary of this model. Figures 3.12a and 3.12b visualise the significant effects of Group and Log Phone Duration on F2-F1 difference in /l/ in English only.

Table 3.8: Model summary for control groups in English for /l/

	Dependent variable:
	F2-F1 difference
Intercept	1,010.939*** (25.529)
Group Effect	−568.967*** (14.548)
Vowel Height Non High	−14.609 (14.184)
Scaled Log Phone Duration	25.107*** (7.616)
Observations	610
Log Likelihood	−4,039.118
Akaike Inf. Crit.	8,090.235
Bayesian Inf. Crit.	8,116.716
Note:	*p<0.05; **p<0.01; ***p<0.001



(a) Effect of Group on F2-F1 Difference for /l/ in English



(b) Effect of Phone Duration on F2-F1 Difference in /l/

Figure 3.12: Significant effects of Group and Phone Duration on F2-F1 difference in word-initial /l/ in English in Table 3.8

To begin with, there was a significant effect of scaled Log Phone Duration on F2-F1 difference in English ($\beta = 25.11, t(604) = 3.30, p = .001$). This was to the effect that per unit increase in the duration of /l/ increased the F2-F1 difference by 74 Hz (Figure 3.12b). Therefore, the longer the duration of /l/, the clearer it was in English. Previous research on the effect of the duration of the token on the quality of /l/ has been divided. Some research argues that the longer the duration of /l/, the darker it is because longer time allows the tongue dorsum to fully reach the velum (Al-Asiri, 2023; Sproat & Fujimura, 1993; Turton, 2017). At the same time, the effect of duration of the token on the quality of /l/ has also been found to be inconsistent (Carter, 2002, 2003) due to involvement of factors such as transition phases and syllabic position. The effect of Vowel Height, however, was non-significant ($\beta = -14.61, t(604) = -1.03, p = 0.303$). This is to say that F2-F1 difference in English was not affected by whether it was followed by a high or non-high vowel.

Finally, a significant effect emerged for Group ($\beta = -568.97, t(604) = -39.11, p < .001$). This is visualised in Figure 3.12a in which Glaswegians have smaller F2-F1 difference than Indians in English. Smaller F2-F1 difference corresponds to darker /l/, whereas larger F2-F1 difference corresponds to clearer /l/. Therefore, in English, Indian /l/ is clearer than Glaswegian /l/. This is important for the next stage of analysis: if Glaswasian /l/ in English has smaller F2-F1 difference than Indian /l/ in English (in direction of Glaswegian English /l/), then it would be indicative of assimilation; if Glaswasian /l/ in English has higher F2-F1 difference than Indian /l/ in English, then it would be indicative of dissimilation. However, if Glaswasian /l/ in English has similar F2-F1 difference as Indian /l/ in English, then that would be indicative of no change.

In the second stage of analysis of F2-F1 difference, another linear mixed model was fitted to predict F2-F1 difference by fixed factors of Language (English/ Hindi), Group (Glaswasian/ Indian), Vowel Height (High/ Non-High) and scaled Log Duration of /l/. An interaction was specified between Group and Language. The model included a random intercept for Speaker. Table 3.9 presents the summary of this model.

Table 3.9: Model Summary for F2-F1 difference as a function of Group and Language

	Dependent variable:
	F2-F1 Difference
Intercept	1,340.471*** (18.303)
Group Effect	52.246*** (15.671)
Language Hindi	−47.959*** (10.762)
Vowel Height Non High	−44.734*** (10.712)
Scaled Log Phone Duration	37.818*** (6.147)
Group Effect:Language Hindi	86.344*** (21.527)
Observations	1,349
Log Likelihood	−9,052.096
Akaike Inf. Crit.	18,120.190
Bayesian Inf. Crit.	18,161.850
Note:	*p<0.05; **p<0.01; ***p<0.001

Significant effects emerged for Vowel Height ($\beta = -44.73, t(1341) = -4.18, p < .001$) as well as scaled Log Phone Duration ($\beta = 37.82, t(1341) = 6.15, p < .001$). The effect of Vowel Height was such that when followed by a non-high vowel, F2-F1 difference was smaller (darker /l/) than when followed by a high vowel (Figure 3.13; left) (Morris, 2017; Oxley, Buckingham, Roussel, & Daniloff, 2006; Van Hofwegen, 2011). The effect of Log Phone Duration was in the same direction as Table 3.8: the longer the duration of /l/, the clearer it was (Figure 3.13; right).

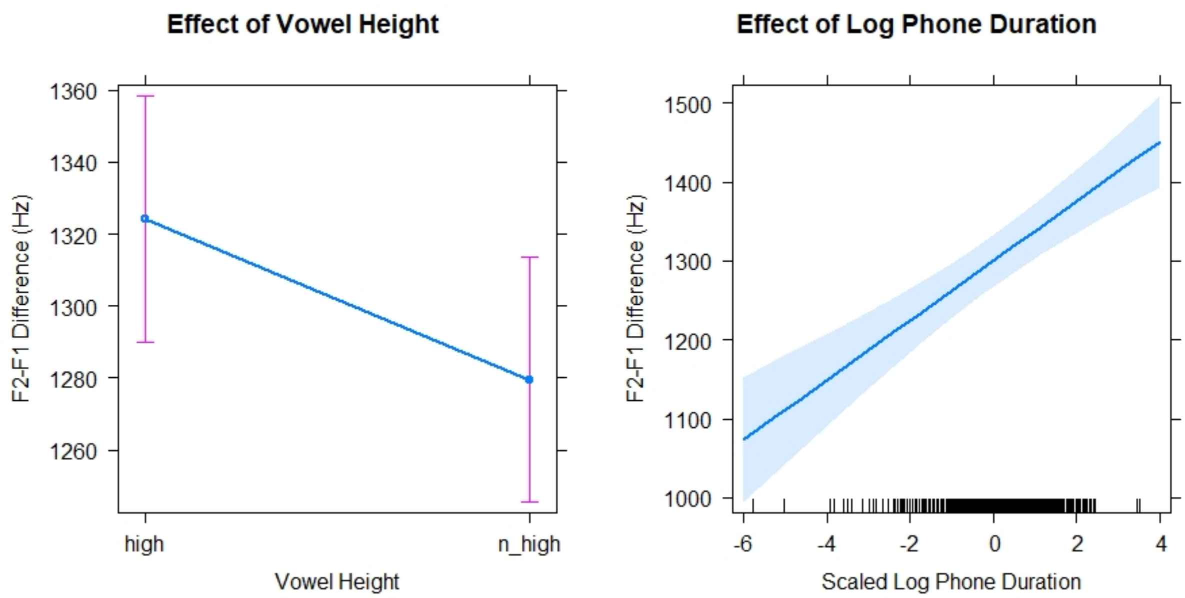


Figure 3.13: Significant effects of Vowel Height (left) and Phone Duration (right) on F2-F1 difference in word-initial /l/ in Glaswasians and Indians (Table 3.9)

Importantly, effects of Language ($\beta = -47.96, t(1341) = -4.46, p < .001$) and Group ($\beta = 52.25, t(1341) = 3.33, p < .001$) emerged as significant, along with an interaction between them ($\beta = 86.34, t(1341) = 4.01, p < .001$). The nature of the Language effect was that in general, Hindi /l/ had smaller F2-F1 difference than English /l/. Therefore, Hindi /l/ was darker than English /l/ in general, which is unexpected and surprising. The nature of the significant Group Effect was that in English, Glaswasians had higher F2-F1 difference (clearer /l/) than Indians, who had smaller F2-F1 difference (darker /l/). Finally, the interaction indicates that the Group Effect was significantly larger in Hindi than in English. This is shown in Figure 3.14.

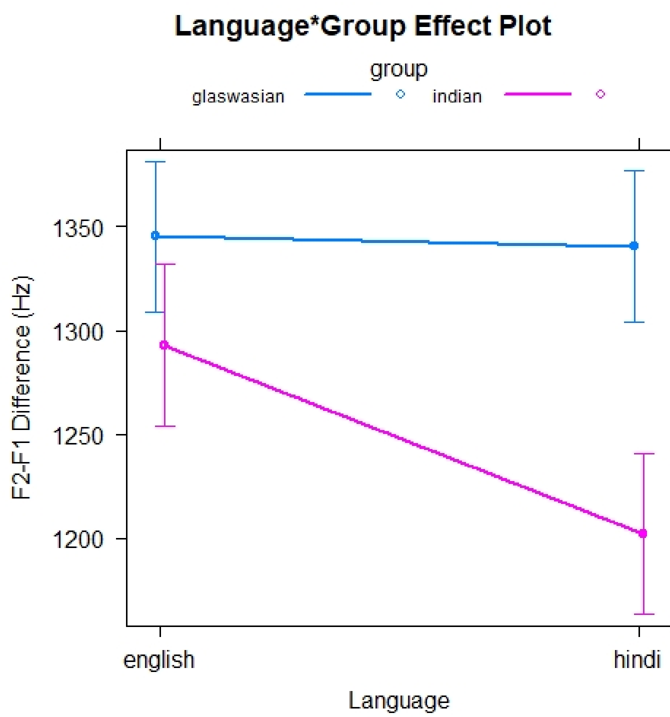


Figure 3.14: Plot depicting the interaction between Language and Group on F2-F1 difference in word-initial /l/ in Glaswasians and Indians in (Table 3.9)

The following summarises the findings of the two-part analysis of F2-F1 difference in /l/:

1. The pattern for F2-F1 difference across Group in English was: *Glaswegians* < *Indians* < *Glaswasians*. This is to say that Glaswasians had the largest F2-F1 difference in English - even larger than Indians.

   The pattern for F2-F1 difference across Group for Hindi was: *Indians* < *Glaswasians*. This reflects that Glaswasians had larger F2-F1 difference (and therefore clearer /l/) than Indians.

2. There was a much bigger difference in F2-F1 difference between Glaswasians and Indians in Hindi than in English.

Based on the above summary, the following can be concluded about transfer in Glaswasians: in both English and Hindi, Glaswasians had clearer /l/ than Indians which is evidence of dissimilation in both languages. However, surprisingly, Indian Hindi /l/ was found to be darker than its English counterpart. This result has implications for the interpretation of the difference in the amount of transfer received by Glaswasians' Hindi versus English. That is, this darker Hindi /l/ produced by Indian controls makes it appear as Glaswasians' Hindi received more transfer than their English.

In conclusion, Glaswasians' Hindi received more transfer than English; therefore, there was higher dissimilation in Hindi than in English; therefore, there was higher dissimilation in Hindi than in English.

3.3.2 The GOOSE Vowel

Three dependent variables were examined for this vowel. These are Hz values for (1) F1, (2) F2 (3) F3. These F1, F2 and F3 values have not been normalised (see §3.2.5.1.2). Glaswasians had a total of 367 and 375 tokens for English and Hindi respectively. Glaswegians had a total of 326 tokens in English. Indians had a total of 285 and 274 tokens in English and Hindi respectively. Separate analyses were conducted for each one of these dependent variables, which have been described in separate sub-sections below.

3.3.2.1 F1

Figure 3.15 depicts F1 in GOOSE across English and Hindi for Glaswasians, Glaswegians and Indians, where F1 scale is inverted following usual phonetic convention of displaying F1 consistent with vowel height.

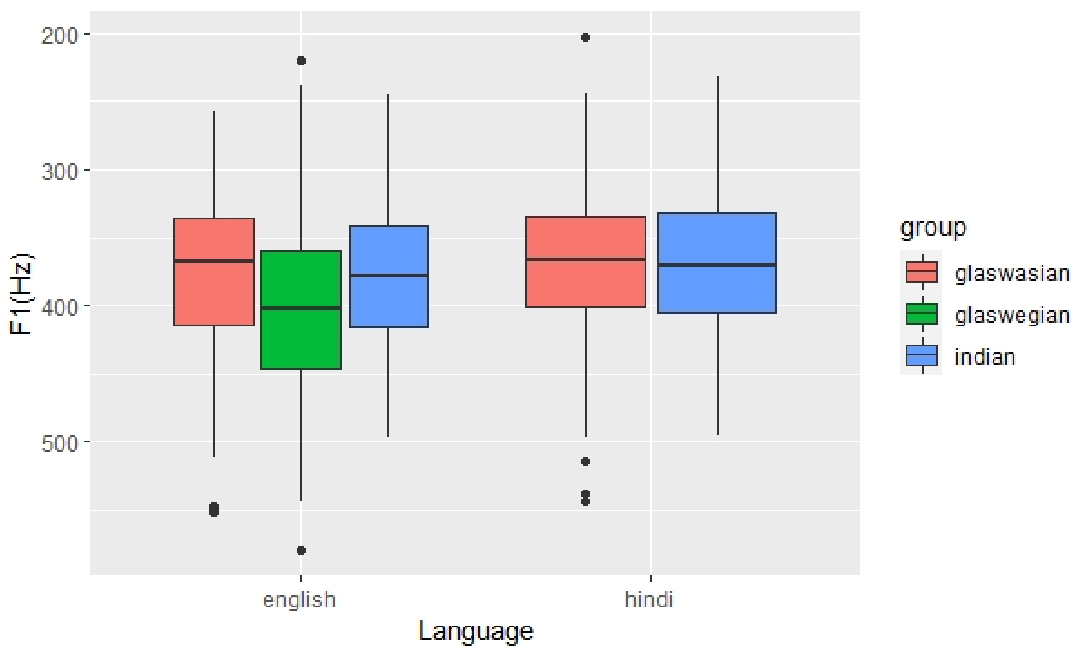


Figure 3.15: F1 in GOOSE across Glaswasians, Glaswegians and Indians in English and Hindi

The analysis for F1 in GOOSE was again carried out in two stages. In the first stage, a linear mixed model was fitted to predict F1 as a function of Group (Glaswegian/ Indian) and scaled Log Duration of /u/. This analysis is for English only. No interactions were specified between these fixed effects and a random intercept for Speaker was added. Table 3.10 presents the model summary and Figure 3.16 visualises the effect of Group on F1 for the control groups.

Table 3.10: Model summary for control groups in English for F1 in GOOSE

	Dependent variable:
	F1
Intercept	387.690*** (7.245)
Group Effect	20.477*** (4.458)
Scaled Log Phone Duration	−2.109 (2.327)
Observations	611
Log Likelihood	−3,255.398
Akaike Inf. Crit.	6,520.797
Bayesian Inf. Crit.	6,542.872
Note:	*p<0.05; **p<0.01; ***p<0.001

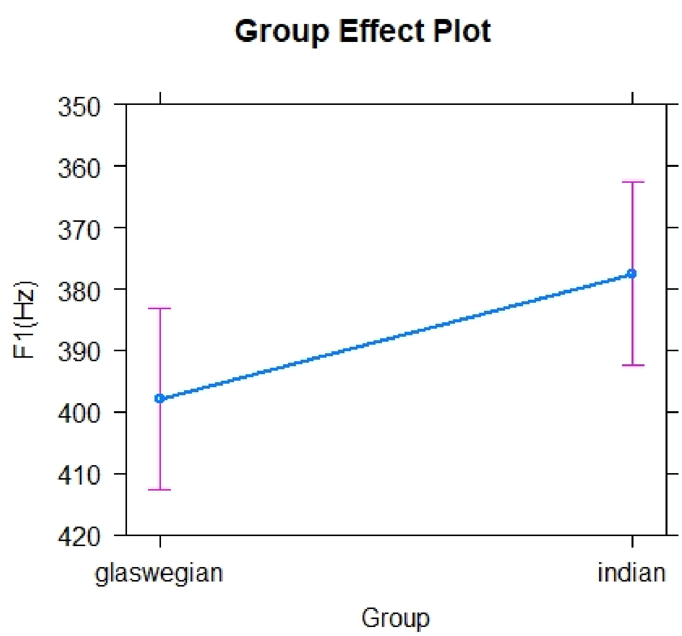


Figure 3.16: Effect of Group on F1 in GOOSE in English for Glaswegians and Indians

The effect of scaled Log Phone Duration was not significant ($\beta = -2.11, t(606) = -0.91, p = .365$). However, a significantly positive effect emerged for Group ($\beta = 20.48, t(606) = 4.59, p < .001$). This is visualised in Figure 3.16 and indicates that Glaswegians had higher F1 values than Indians in English, that is, Glaswegian English has more open GOOSE than Indian English.

Therefore, in the second stage of analysis, if Glaswasians have significantly higher F1 values than Indians (in direction of Glaswegians) in either language, it would be indicative of assimilation. However, if Glaswasians have significantly lower F1 values than Indians in either language, it would be indicative of dissimilation; similar F1 values for Glaswasians and Indians would be indicative of no change.

In the second stage, another linear mixed model was fitted to predict F1 across Group (Glaswasian/ Indian), Language (English/ Hindi) and scaled Log Duration of /u/. Interactions were specified between Language and Group and a random intercept for Speaker was added. Table 3.11 presents the model summary and Figure 3.17 visualises the interaction between Group and Language on F1 for the experimental group (Glaswasians) and Indians.

Table 3.11: Model summary for F1 in GOOSE across Language and Group for Glaswasians and Indians

	Dependent variable:
	F1
Intercept	378.190*** (10.116)
Language Hindi	−9.843*** (2.662)
Scaled Log Phone Duration	−8.243*** (1.540)
Group Effect	−2.067 (3.784)
Language Hindi:Group Effect	4.662 (5.186)
Observations	1,301
Log Likelihood	−6,868.685
Akaike Inf. Crit.	13,751.370
Bayesian Inf. Crit.	13,787.570
Note:	*p<0.05; **p<0.01; ***p<0.001

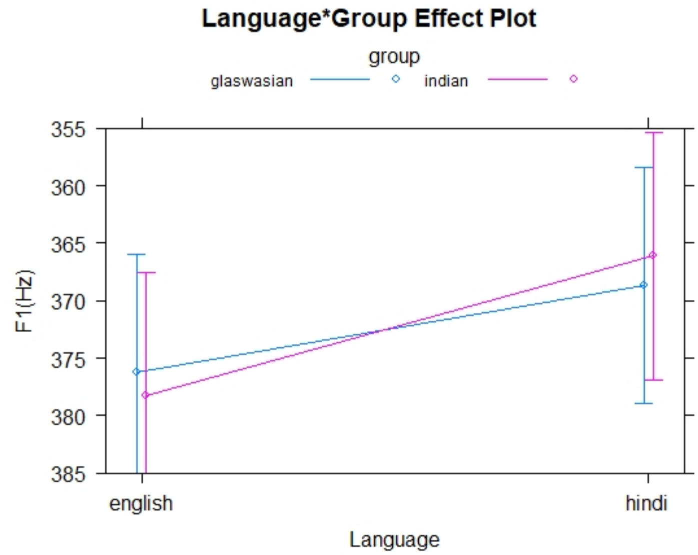


Figure 3.17: Language by Group interaction plot for F1 in GOOSE for Glaswasians and Indians in Table 3.11

The effect of scaled Log Phone Duration was significantly negative ($\beta = -8.243, t(1294) = -5.35, p < .001$): F1 values decreased as the duration of /u/ increased. This indicates that with longer duration, /u/ becomes a closer, more peripheral vowel (B. Lindblom, 1963; Nance, 2013).

The effect of language emerged as significantly negative ($\beta = -7.51, t(1294) = -2.19, p = .028$). However, the Group Effect was non-significant ($\beta = 2.07, t(1294) = 0.55, p = .585$), along with the interaction between Group and Language ($\beta = -4.66, t(1294) = -0.90, p = .369$). The nature of the language effect was that English had higher F1 values than Hindi, in general, indicating a more open vowel quality. The non-significant nature of the Group Effect and its interaction with language indicates that Glaswasians had similar F1 values as Indians in both languages.

The following summarises the findings of the two-part analysis of F1 in /u/:

1. The pattern for F1 across Group in English was: $Glaswasians = Indians < Glaswegians$. This reflects that Glaswegians had highest F1 values, followed by Indians and Glaswasians who had similar F1 values in English.

   The pattern for F1 across Group for Hindi was: $Indians = Glaswasians$. This indicates that Indians and Glaswasians had similar F1 values in Hindi.

Based on the above summary, it is concluded that there was no transfer of Glaswegian English on either native language of Glaswasians for F1 in /u/.

3.3.2.2 F2

Figure 3.18 depicts F2 in GOOSE across English and Hindi for Glaswasians, Glaswegians and Indians.

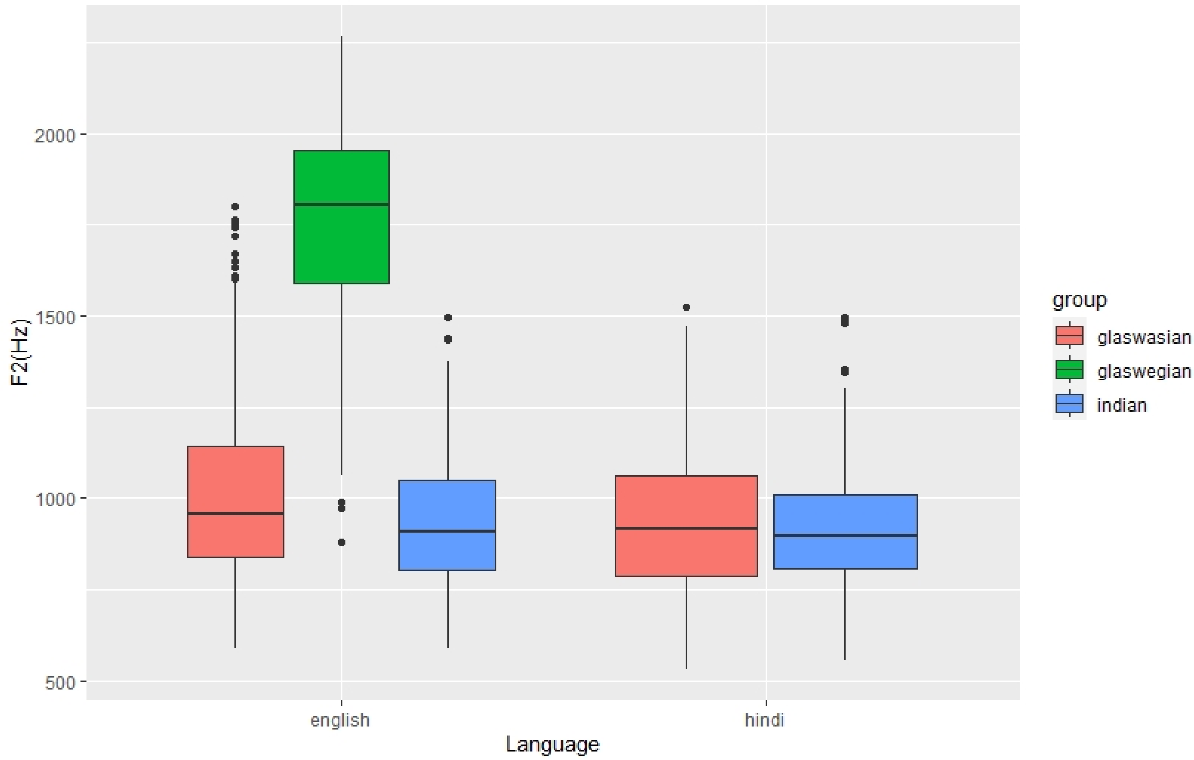


Figure 3.18: F2 in GOOSE across Glaswasians, Glaswegians and Indians in English and Hindi

The analysis for F2 in /u/ was also conducted in two stages.

In the first stage, a linear mixed model was fitted to predict F2 as a function of Group (Glaswegian/ Indian) and scaled Log Duration of /u/. This analysis is for the control groups in English only. No interactions were specified between these fixed effects and random intercept for Speaker was added. Table 3.12 presents the model summary and Figure 3.19 visualises the effect of Group on F2 for the control groups.

Table 3.12: Model summary for control groups in English for F2 in GOOSE

	Dependent variable:
	F2
Intercept	1,342.331*** (18.740)
Group Effect	809.702*** (19.610)
Scaled Log Phone Duration	1.063 (10.139)
Observations	611
Log Likelihood	−4,143.257
Akaike Inf. Crit.	8,296.514
Bayesian Inf. Crit.	8,318.590
Note:	*p<0.05; **p<0.01; ***p<0.001

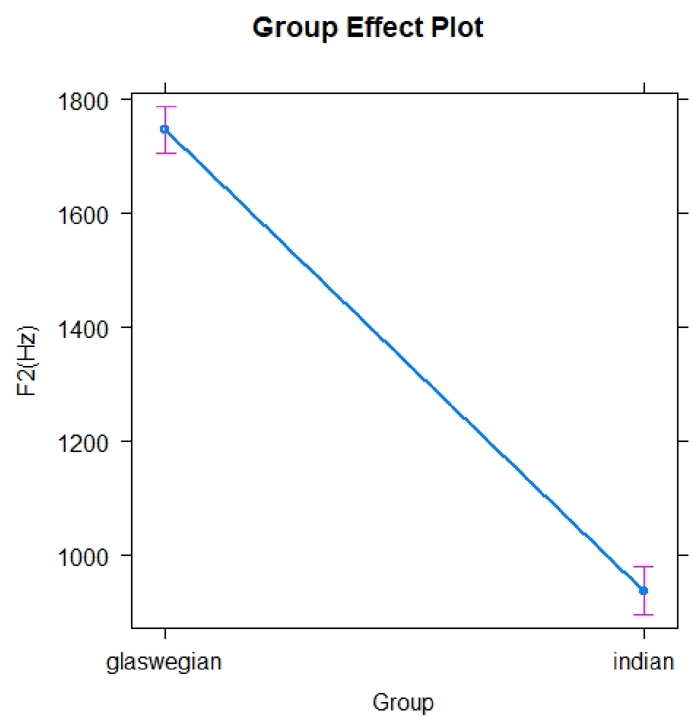


Figure 3.19: Effect of Group on F2 in GOOSE in English in Table 3.12

The effect of scaled Log Phone Duration was not significant ($\beta = 1.063, t(606) = 0.10, p = .917$). However, a significantly positive effect emerged for Group ($\beta = 809.70, t(606) = 41.29, p < .001$). Figure 3.19 visualises this and indicates that Glaswegians had much higher F2 values than Indians in English, indicating a fronter vowel in Glaswegian English than Indian English.

Therefore, in the following second stage of analysis, if Glaswasians have significantly higher

F2 values than Indians (in direction of Glaswegians) in either language, it would be indicative of assimilation. However, if Glaswasians have significantly lower F2 values than Indians in either language, it would be indicative of dissimilation.

In the second stage of analysis, a linear mixed model was fitted to predict F2 as a function of Group (Glaswasian/ Indian), Language (English/ Hindi) and scaled Log Duration of /u/. An interaction was specified between Language and Group and random intercept for Speaker was added. Table 3.13 presents the model summary and Figure 3.20 visualises the interaction between Group and Language on F2 for the experimental group (Glaswasians) and Indians.

Table 3.13: Model summary for F2 in GOOSE across Language and Group for Glaswasians and Indians

	Dependent variable:
	F2
Intercept	1001.767*** (15.152)
Scaled Log Phone Duration	−43.004*** (5.863)
Language Hindi	−70.984*** (10.212)
Group Effect	26.576 (14.481)
Language Hindi:Group Effect	−54.645** (19.901)
Observations	1,301
Log Likelihood	−8,601.383
Akaike Inf. Crit.	17,216.770
Bayesian Inf. Crit.	17,252.960
Note:	*p<0.05; **p<0.01; ***p<0.001

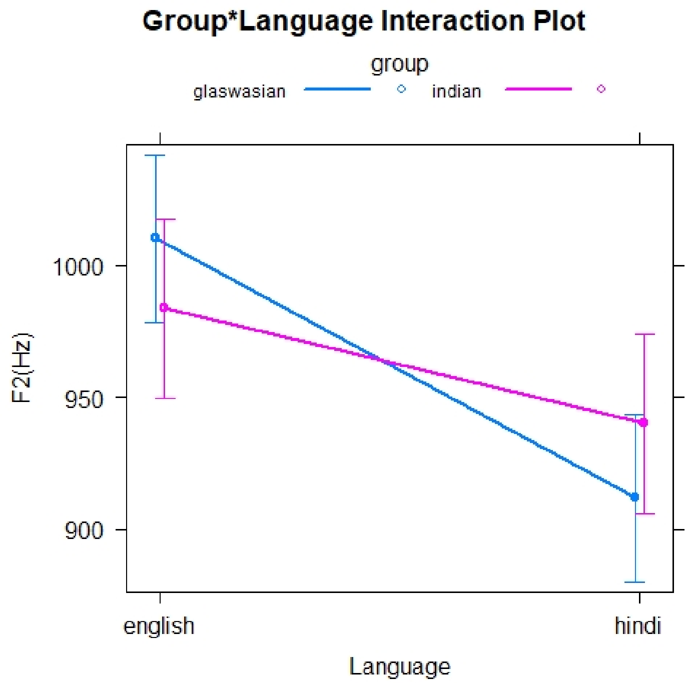


Figure 3.20: Language by Group Interaction Plot for F2 in GOOSE for Glaswasians and Indians in Table 3.13

The effect for scaled Log Phone Duration was similar to that in the analysis of F1: as the duration of /u/ increased, F2 values decreased ($\beta = -43.004, t(1294) = -7.34, p < .001$), indicating less centralisation of the vowel, as expected. The Language effect was significantly negative ($\beta = -70.98, t(1294) = -6.95, p < .001$), that is, Hindi had lower F2 values than English, in general. This indicates fronter /u/ in English, and backer /u/ in Hindi, overall. The Group Effect in English was non-significant ($\beta = 26.58, t(1294) = 1.84, p = .067$), but the interaction between group and language was significantly negative ($\beta = -54.64, t(1294) = -2.75, p = .006$).

Therefore, Indians and Glaswasians had similar F2 values in English. However, even though Glaswasians have lower F2 than Indians in Hindi, it is not clear if this is significantly different, as Glaswasian F2 is just reduced relative to Indian F2 more in Hindi, than in English (Figure 3.20). To overcome this, the model was relevelled with Hindi as the reference level for Language. Table 3.14 presents the summary of this relevelled model.

Table 3.14: Model summary for F2 across Language and Group in /u/ when relevelled with Hindi as the reference level for Language

	Dependent variable:
	f2
Intercept	930.783^{***} (15.083)
Scaled Log Phone Duration	-43.004^{***} (5.863)
Language English	70.984^{***} (10.212)
Group Effect	-28.069 (14.458)
Language English:Group Effect	54.645^{**} (19.901)
Observations	1,301
Log Likelihood	$-8,601.383$
Akaike Inf. Crit.	17,216.770
Bayesian Inf. Crit.	17,252.960
Note:	*p<0.05; **p<0.01; ***p<0.001

The insignificant Group Effect in the above model indicates that Glaswasians and Indians had similar F2 values in Hindi as well ($\beta = -28.07, t(1294) = -1.94, p = .052$). However, relevelling is effectively a post-hoc test which increases the possibility of Type I error (Schad et al., 2020). However, the significant Language by Group interaction in both models above (Table 3.13 ($\beta = -54.64, t(1294) = -2.75, p = .006$) and Table 3.14 ($\beta = 54.64, t(1294) = 2.75, p = .006$)) seems to indicate that Glaswasians are differentiating their Hindi and English more than Indians.

In any case, the conclusions that can be drawn from this model regarding the difference between Glaswasians and Indians are limited.

The following summarises the findings of the two-part analysis of F2 in /u/:

1. The pattern for F2 across Group in English and Hindi was: $Glaswasians = Indians < Glaswegians$. This reflects that Glaswegians had highest F2, followed by Indians and Glaswasians who had similar F2 in English as well as Hindi. Therefore, Glaswegians had fronter GOOSE as compared to both Indians and Glaswasians who had similarly backer /u/.

Based on the above summary, Glaswasians had similar F2 as Indians in English and Hindi. Therefore, there was no transfer in English or Hindi.

3.3.2.3 F3

Figure 3.21 depicts F3 for GOOSE across English and Hindi for Glaswasians, Glaswegians and Indians.

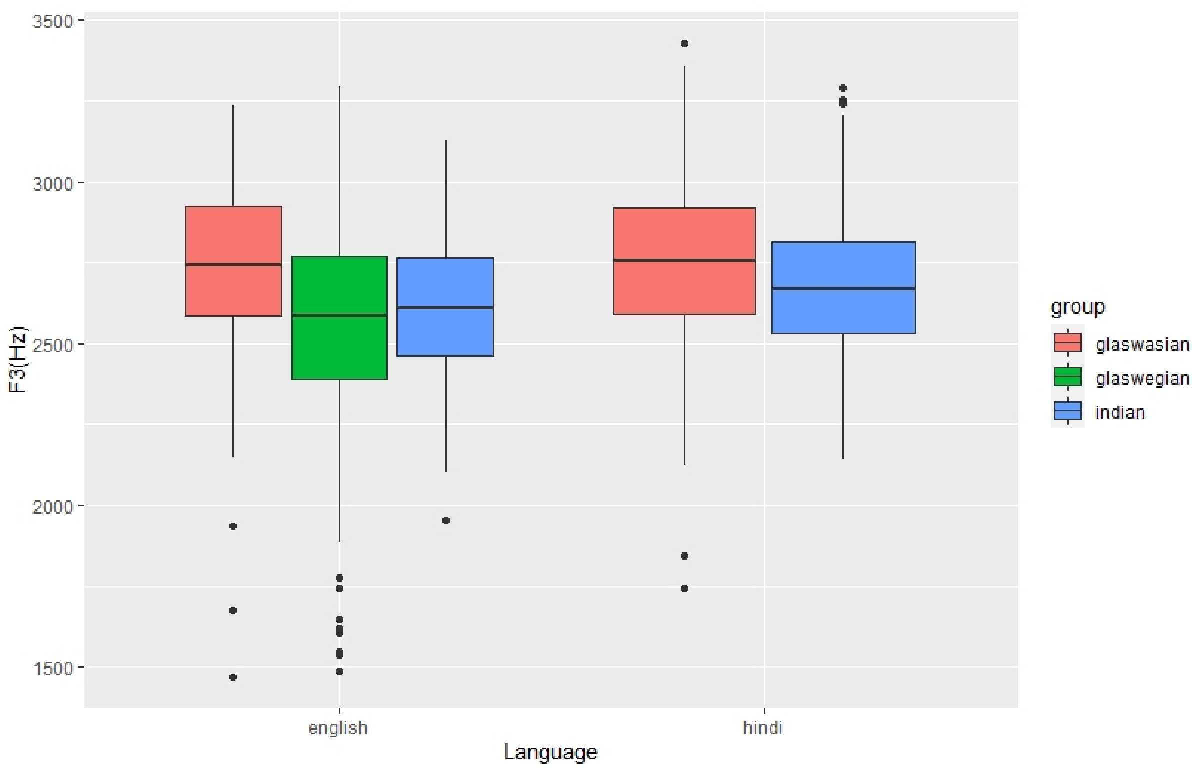


Figure 3.21: F3 in GOOSE across Glaswasians, Glaswegians and Indians in English and Hindi

In the first stage of analysis, a linear mixed model was fitted to predict F3 as a function of Group (Glaswegian/ Indian) and scaled Log Duration of /u/. This analysis is for English only. No interactions were specified between these fixed effects and a random intercept for Speaker was added. Table 3.15 presents the model summary.

Table 3.15: Model summary for control groups in English for F3 in GOOSE

	Dependent variable:
	F3
Intercept	2,581.796*** (27.920)
Group Effect	−33.148 (21.213)
Scaled Log Phone Duration	4.561 (11.043)
Observations	611
Log Likelihood	−4,198.244
Akaike Inf. Crit.	8,406.488
Bayesian Inf. Crit.	8,428.563
Note:	*p<0.05; **p<0.01; ***p<0.001

The effects of scaled Log Phone Duration and Group were not significant (Log Phone Duration: $(\beta = 4.561, t(606) = 0.41, p = .68)$; Group: $(\beta = -33.15, t(606) = -1.56, p = .119)$). Therefore, Indians had similar F3 as Glaswegians. So in the following analysis, if Glaswasians have similar F3 as Indians, then it would indicate no transfer, but if Glaswasians are significantly different from Indians, it is doubtful if that difference could be attributed to transfer effects.

In the second stage of analysis, a linear mixed model was fitted to predict F3 as a function of Group (Glaswasian/ Indian), Language (English/ Hindi) and scaled Log Duration of /u/. An interaction was specified between Language and Group and a random intercept for Speaker was added. Table 3.16 presents the model summary and Figure 3.22 visualises the interaction between Group and Language on F3.

Table 3.16: Model summary for F3 in GOOSE across Language and Group for Glaswasians and Indians

	Dependent variable:
	F3
Intercept	2,663.484*** (18.268)
Language Hindi	38.708** (12.535)
Scaled Log Phone Duration	0.994 (7.191)
Group Effect	160.298*** (17.771)
Language Hindi:Group Effect	−59.546* (24.428)
Observations	1,301
Log Likelihood	−8,866.243
Akaike Inf. Crit.	17,746.490
Bayesian Inf. Crit.	17,782.680
Note:	*p<0.05; **p<0.01; ***p<0.001

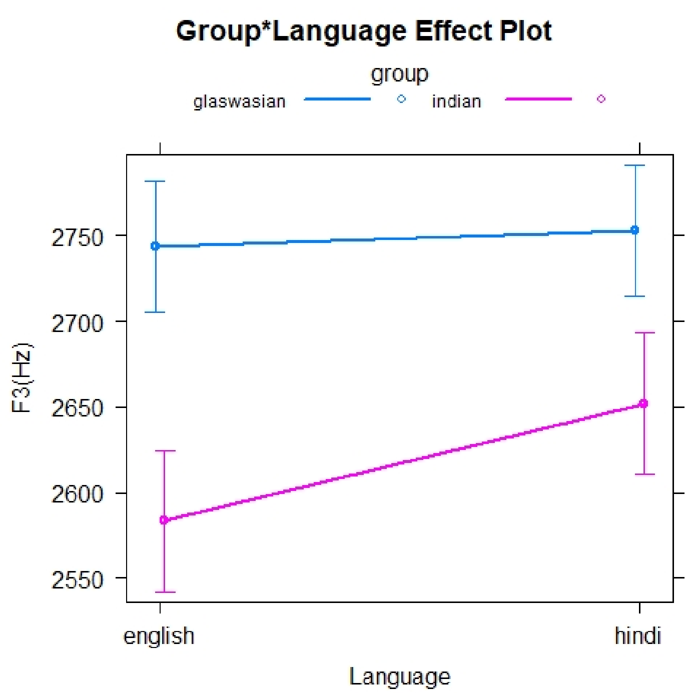


Figure 3.22: The effect of Group by Language on F3 in GOOSE in Table 3.16

The effect of scaled Log Phone Duration was non-significant ($\beta = 0.994, t(1294) = 0.14, p = .89$). The effects of Language ($\beta = 38.71, t(1294) = 3.09, p = .002$) and Group ($\beta = 160.30, t(1294) = 9.02, p < .001$) emerged as significant, along with an interaction between them ($\beta = -59.55, t(1294) =$

$-2.44, p = .015$). The nature of the Language effect was that Hindi had higher F3 values than English, in general. Furthermore, the nature of the significant Group Effect was that in English, Glaswasians had higher F3 values than Indians. In Hindi, the Group Effect was significantly smaller than in English (as shown in Figure 3.22).

The following summarises the findings of the two-part analysis of F3 in /u/:

1. The pattern for F3 across Group in English was: $Indians = Glaswegians < Glaswasians$. This reflects that Glaswasians had higher F3 than both control groups which had similar F3.

   The pattern for F3 across Group for Hindi was: $Indians < Glaswasians$. This indicates that Glaswasians had higher F3 than Indians in Hindi.

2. Indians had a bigger difference in F3 between Hindi and English.

However, as mentioned above, it is unclear if this difference between Glaswasians and Indians can be attributed to transfer effects at all, as both control groups have similar F3 values in both languages. Glaswasians could be contrasting their Indian F3 values from GE by way of dissimilation, but it is tricky to make that interpretation from the analysis. Therefore, it is concluded that Glaswasians did not undergo transfer in either language for F3.

3.3.3 The Voiced Stops: /b, d, g/

For the voiced stops, three dependent variables were examined. These are (1) Voice Onset Time (VOT), (2) Voicing During Closure (VDC) and (3) Relative Burst Intensity (RBI). Separate analysis were conducted for each one of these variables.

3.3.3.1 Voice Onset Time (VOT)

For this analysis, VOT values have been log-transformed to normalise variability. Table 3.17 shows the number of tokens for this variable across groups and voiced stops /b d g/.

Phone	Group	English	Hindi
/b/	Glaswegians	318	-
	Glaswasians	361	335
	Indians	285	277
/d/	Glaswegians	321	-
	Glaswasians	379	367
	Indians	291	288
/g/	Glaswegians	309	-
	Glaswasians	334	334

	Indians	281	275

Table 3.17: Number of tokens across the voiced stops /b d g/ and groups for VOT

Figure 3.23 depicts VOT for /b d g/ across Group and Language.

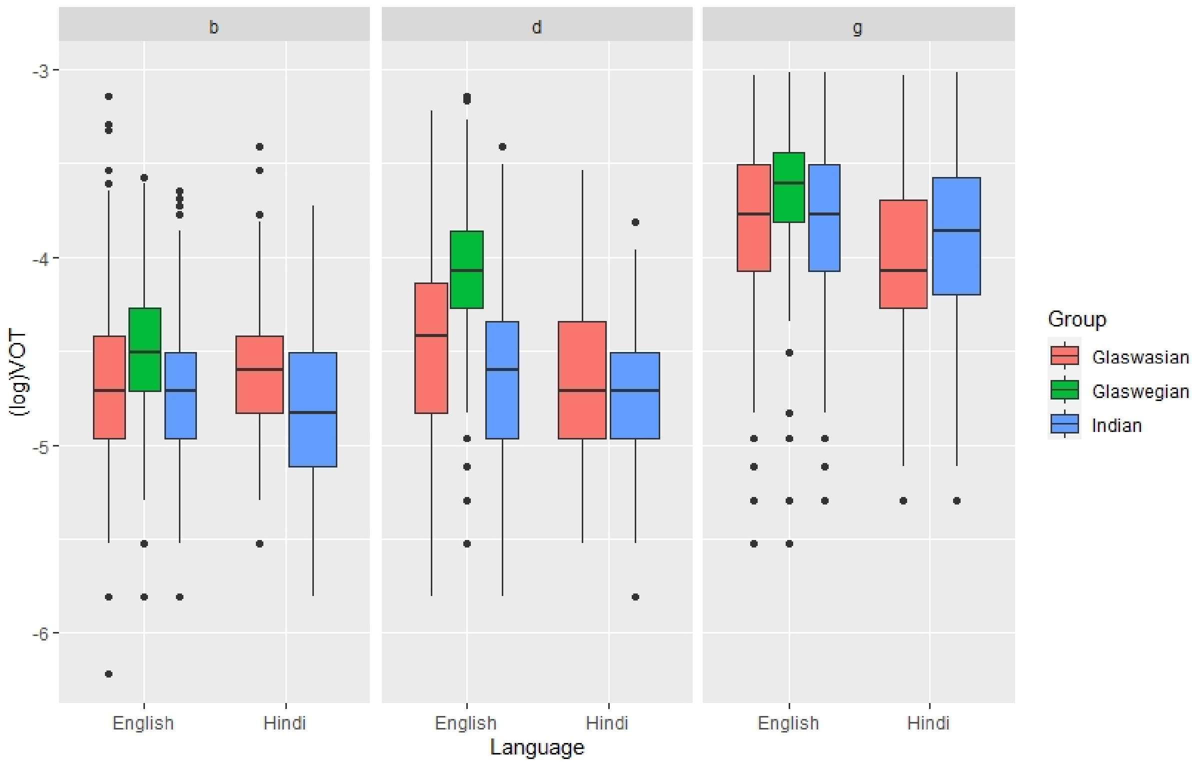


Figure 3.23: (log)VOT for /b d g/ across Language and Group

Similar to the above phone categories, the analysis was performed in two stages.

In the first stage, the control groups were compared. Therefore, a linear mixed model was fitted to predict log VOT as a function of Phone (b/ d/ g), Group (Glaswegian/ Indian) and Vowel Height (High/ Non-High). This analysis is for English only. The model included a random intercept for Speaker and an interaction term was specified between Phone and Group. Table 3.18 presents the summary of this model. Please refer to Figure 3.24 to view the model effects plot for interaction between Phone and Group.

Table 3.18: Model Summary for log VOT in English across Phone for control groups

	Dependent variable:
	Log VOT
Intercept	-4.548^{***} (0.036)
Phone d	0.257^{***} (0.020)
Phone g	0.894^{***} (0.020)
Vowel Height Non High	-0.075^{***} (0.017)
Group Effect	0.188^{***} (0.029)
Phone d:Group Effect	0.325^{***} (0.041)
Phone g:Group Effect	-0.064 (0.041)
Observations	1,825
Log Likelihood	-750.363
Akaike Inf. Crit.	1,518.725
Bayesian Inf. Crit.	1,568.309
Note:	*p<0.05; **p<0.01; ***p<0.001

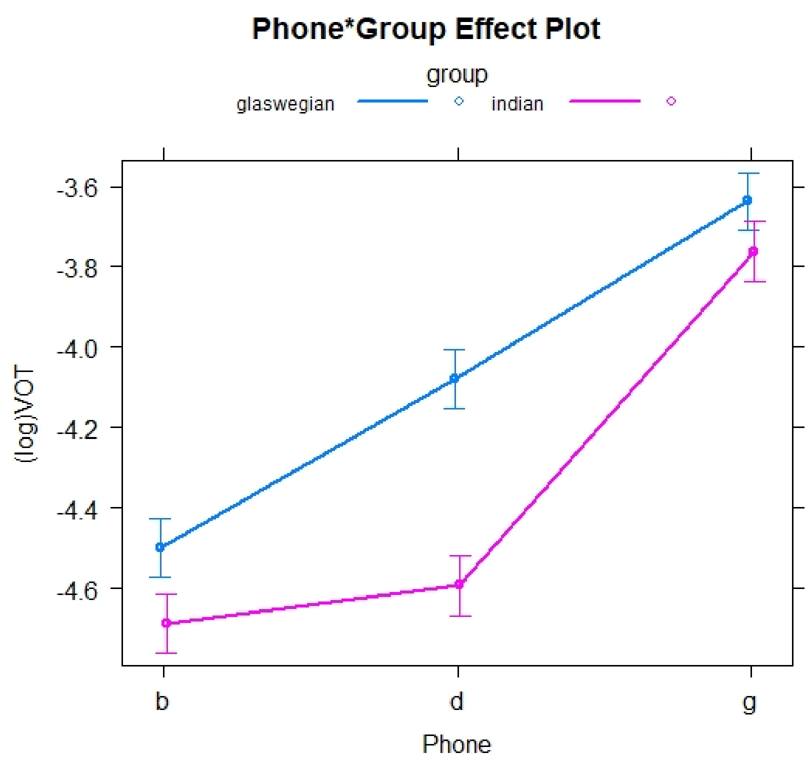


Figure 3.24: Phone by Group interaction plot for the control groups for log VOT in Voiced Stops in Table 3.18

There was a significant effect of Vowel Height on log VOT ($\beta = -0.08, t(1816) = -4.45, p < .001$), such that when followed by a non-high vowel, log VOT was significantly shorter (more negative) than when followed by a high vowel (Docherty, 1992; Klatt, 1975; Stuart-Smith et al., 2015) (Figure 3.25).

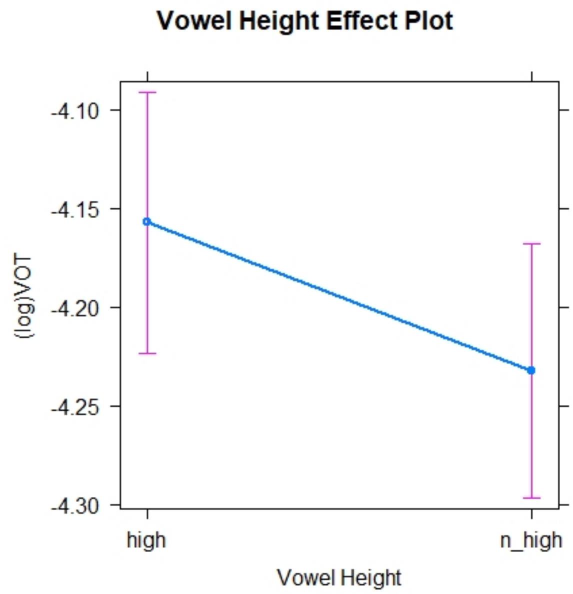


Figure 3.25: The effect of Vowel Height on log VOT in voiced stops in control groups in Table 3.18

Significant effects for Phone /d/ and /g/ also emerged that were averaged across Glaswegians and Indians in English (/d/ ($\beta = 0.26, t(1816) = 12.67, p < .001$) ; /g/ ($\beta = 0.89, t(1816) = 44.00, p < .001$)). These effects indicated that different places of articulation had different VOT values (Cho & Ladefoged, 1999; Chodroff & Wilson, 2018; Lisker & Abramson, 1964) (see Figure 3.24). The phone /g/ had much longer VOT as compared to /b/. The phone /d/ also had longer VOT than /b/.

Finally, significant Group Effects emerged. For /b/ in English, the Group Effect was significant ($\beta = 0.19, t(1816) = 6.48, p < .001$). Furthermore, for /d/ in English, the Group Effect was significantly larger than for /b/ ($\beta = 0.33, t(1816) = 8.03, p < .001$). However, for /g/ in English, there was no significant difference in Group Effect relative to /b/ ($\beta = -0.06, t(1816) = -1.56, p = .118$). All in all, as expected, Indians had more negative VOTs (shorter VOT) than Glaswegians for all three voiced stops (Davis, 1994; Sonderegger et al., 2020; Stuart-Smith et al., 2015), as Figure 3.24 also shows.

Therefore, in the following analysis, if Glaswasians have longer VOT than Indians (in direction of Glaswegians) for any of the stops, it would be indicative of assimilation. Shorter VOT than Indians for any of the stops would be indicative of dissimilation, whereas similar VOT as Indians would indicate no change in that Glaswasian stop for VOT.

In the second stage of analysis, another linear mixed model was fitted to predict (log)VOT by Language (English/ Hindi), Phone (b/ d/ g), Vowel Height (High/ Non-High) and Group (Glaswasian/ Indian). Interactions were specified between Language, Group and Phone along with all the lower level interactions. The model included a random intercept for Speaker. The model summary is presented in Table 3.19 and Figure 3.26 visualises the interaction effect between Phone, Language and Group.

Table 3.19: Model summary for log VOT in /b d g/ as a function of Phone, Language and Group for Glaswasians and Indians

	Dependent variable:
	Log VOT
Intercept	-4.644^{***} (0.032)
Phone d	0.160^{***} (0.021)
Phone g	0.903^{***} (0.021)
Vowel Height Non High	-0.080^{***} (0.012)
Language Hindi	-0.013 (0.021)
Language Hindi:Phone d	-0.125^{***} (0.029)
Language Hindi:Phone g	-0.157^{***} (0.030)
Group Effect	0.021 (0.030)
Phone d:Group Effect	0.126^{**} (0.041)
Phone g:Group Effect	-0.051 (0.042)
Language Hindi:Group Effect	0.138^{**} (0.042)
Language Hindi:Phone d:Group Effect	-0.205^{***} (0.059)
Language Hindi:Phone g:Group Effect	-0.235^{***} (0.060)
Observations	3,832
Log Likelihood	$-1,736.453$
Akaike Inf. Crit.	3,502.905
Bayesian Inf. Crit.	3,596.672
Note:	*p<0.05; **p<0.01; ***p<0.001

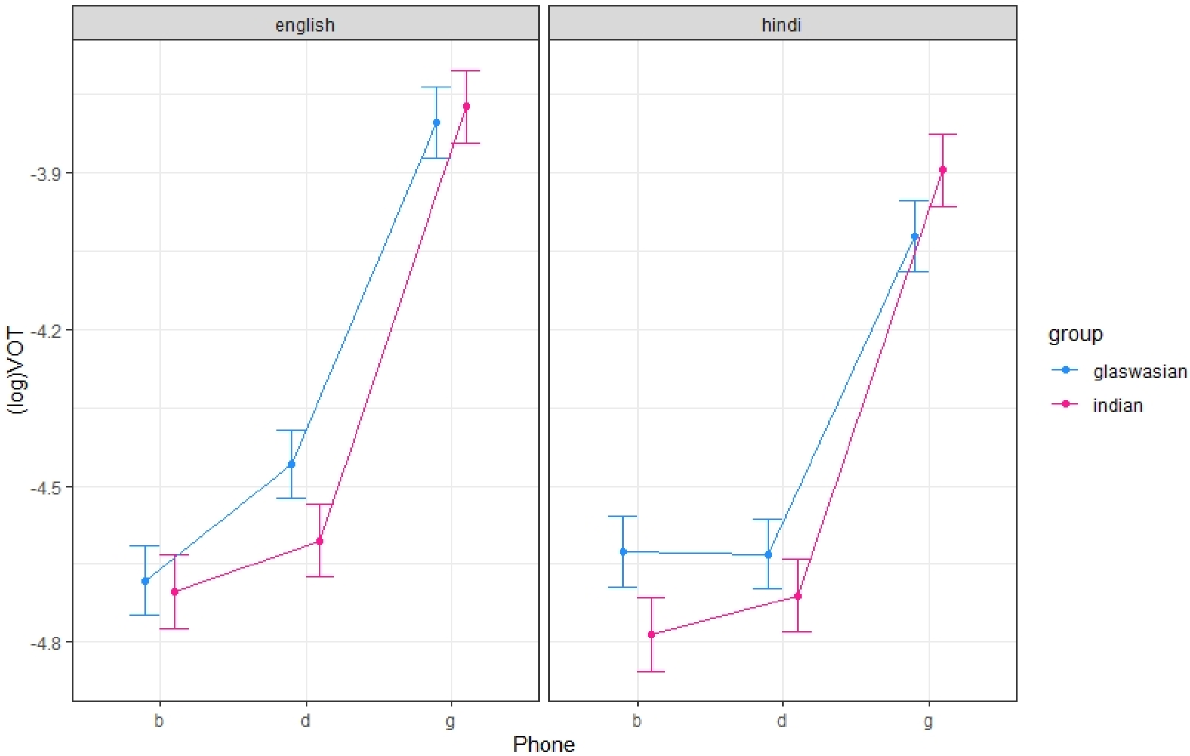


Figure 3.26: The effect of interaction between Group, Phone and Language on log VOT in /b d g/ for Glaswasians and Indians in Table 3.19

Significant effects for Phone emerged here in the same direction as in Table 3.18. The phone /g/ had much longer VOT as compared to /b/ ($\beta = 0.90, t(3817) = 43.15, p < .001$). The phone /d/ also had longer VOT than /b/ ($\beta = 0.16, t(3817) = 7.74, p < .001$).

For /b/ in English, the Group Effect was not significant ($\beta = .021, t(3817) = .69, p = .49$). However, in Hindi, the Group Effect was significantly larger than in English ($\beta = .14, t(3817) = 3.27, p = .001$). This is shown in Figure 3.26.

For /d/ in English, the Group Effect was significantly larger than for /b/ ($\beta = .126, t(3817) = 3.05, p = .002$). On the other hand, in Hindi, the increase in Group Effect from /b/ to /d/ is reduced relative to English ($\beta = -.205, t(3817) = -3.48, p < .001$). The panel for English (on the left) for /d/ shows a larger difference than the panel for Hindi (on the right) for /d/.

Finally, for /g/ in English there was no significant change in Group Effect relative to /b/ ($\beta = -.051, t(3817) = -1.21, p = .227$). By contrast, in Hindi, there was a significant change in Group Effect, relative to the change in English ($\beta = -.235, t(3817) = -3.94, p < .001$), reflecting a larger increase in VOT for Indians in /g/ than for Glaswasians. This can be seen in the rightmost panel of Figure 3.26, which shows a higher predicted VOT for Indian /g/ than Glaswasian /g/, reversing the pattern of lower VOTs in the other consonants.

To sum up,

1. The pattern for VOT across places of articulation as found in both analyses is: $/b/ <$

$/d/ < /g/$. This is to say that /b/ had the shortest VOT, whereas /g/ had the longest (Cho & Ladefoged, 1999; Chodroff & Wilson, 2018; Lisker & Abramson, 1964).

2. The following pattern was found for VOT across Group in English:

   (a) **/b/:** $Glaswasian = Indian < Glaswegian$. That is, Glaswegians had longer VOT than both Indians and Glaswasians who had similar VOT for /b/ in English.

   (b) **/d/:** $Glaswasian > Indian < Glaswegian$. Indians had shorter VOT than Glaswegians. Glaswasians, on the other hand, had longer VOT than Indians.

   (c) **/g/:** $Glaswasian = Indian < Glaswegian$. That is, Glaswegians had longer VOT than both Indians and Glaswasians who had similar VOT for /g/ in English.

3. The following pattern was found for VOT across Group in Hindi:

   (a) **/b d/:** $Indian < Glaswasian$. Glaswasians had longer VOT than Indians for /b/ and /d/.

   (b) **/g/:** $Glaswasian < Indian$. Indians had longer VOT than Glaswasians for /g/.

Based on the above summary, the following can be concluded about transfer in Glaswasians: In English, there was no change in Glaswasian VOT for /b/ and /g/, but there was assimilation in /d/. In Hindi, there was assimilation in Glaswasian VOT for /b/ and /d/, whereas dissimilation for /g/.

3.3.3.2 Voicing During Closure (VDC)

For this analysis, mixed-effects binomial logistic regression was employed using the `glmer()` function in the `lme4` package (Bates et al., 2015) in R (R Core Team, 2020). This is because the dependent variable here (Voicing During Closure - VDC) was transformed from a continuous % scale to three ordered levels: None, Some, All (based on Sonderegger et al. (2020)). These three levels represent the amount of voicing during the closure of the respective voiced stop. The 'none' level represents absolutely no VDC, the 'some' level represents 1 to 99 percent VDC, and the 'all' level represents 100 percent VDC. Figure 3.27 presents the distribution of percentage of VDC across /b d g/ for the three groups.

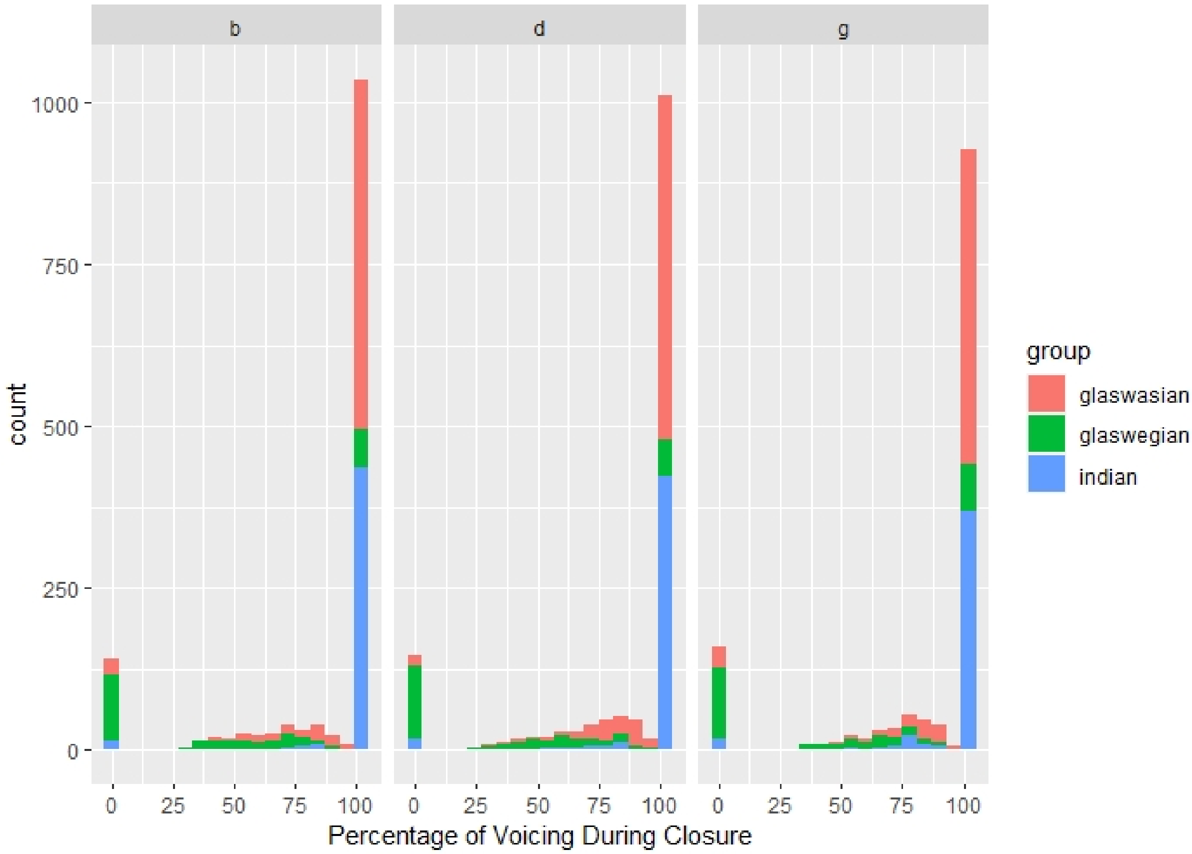


Figure 3.27: The distribution of VDC percentage across /b d g/ for Glaswegians, Glaswasians and Indians

This analysis is based on Sonderegger et al. (2020) who used binary mixed-effects logistic regression to model the probability of one level over the other. They did this by creating two such regression models. The first modelled 'None versus Some/All' voicing, that is, the probability of no voicing over the probability of any voicing during closure (VDC). The second regression modelled 'Some versus All' voicing, that is, the probability of some VDC over full VDC. Therefore, based on this, two regression models (Model 1: 'None versus Some/All' (Any) model; Model 2: 'Some versus All' model) were generated. Within each of two big models, the analysis was carried out in two stages (similar to all the above analysis).

The first stage within Model 1 ('None versus Some/All' model) examined the control groups (Glaswegian and Indian) to project the baselines of VDC for 'none' and 'some/all' levels in English. In the second stage for Model 1, the experimental group (Glaswasians) was compared to the Indian control group across Language. In this 'None versus Some/All' model, the dependent variable (VDC) had two levels: 'none' and 'some/all'. 'None' was coded as 0 (the reference level) and 'Some/All' as 1. This means that a positive coefficient for a predictor indicates increased log-odds of having 'some/all' VDC, while a negative coefficient indicates decreased log odds of 'some/all' VDC (and hence increased log odds of having 'none' VDC). A coefficient of 0 indicates equal likelihood of having 'none' or 'some/all' VDC.

Analysis for the ‘Some versus All’ model (Model 2) was done in similar stages as the ‘None versus Some/All’ model (Model 1). In Model 2, the dependent variable (VDC) had two levels: ‘some’ and ‘all’. ‘Some’ was coded as 0 (the reference level) and ‘all’ as 1. This means that a positive coefficient for a predictor indicates increased log-odds of having ‘all’ VDC, while a negative coefficient indicates decreased log odds of ‘all’ VDC (and hence increased log odds of having ‘some’ VDC). A coefficient of 0 indicates equal likelihood of having ‘some’ or ‘all’ VDC.

3.3.3.2.1 None versus Some/All Model

In the first stage of analysis, a logistic mixed model was fitted to predict VDC as a function of Group (Glaswegian/ Indian) and Phone (b/ d/ g) in English. An interaction term was specified between Group and Phone, and a random intercept was added for Speaker. Figure 3.28 presents the distribution of ‘none’ versus ‘some/all’ (any) VDC across the voiced stops and groups.

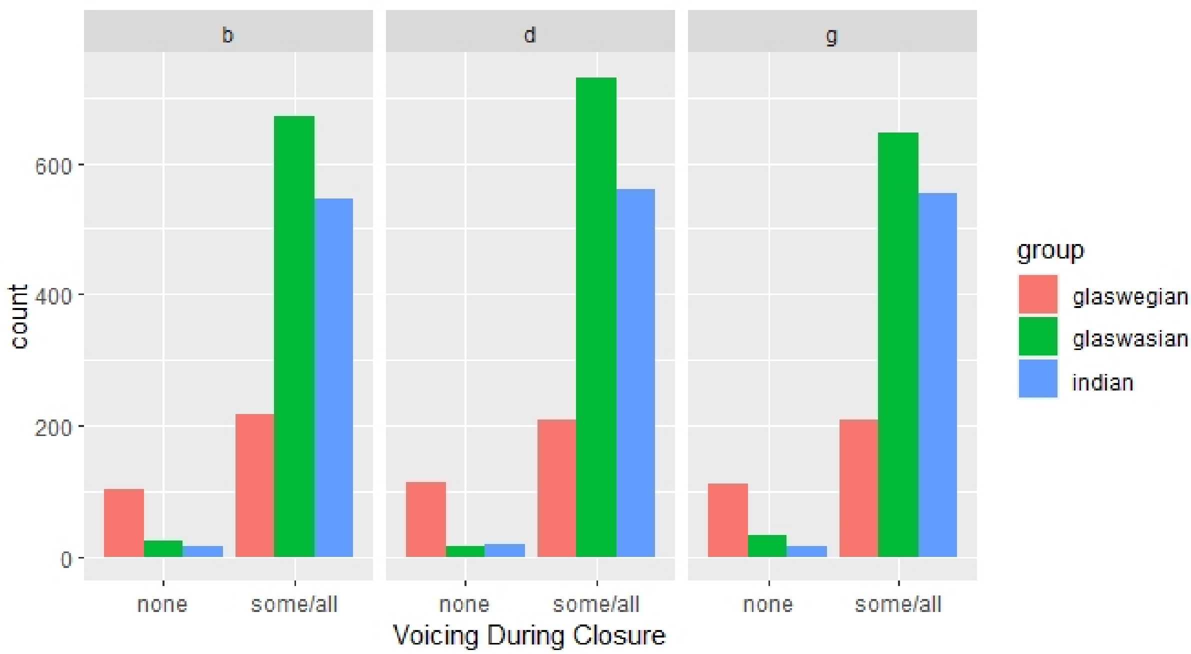


Figure 3.28: The distribution of ‘none’ versus ‘some/all’ VDC across Phone and Group

Table 3.20 presents the model summary and Figure 3.29 visualises the interaction between Group and Phone on VDC for the control groups.

Table 3.20: Model summary for the 'None versus Some/All' model for the control groups

	Dependent variable:
	VDC
Intercept	3.054*** (0.395)
Phone d	−0.198 (0.267)
Phone g	−0.291 (0.260)
Group Effect	−3.487*** (0.402)
Group Effect:Phone d	0.019 (0.534)
Group Effect:Phone g	0.278 (0.519)
Observations	1,825
Log Likelihood	−576.324
Akaike Inf. Crit.	1,166.649
Bayesian Inf. Crit.	1,205.214
Note:	*p<0.05; **p<0.01; ***p<0.001

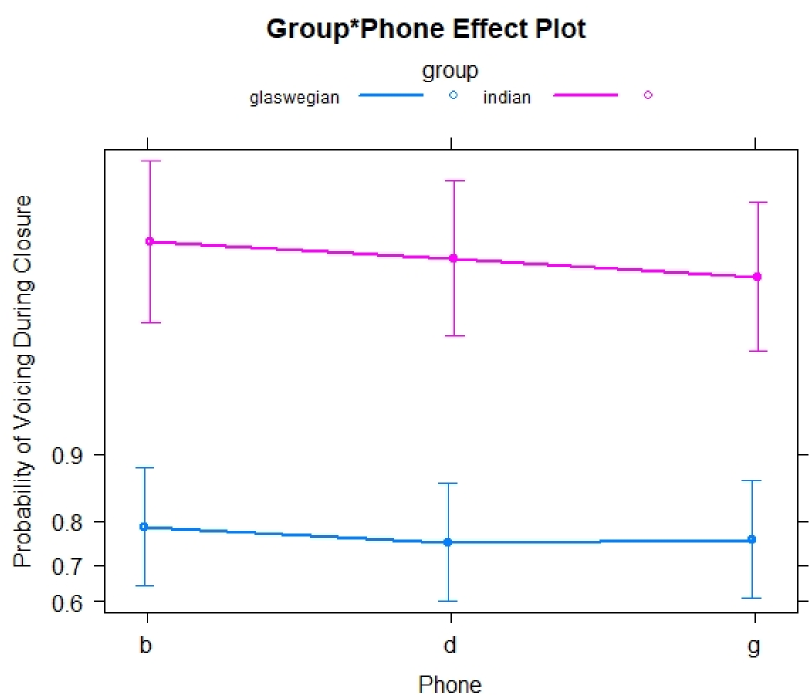


Figure 3.29: The effect of interaction between Group and Phone on VDC (categorized as 'none' versus 'some/all') in English /b d g/ in Table 3.20

The intercept for this model (Table 3.20) represents the grand mean of the log-odds of Glaswegians and Indians for the Phone /b/ in English. It is significantly different from 0 and the positive log-odds indicate a higher likelihood of having ‘some/all’ VDC ($\beta = 3.05, p < .001$).

The simple effects of Phone for /d/ and /g/ (/d/ ($\beta = -0.20, p = .459$); /g/ ($\beta = -0.29, p = .263$)) were not significantly different from the intercept, representing similarly higher likelihood of having any (‘some/all’) VDC for all stops when averaged across Group.

For /b/ in English, there was a significant Group Effect ($\beta = -3.49, p < .001$), such that Indians had higher log-odds of having ‘some/all’ voicing than Glaswegians (as seen in Figure 3.29). For /d/ in English, the Group Effect was not significantly different from the Group Effect for /b/ ($\beta = .02, p = .972$). Similarly for /g/ in English, the Group Effect was not significantly different from the Group Effect for /b/ ($\beta = .28, p = .593$). The following presents the results of the analysis testing whether the experimental group, Glaswasians, is different from the Indian control group.

In the second stage of ‘None versus Some/All’ analysis, another logistic model was fitted to predict VDC as a function of Group (Glaswasian/ Indian), Language (English/ Hindi) and Phone (b/ d/ g). An interaction was specified between Group, Language and Phone along with all the lower level interactions. A random intercept for Speaker was not included due to issues of convergence. Table 3.21 presents the summary of this model and Figure 3.30 plots the interaction between Phone, Group and Language in this model.

Table 3.21: Model summary for the 'None versus Some/All' Model for Glaswasians against Indians

	Dependent variable:
	VDC
Intercept	3.551^{***} (0.241)
Phone d	−0.024 (0.335)
Phone g	−0.508 (0.308)
Language Hindi	−0.159 (0.336)
Phone d:Language Hindi	0.379 (0.486)
Phone g:Language Hindi	0.654 (0.468)
Group Effect	0.014 (0.481)
Group Effect:Phone d	0.370 (0.670)
Group Effect:Phone g	−0.212 (0.617)
Group Effect:Language Hindi	−0.534 (0.673)
Group Effect:Phone d:Language Hindi	0.535 (0.972)
Group Effect:Phone g:Language Hindi	−0.206 (0.935)
Observations	3,832
Log Likelihood	−534.256
Akaike Inf. Crit.	1,092.511
Note:	*p<0.05; **p<0.01; ***p<0.001

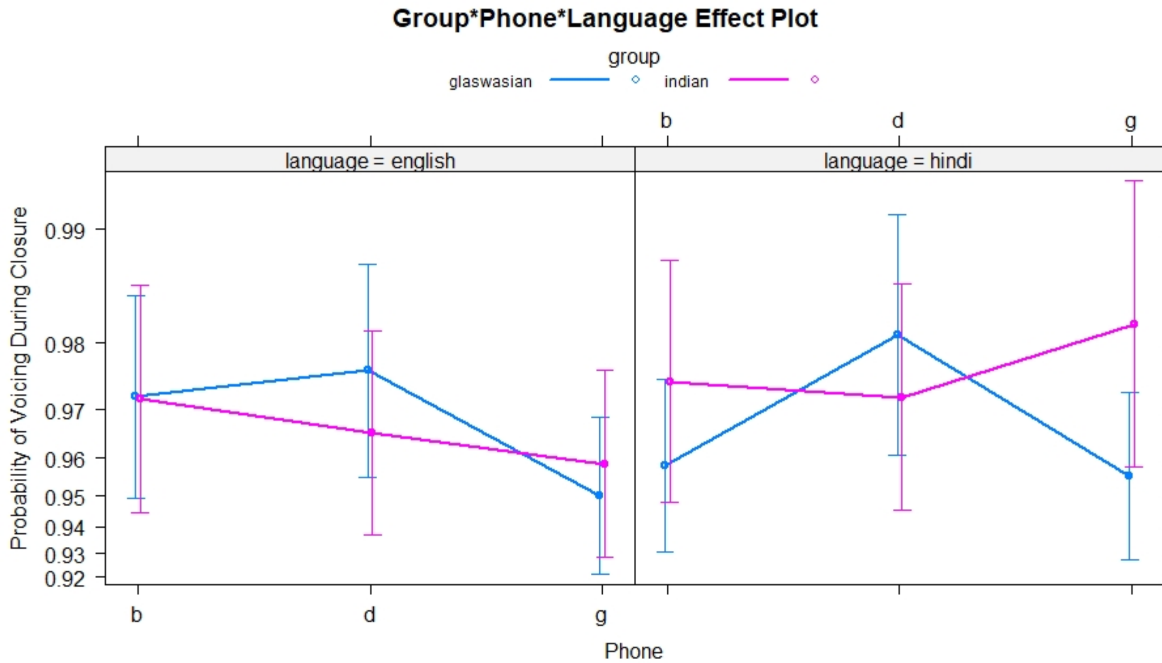


Figure 3.30: The effect of interaction between Group, Language and Phone on VDC (categorized as 'none' versus 'some/all') in Table 3.21

The intercept in this model (the grand mean of Glaswasians and Indians for English /b/) had a positive log-odds ratio ($b = 3.551, p < .001$). This indicates higher likelihood of having some/all VDC over none in /b/ in English. As seen in the model summary (Table 3.21), none of the other effects or interactions were significantly different from the intercept. Therefore, Glaswasians and Indians had similarly higher likelihood of having any VDC ('some' or 'all') than no VDC across Phone and Language.

To summarise the findings from the 'None versus Some/All' Model:

1. In English, Indians had higher probability for 'any' ('some' or 'all') VDC than Glaswegian for all three voiced stops. On the other hand, Indians and Glaswasians had similarly higher probability of 'any' ('some' or 'all') VDC in all the three voiced stops in English.

2. In Hindi, Indians and Glaswasians had similarly higher probability of 'any' ('some' or 'all') VDC in all the three voiced stops

Therefore, based on the above summary, there was no transfer in Glaswasians for VDC in all three voiced stops in the 'None versus Some/All' model.

3.3.3.2.2 Some versus All Model

In the first stage of 'Some versus All' VDC analysis, a logistic mixed model was fitted to predict VDC as a function of Group (Glaswegian/ Indian) and Phone (b/ d/ g) in English. An interaction was specified between Group and Phone, and a random intercept was added for Speaker. Figure 3.31 presents the distribution of 'some' versus 'all' VDC across the voiced stops and groups.

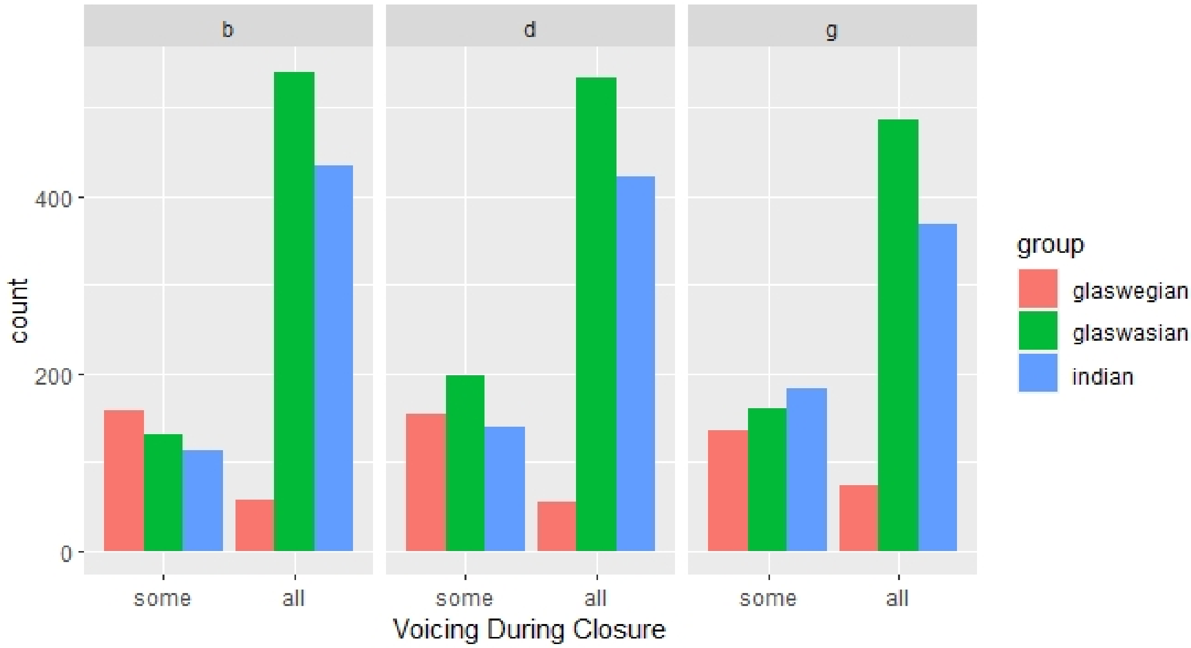


Figure 3.31: The distribution of 'some' versus 'all' VDC across Phone and Group

Table 3.22 presents the model summary and Figure 3.32 visualises the interaction effect between Group and Phone on VDC for the control groups in English only.

Table 3.22: Model summary for the 'Some versus All' Model for the control groups

	Dependent variable:
	VDC
Intercept	0.158 (0.257)
Phone d	−0.141 (0.170)
Phone g	0.033 (0.165)
Group Effect	-3.215^{***} (0.261)
Group Effect:Phone d	0.135 (0.340)
Group Effect:Phone g	1.021^{**} (0.332)
Observations	1,469
Log Likelihood	−717.071
Akaike Inf. Crit.	1,448.142
Bayesian Inf. Crit.	1,485.188
Note:	*p<0.05; **p<0.01; ***p<0.001

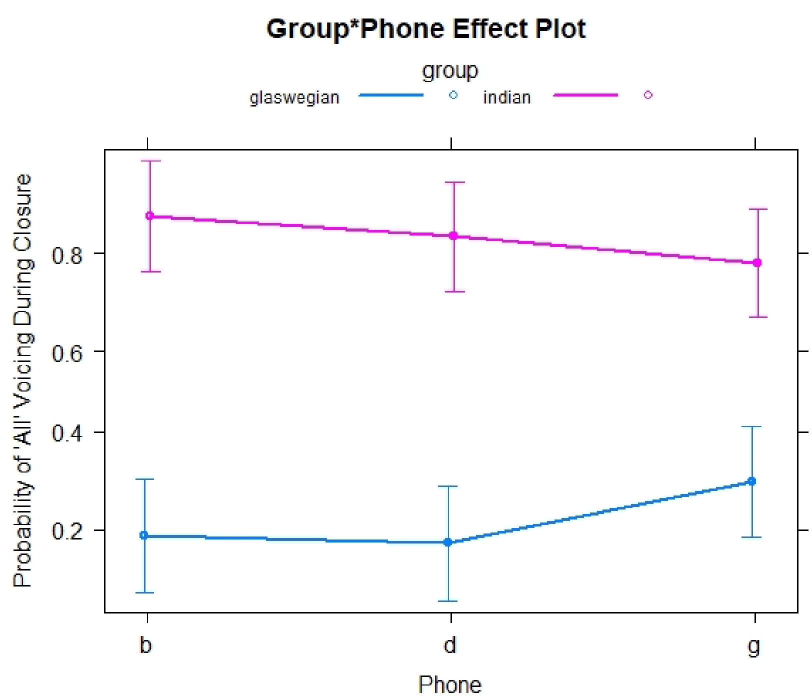


Figure 3.32: The effect of interaction between Group and Phone on VDC (categorized as 'some' versus 'all') in English /b d g/ in Model 3.22

The intercept for this model (Table 3.22) represents the grand mean of the log-odds of Glaswegians and Indians for the Phone /b/ in English. It is not significantly different from 0 and represents equal likelihood of having 'some' or 'all' VDC ($\beta = .16, p = 0.540$). The simple effects of Phone for /d/ and /g/ (/d/ ($\beta = -0.14, p = .408$); /g/ ($\beta = .03, p = .840$)) were not significantly different from the intercept and had equally similar likelihood of having partially or fully voiced closures.

For /b/ in English, there was a significant Group Effect ($\beta = -3.21, p < .001$), such that Indians had significantly higher likelihood of having 'all' VDC (that is, fully voiced closures) than Glaswegians for whom this probability was lower than .5 (that is, higher likelihood of partially voiced closures; as seen in Figure 3.32). For /d/ in English, the Group Effect was not significantly different from the Group Effect for /b/ ($\beta = 0.13, p = .692$). For /g/ in English, however, the Group Effect was significantly smaller than the Group Effect for /b/ ($\beta = 1.02, p = .002$). Nevertheless, Indians still had a higher likelihood for 'all' VDC (above .5), whereas Glaswegians still had a lower likelihood for 'all' VDC (below .5), as seen in Figure 3.32. The following presents the results of the analysis testing whether the experimental group, Glaswasians, is different from the Indian control group.

In the second stage of 'Some versus All' VDC analysis, another logistic model was fitted to predict VDC as a function of Group (Glaswasian/ Indian), Language (English/ Hindi) and Phone (b/ d/ g). Interaction was specified between Group, Language and Phone along with all the lower level interactions. A random intercept for Speaker was not included due to issues of convergence. The model's explanatory power was very weak (Tjur's R^2 = 0.02) Table 3.23 presents the summary of this model and Figure 3.33 plots the interaction between Phone, Group and Language within this model.

Table 3.23: Model summary for the ‘Some versus All’ Model for Glaswasians against Indians

	Dependent variable:
	VDC
Intercept	1.355^{***} (0.100)
Phone d	-0.357^{**} (0.135)
Phone g	-0.427^{**} (0.135)
Language Hindi	0.071 (0.144)
Phone d:Language Hindi	0.052 (0.194)
Phone g:Language Hindi	-0.090 (0.194)
Group Effect	-0.036 (0.199)
Group Effect:Phone d	-0.410 (0.269)
Group Effect:Phone g	-0.099 (0.270)
Group Effect:Language Hindi	0.207 (0.289)
Group Effect:Phone d:Language Hindi	0.470 (0.387)
Group Effect:Phone g:Language Hindi	0.906^{*} (0.389)
Observations	3,710
Log Likelihood	$-2,049.142$
Akaike Inf. Crit.	4,122.284
Note:	*p<0.05; **p<0.01; ***p<0.001

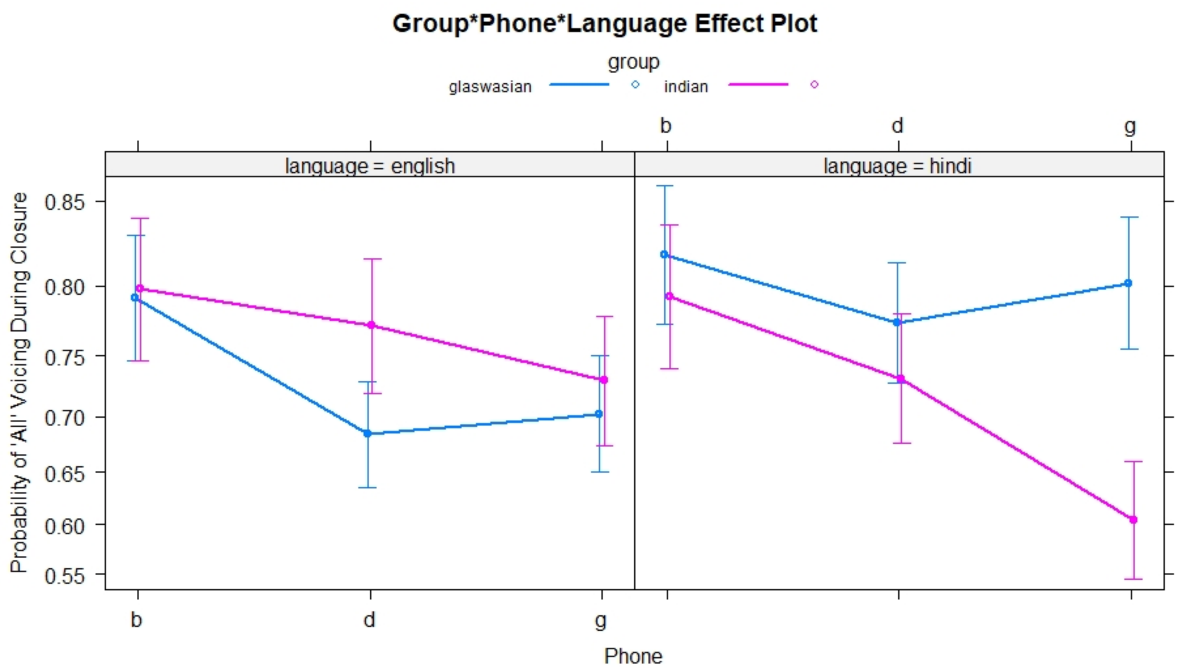


Figure 3.33: The effect of interaction between Group, Language and Phone on VDC (categorized as 'some' versus 'all') in Table 3.23

In this model (Table 3.23), the Intercept represents the grand mean of the log-odds of Glaswasians and Indians for /b/ in English. This had a positive log-odds ratio ($b = 1.35, p < .001$) indicating higher likelihood for 'all' VDC (that is, fully voiced closures).

There were significant effects of Phone (/d/ ($\beta = -0.36, p = .008$); /g/ ($\beta = -0.43, p = .002$)). As compared to /b/, the grand mean of log-odds ratio of Glaswasians and Indians for /d/ and /g/ in English was smaller, but nevertheless positive. This meant that though /d/ and /g/ had lower likelihood than /b/ of having 'all' VDC, this probability was still above .5, as seen in Figure 3.33.

For /b/ in English, the Group Effect was not significant ($\beta = -0.04, p = .858$). In Hindi, the Group Effect was not significantly different than in English ($\beta = 0.21, p = .474$). For /d/ in English, the Group Effect was not significant ($\beta = -0.41, p = .127$). In Hindi, the Group Effect was not significantly different than in English ($\beta = 0.47, p = .225$). For /g/ in English, the Group Effect was not significant ($\beta = -0.10, p = .712$). However, in Hindi, the Group Effect was significantly larger than in English ($\beta = 0.91, p = .02$). Glaswasians had significantly higher likelihood of 'all' VDC than Indians. This is shown in Figure 3.33.

To summarise the findings for the 'Some versus All' Model:

1. In English, Indians had higher probability of having 'all' VDC (that is, fully voiced closures) for all three stops, whereas Glaswegians had a probability lower than .5 of having 'all' VDC (therefore, much lower likelihood of fully voiced closures) for all three stops. Glaswasians, on the other hand, had similarly higher probability for 'all' (full) VDC in all three stops as Indians.

2. In Hindi, both Glaswasians and Indians were equally likely to have 'all' VDC (that is, fully voiced closures) in /b/ and /d/. However, Glaswasians had a significantly higher probability of having full VDC for /g/ than Indians.

Therefore, there was no transfer in Glaswasians for VDC for any of the three stops in English, and for /b/ and /d/ in Hindi. However, for /g/ in Hindi, Glaswasians had significantly higher probability than Indians of having full VDC for /g/ than Indians. This is evidence of dissimilation for /g/ in Hindi, in that this stop is more voiced in the Hindi of Glaswasians, than Indians.

3.3.3.3 Relative Burst Intensity (RBI)

Table 3.24 shows the number of tokens for this variable across groups and voiced stops /b d g/.

Phone	Group	English	Hindi
/b/	Glaswegians	319	-
	Glaswasians	361	335
	Indians	285	277
/d/	Glaswegians	322	-
	Glaswasians	380	367
	Indians	291	288
/g/	Glaswegians	318	-
	Glaswasians	340	338
	Indians	290	280

Table 3.24: Number of tokens across the voiced stops /b d g/, groups and languages for RBI

Figure 3.34 depicts RBI for /b d g/ across Group, Phone and Language.

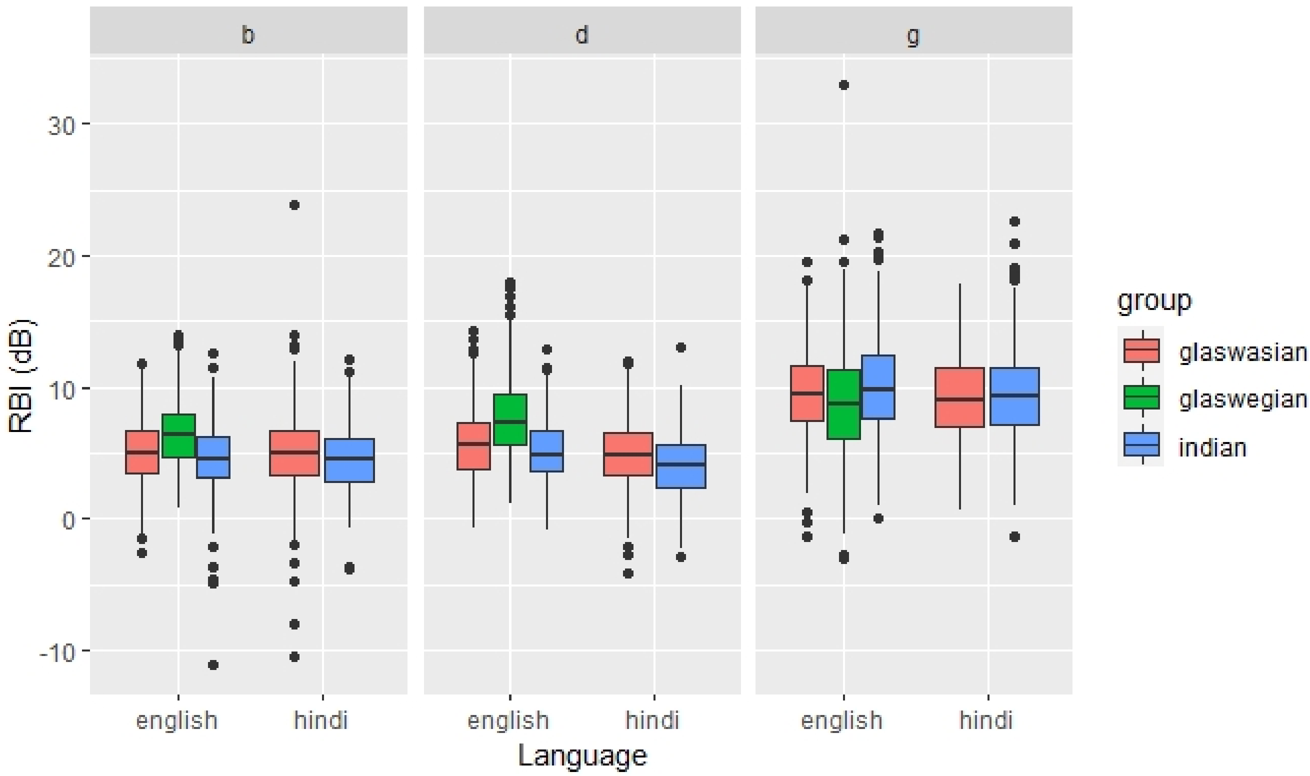


Figure 3.34: RBI for /b d g/ across Language and Group

The analysis was again performed in two stages.

In the first stage, a linear mixed model was fitted to predict RBI as a function of Phone (b/ d/ g), Group (Glaswegian/ Indian) and Vowel Height (High/ Non-High). This analysis is for the control groups in English only. The model included a random intercept for Speaker and an interaction term was specified between Phone and Group. Table 3.25 presents the summary of this below.

Table 3.25: Model summary for RBI across control groups in English

	Dependent variable:
	RBI
Intercept	6.361*** (0.263)
Phone d	0.879*** (0.168)
Phone g	3.879*** (0.168)
Vowel Height Non High	−1.229*** (0.140)
Group Effect	1.816*** (0.239)
Phone d:Group Effect	0.586 (0.335)
Phone g:Group Effect	−3.328*** (0.336)
Observations	1,823
Log Likelihood	−4,578.907
Akaike Inf. Crit.	9,175.815
Bayesian Inf. Crit.	9,225.389
Note:	*p<0.05; **p<0.01; ***p<0.001

There was a significant effect of Vowel Height ($\beta = -1.23, t(1814) = -8.81, p < .001$). According to this, when followed by non-high vowels, the voiced stops had higher RBI than when followed by high vowels (Figure 3.35) (Koffi, 2020; Ladefoged & Johnson, 2014).

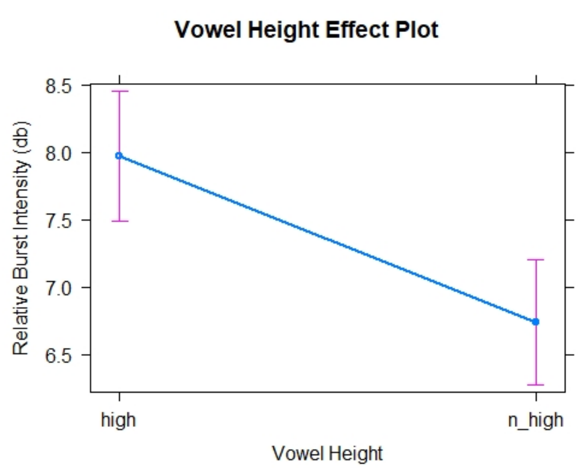


Figure 3.35: The Effect of Vowel Height on RBI in Voiced Stops

Significant simple effects for Phones /d/ and /g/ also emerged (/d/ ($\beta = 1.17, t(1814) = 5.08, p < .001$); /g/ ($\beta = 2.22, t(1814) = 9.58, p < .001$). These effects indicate that different places of articulation had different RBI values. Both phones /d/ and /g/ had lower RBI as compared to /b/ (Ogden, 2017). This can also be seen in Figure 3.36, which presents the effect plot for interaction between Phone and Group for English only in Table 3.25.

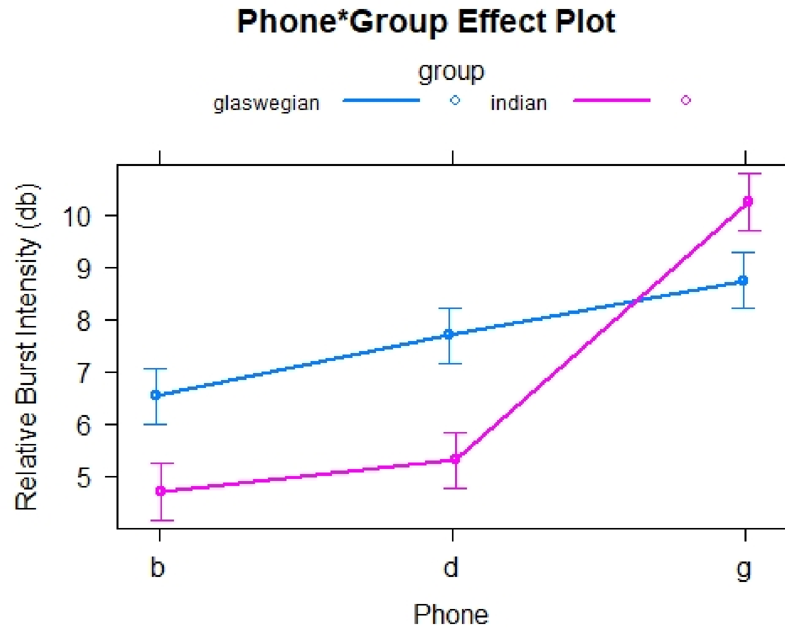


Figure 3.36: Phone by Group interaction plot for RBI in voiced stops in English in Table 3.25

Finally, significant Group Effects emerged. For /b/ in English, the Group Effect was significant ($\beta = -1.82, t(1814) = -7.59, p < .001$). However, for /d/ in English, the Group Effect was not significantly larger than for /b/ ($\beta = -0.59, t(1814) = -1.75, p = .081$). However, for /g/ in English, there was a significant difference in Group Effect relative to /b/ ($\beta = 3.33, t(1814) = 9.91, p < .001$). As shown in Figure 3.36, Glaswegians had lower RBI than Indians for /b/ and /d/, but higher RBI than Indians for /g/.

Therefore, in the following analysis, if Glaswasians have lower RBI than Indians (in direction of Glaswegians) for any of the stops except /g/ in English, it would indicate assimilation. If Glaswasians have higher RBI than Indians for any of the stops (except for English /g/), it would indicate dissimilation, whereas similar RBI for Glaswasians and Indians for any of the stops would indicate no transfer for that stop.

In the second stage of the analysis, another linear mixed model was fitted to predict RBI by Language (English/ Hindi), Phone (b/ d/ g), Vowel Height (High/ Non-High) and Group (Glaswasian/ Indian). Interactions were specified between Language, Group and Phone along with all the lower level interactions. Table 3.26 presents the model summary, whereas Figure 3.37 visualises the interaction effect between Phone, Language and Group.

Table 3.26: Model summary for the effect of interaction between Phone, Group and Language on RBI in /b d g/ for Glaswasians and Indians

	Dependent variable:
	RBI
Intercept	5.678*** (0.200)
Phone d	0.586*** (0.148)
Phone g	5.001*** (0.150)
Vowel Height Non High	−1.345*** (0.088)
Language Hindi	0.010 (0.151)
Language Hindi:Phone d	−0.841*** (0.211)
Language Hindi:Phone g	−0.422** (0.214)
Group Effect	0.296 (0.213)
Phone d:Group Effect	0.084 (0.296)
Phone g:Group Effect	−1.037*** (0.300)
Language Hindi:Group Effect	−0.074 (0.302)
Language Hindi:Phone d:Group Effect	0.413 (0.422)
Language Hindi:Phone g:Group Effect	0.378 (0.427)
Observations	3,832
Log Likelihood	−9,243.826
Akaike Inf. Crit.	18,517.650
Bayesian Inf. Crit.	18,611.420
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 3.27

	Dependent variable:
	RBI
Intercept	0.927*** (0.003)
Phone d	−0.008*** (0.002)
Phone g	−0.065*** (0.002)
Vowel Height Non High	0.018*** (0.001)
Language Hindi	−0.001 (0.002)
Language Hindi:Phone d	0.011*** (0.003)
Language Hindi:Phone g	0.005 (0.003)
Group Effect	−0.003 (0.003)
Phone d:Group Effect	−0.001 (0.004)
Phone g:Group Effect	0.014*** (0.004)
Language Hindi:Group Effect	0.001 (0.004)
Language Hindi:Phone d:Group Effect	−0.006 (0.006)
Language Hindi:Phone g:Group Effect	−0.005 (0.006)
Observations	3,832
Log Likelihood	7,304.757
Akaike Inf. Crit.	−14,579.510
Bayesian Inf. Crit.	−14,485.750
Note:	*p<0.05; **p<0.01; ***p<0.001

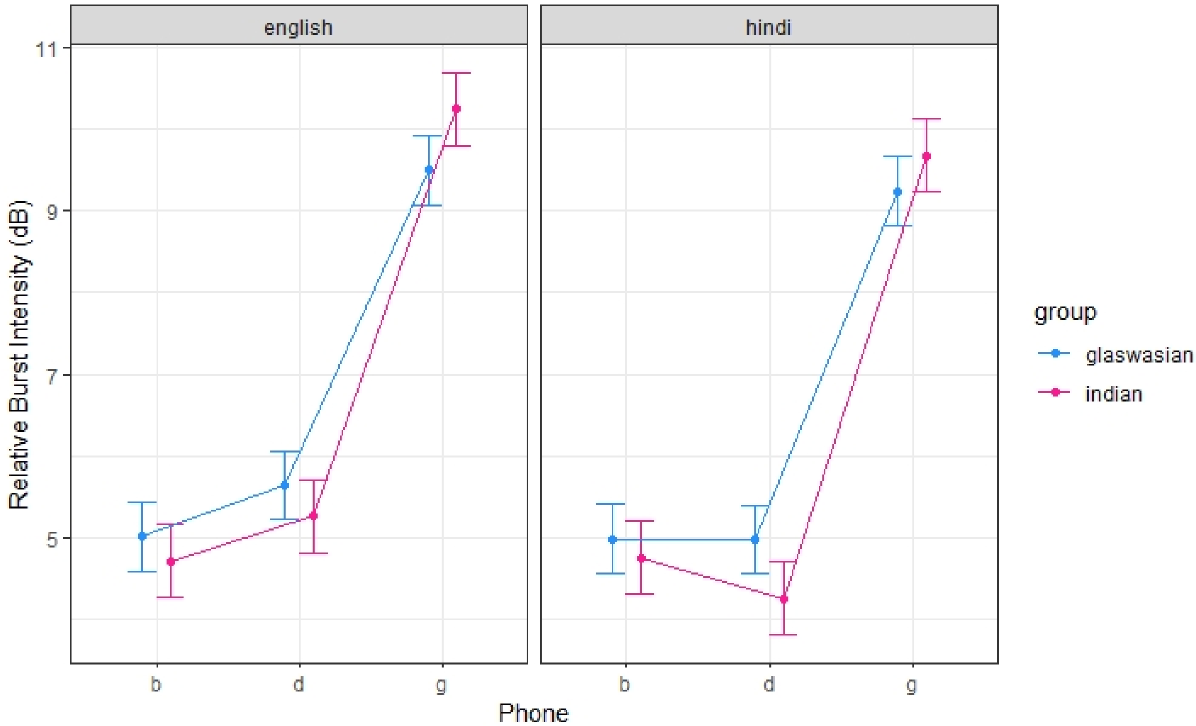


Figure 3.37: The effect of the interaction between Phone, Group and Language on RBI in /b d g/ for Glaswasians and Indians

A significant effect of Vowel Height emerged here as well, in the same direction as in Table 3.25: RBI was significantly higher when followed by a non-high vowel, than when followed by a high vowel($\beta = -1.34, t(3817) = -15.29, p < .001$) (Koffi, 2020; Ladefoged & Johnson, 2014).

Simple effects of Phone emerged here (averaged across Glaswasians and Indians in English) in the same direction as in Model 3.25. Different places of articulation had different RBI values: phones /d/ and /g/ had significantly much lower RBI as compared to /b/ (/d/ ($\beta = 0.63, t(3817) = 3.21, p = .001$); /g/ ($\beta = 4.48, t(3817) = 22.27, p < .001$). This can be seen in Figure 3.37.

For /b/ in English, the Group Effect was not significant ($\beta = -0.30, t(3817) = -1.39, p = .164$). This was also the case for Hindi ($\beta = 0.07, t(3817) = 0.25, p = .806$). Therefore, Glaswasians and Indians had similar RBI for /b/ in English and Hindi.

For /d/ in English, the Group Effect was non-significantly different from /b/ ($\beta = -0.08, t(3817) = -0.28, p = .777$). Additionally, the Group Effect in Hindi was not significantly different from the Group Effect in English ($\beta = -0.41, t(3817) = -0.98, p = .328$). Thus, Glaswasians and Indians had similar RBI in English and Hindi for /d/.

For /g/ in English, there was a significant Group Effect ($\beta = 1.04, t(3817) = 3.46, p < .001$) relative to /b/. This meant that Glaswasians had higher RBI compared to Indians (Figure 3.37). In Hindi, the Group Effect was not significantly different from the Group Effect in English ($\beta = -0.38, t(3817) = -0.88, p = 0.377$).

To sum up,

1. RBI for different places of articulation was found to be different as described here: /b/ had the highest RBI, followed by /d/ and /g/ (Ogden, 2017).

2. The following pattern was found for RBI across Group in English:

   (a) **/b d/:** $Glaswasian = Indian > Glaswegian$. Glaswegians had lower RBI than both Indians and Glaswasians who had similar RBI for /b/ and /d/ in English.

   (b) **/g/:** $Glaswasian > Indian < Glaswegian$. Glaswegians had higher RBI than Indians. Furthermore, Glaswasians were found to have higher RBI than Indians as well.

3. The following pattern was found for RBI across Group in Hindi:

   (a) **/b/, /d/:** $Indian = Glaswasian$. Glaswasians and Indians had similar RBI for /b/ and /d/ in Hindi.

   (b) **/g/:** $Indian < Glaswasian$. Glaswasians had higher RBI than Indians for /g/ in Hindi.

Based on the above summary, the following can be concluded about transfer in Glaswasians for RBI: In English, there was no transfer in Glaswasians for /b/ and /d/, but assimilation in /g/. In Hindi, there was no transfer in Glaswasians for RBI in /b/ and /d/, but assimilation in Glaswasians for Hindi /g/. Furthermore, for RBI in /g/, there was equal amount of transfer in both language, that is, no language was more susceptible to transfer than the other.

3.3.4 The Voiceless Stop: /t/

For /t/, the dependent variable was Voice Onset Time (VOT). Table 3.28 presents raw VOT values for word-initial /t/ (in milliseconds) across Glaswegians, Glaswasians, Indians in English and Hindi.

Group	Language	
	English	Hindi
Glaswegian	90.91 ms	-
Glaswasian	21.60 ms	14.15 ms
Indian	12.45 ms	10.52 ms

Table 3.28: Raw VOT values for word-initial /t/ across Glaswegians, Glaswasians, Indians in English and Hindi

For analysis, raw VOT values were log-transformed for normalising variability. Glaswasians had a total of 365 and 375 tokens in English and Hindi respectively. Glaswegians had 321 tokens in English. Indians had 273 and 266 tokens in English and Hindi respectively.

Figure 3.38 depicts log VOT for /t/ across English and Hindi for Glaswasians, Glaswegians and Indians. In this graph, the more negative the log VOT value, the shorter the VOT duration.

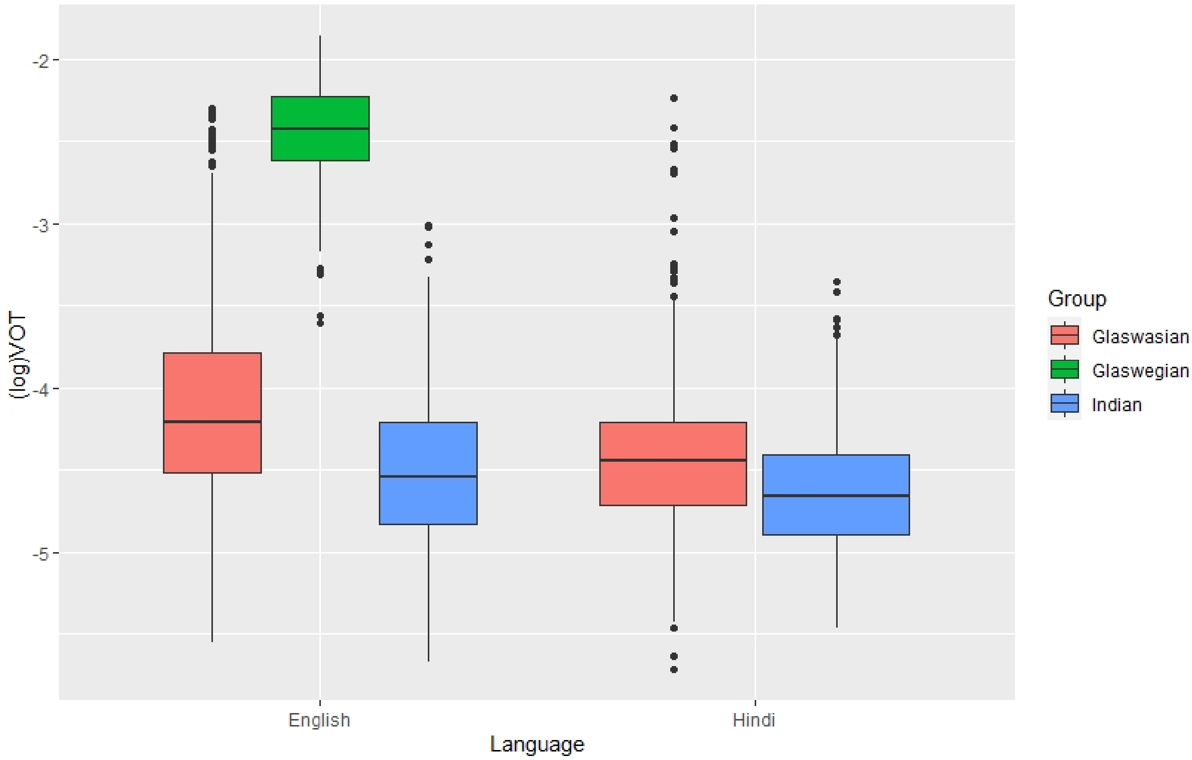


Figure 3.38: Log VOT in word-initial /t/ across Glaswasians, Glaswegians and Indians in English and Hindi

In the first stage of analysis, a linear mixed model was fitted to predict log VOT in English as a function of Group (Glaswegian/ Indian) and Vowel Height (High/ Non High). The model included a random intercept for Speaker. No interaction between any of these variables was specified. Table 3.29 presents the summary of this model.

Table 3.29: Model summary for control groups in English for VOT in /t/

	Dependent variable:
	Log VOT
Intercept	-3.439^{***} (0.043)
Group Effect	2.049^{***} (0.027)
Vowel Height Non High	-0.055^{*} (0.027)
Observations	594
Log Likelihood	-206.437
Akaike Inf. Crit.	422.873
Bayesian Inf. Crit.	444.808
Note:	*p<0.05; **p<0.01; ***p<0.001

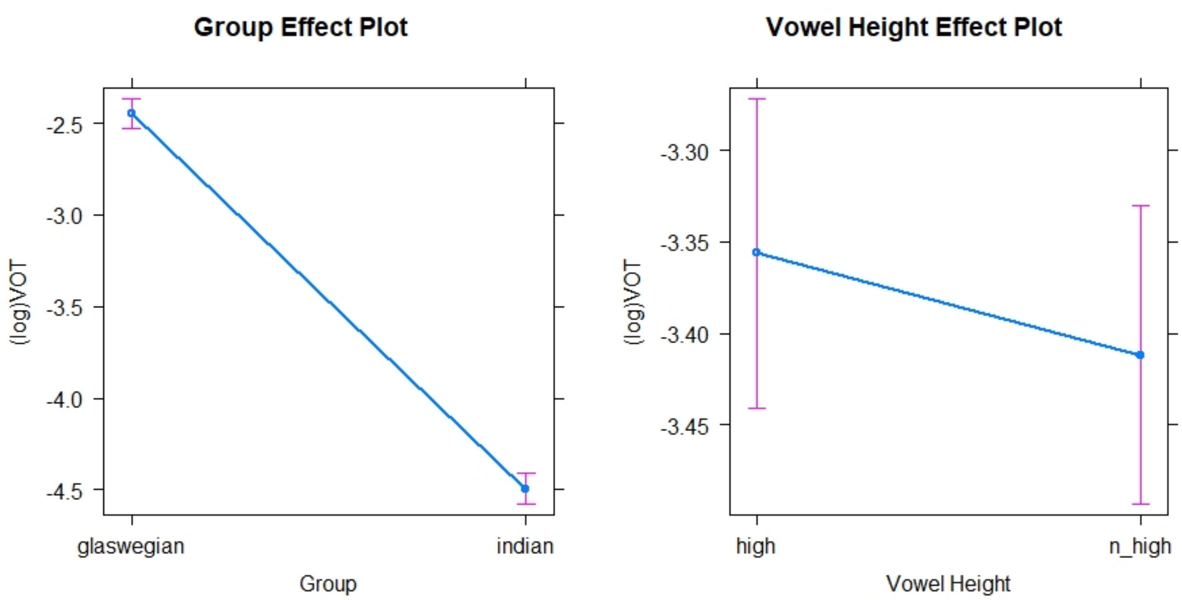


Figure 3.39: Significant effects of Group (left) and Vowel Height (right) on log VOT in word-initial /t/ in English in control groups in Table 3.29

A significantly negative effect emerged for Non High Vowel Height ($\beta = -0.06, t(589) = -2.09, p = 0.037$), as shown in Figure 3.39. This meant that when followed by a non-high vowel, /t/ had a more negative log VOT (shorter VOT) than when followed by a high vowel (also reported by Docherty, 1992; Klatt, 1975; Stuart-Smith et al., 2015).

Furthermore, as shown in Figure 3.39, a significant Group Effect also emerged ($\beta = 2.05, t(589) = 76.31, p < .001$). Glaswegians had less negative log VOT (longer VOT) than Indians in English. This is important for the next stage of analysis of log VOT: if Glaswasian /t/ has longer VOT than

Indians (in direction of Glaswegians), then it would be indicative of assimilation; if Glaswasian /t/ has shorter VOT than Indians, then it would be indicative of dissimilation. However, if Glaswasian /t/ has similar VOT as Indians, then that would be indicative of no change.

In the second stage of this analysis, another linear mixed model was fitted to predict log VOT by Language (English/ Hindi), Group (Glaswasian/ Indian) and Vowel Height (High/ Non-High). There was also an interaction specified between Language and Group. This model included a random intercept for Speaker. The model summary is presented in Table 3.30.

Table 3.30: Model summary for log VOT in word-initial /t/ as a function of Group, Language and Vowel Height in Glaswasians and Indians

	Dependent variable:
	Log VOT
Intercept	-4.208^{***} (0.050)
Vowel Height Non High	-0.117^{***} (0.025)
Language Hindi	-0.224^{***} (0.025)
Group Effect	0.348^{***} (0.036)
Language Hindi:Group Effect	-0.178^{***} (0.050)
Observations	1,279
Log Likelihood	−821.800
Akaike Inf. Crit.	1,657.601
Bayesian Inf. Crit.	1,693.678
Note:	$^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

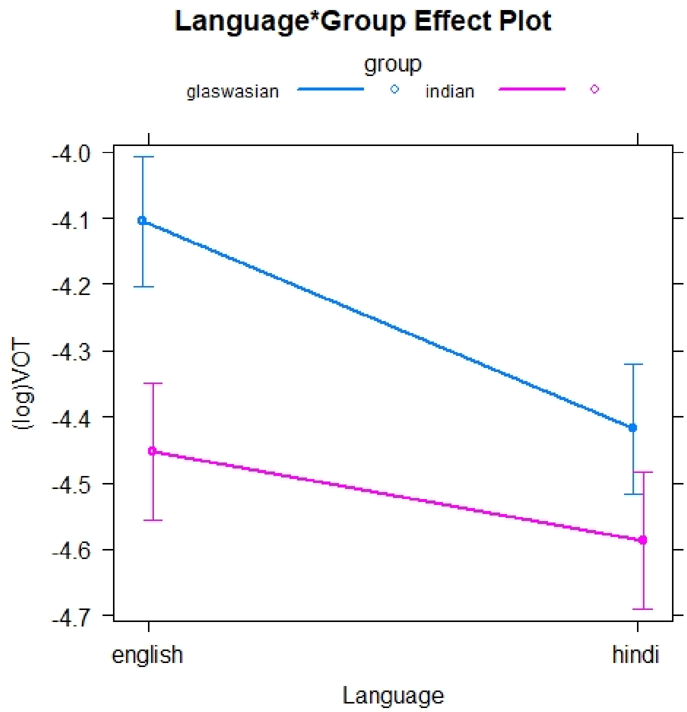


Figure 3.40: Interaction between Group and Language for log VOT in word-initial /t/ for Glaswasians and Indians in Table 3.30

The effect of Vowel Height again emerged as significant, in the same direction as Table 3.29 ($\beta = -.117, t(1272) = -4.69, p < .001$) (Docherty, 1992; Klatt, 1975; Stuart-Smith et al., 2015).

Significant effects emerged for Language ($\beta = -0.22, t(1272) = -9.01, p < .001$) and Group ($\beta = 0.35, t(1272) = 9.58, p < .001$), along with an interaction between them ($\beta = -0.18, t(1272) = -3.57, p < .001$). The nature of the effect of Language was that Hindi had more negative log VOT (shorter VOT) than English in general. The nature of the significant Group Effect was that in English, Glaswasians had less negative log VOT (longer VOT) than Indians. In Hindi, the Group Effect was significantly smaller than in English. That is, the difference in VOT between the two groups was much bigger in English than in Hindi. This is shown in Figure 3.40.

All the above findings from the two-part analysis of log VOT in /t/ have been summarised below:

1. The pattern for VOT across Group in English was: *Indian* < *Glaswegian*. This suggests that Glaswegians had longer VOT than Indians. Glaswasians also had longer VOT than Indians.

   The pattern for VOT across Group in Hindi was: *Indian* < *Glaswasian*. This represents that Glaswasians had longer VOT in Hindi as compared to Indians.

2. The difference in VOT between Glaswasians and Indians was bigger in English than in Hindi.

Based on the above summary, the following can be concluded about transfer in Glaswasians: in English as well as Hindi, Glaswasians had longer VOT than Indians (in direction of Glaswegians). This is evidence of assimilation in both languages. Additionally, the amount of transfer received by Glaswasians in English was different from the transfer received in Hindi: English received more transfer than Hindi. This shows that for VOT in /t/, English was more susceptible to transfer from Glaswegian English, than Hindi.

3.4 Discussion

The purpose of the speech production task was to answer the following two questions:

1. Is there a backward transfer of Glaswegian English (GE) on Indian English (IE) and Hindi? If yes, did it appear as assimilation or dissimilation?

2. Does IE exhibit more transfer from GE than Hindi?

These questions have now been answered with reference to Table 3.31, which summarises the findings from the acoustic analysis.

Sound	**Measure/ Feature**	**Backward Transfer**		**No Change**	**Amount of Transfer**
		Assimilation	**Dissimilation**		
/l/	Difference between F1 and F2 (darkness)	-	English, Hindi	-	Higher dissimilation in Hindi than English
/u/	F1 (vowel height)	-	-	English, Hindi	-
	F2 (vowel frontness/ backness)	-	-	English, Hindi	-
	F3	-	-	English, Hindi	-
/b/	VOT (aspiration)	Hindi	-	English	-
	VDC (pre-voicing)	-	-	English, Hindi	-

	RBI (loudness of the burst)	-	-	English, Hindi	-
/d/	VOT (aspiration)	English, Hindi	-	-	Higher assimilation in English than in Hindi
	VDC (pre-voicing)	-	-	English, Hindi	-
	RBI (loudness of the burst)	-	-	English, Hindi	-
/g/	VOT (aspiration)	-	Hindi	English	-
	VDC (pre-voicing)	-	Hindi	English	-
	RBI (loudness of the burst)	English, Hindi	-	-	Equal amount in both
/t/	VOT (Aspiration)	English, Hindi	-	-	Higher assimilation in English than in Hindi

Table 3.31: Direction and degree of backward transfer summarised across sounds for Glaswasians' English and Hindi. Assimilation indicates phonetically more like Glaswegian, dissimilation less like Glaswegian

Table 3.31 presents the findings of the acoustic analysis across phone categories and respective measures to indicate the type of backward transfer (assimilation or dissimilation) and amount of transfer. As shown in this table, there is no evidence for backward transfer for GOOSE, whereas all consonants show some evidence of transfer. Assimilation was exhibited by /t/ and /d/ for VOT and /g/ for RBI in both languages, whereas dissimilation was exhibited by /l/ in both languages and /g/ for VOT and VDC in Hindi only. In relation to the amount of transfer, /t/ and /d/ for VOT showed higher assimilation in Indian English than Hindi, whereas /g/ for RBI showed equal amount of transfer in both languages; /l/ showed higher dissimilation in Hindi than in Indian English.

To answer the first question, yes, there was backward transfer of GE on Glaswasians' native language (Hindi) as well their native dialect of English (Indian English). Table 3.31 also shows that this transfer manifested as assimilation and dissimilation, and there were cases of no transfer as well. However, this transfer varied across sound categories and cues: the GOOSE vowel showed no evidence for backward transfer, but the consonants /l t b d g/ did. The categories /l/ and /t/ underwent dissimilation and assimilation respectively in both languages for the one measure that was examined for each category. However, when multiple measures were examined, as in the case of the voiced stops /b d g/, 'partial assimilation' (Romaine, 1989) was found in the sense that some but not all measures showed backward transfer effects (Table 3.31).

To answer the second question, Indian English did not show more instances of transfer (assimilation or dissimilation) than Hindi numerically. However, interestingly, out of the three cases where both native varieties underwent assimilation (VOT in /t/ and /d/, RBI in /g/), English showed quantitatively higher amount of assimilation than Hindi for VOT in /t/ and /d/, whereas both languages showed equal amount of transfer for RBI in /g/. On the contrary, in the one case of dissimilation in both native varieties (F2-F1 difference in /l/), Hindi showed more dissimilation than English. Thus, the process of backward transfer seems to vary by language and sound, and multiple patterns can be seen here. The sub-sections below address and discuss these two points separately:

1. Patterns of transfer found across sound categories and cues
2. Difference in transfer by language and dialect

3.4.1 The Process of Backward Transfer and Patterns of Assimilation and Dissimilation

As mentioned above, the process of backward transfer seems to vary by language, sound and cue, and several transfer patterns are seen here. Three such patterns have been identified in Table 3.31. First, Glaswasians showed equivalent behaviour of sound categories for features in both languages, such that /t/ and /d/ underwent assimilation for VOT in both native languages (that is, became more aspirated), along with /g/ for RBI (assimilated to louder bursts), whereas /l/ underwent dissimilation in both languages for F2-F1 difference (became clearer). The second pattern is that of no change, as in case of the GOOSE vowel, where no transfer was found. The third and final pattern is that of 'partial-assimilation' (Romaine, 1989), where within the same phonetic category, some features but not others underwent transfer. For example in /d/, some measures (VOT), but not others (VDC, RBI), showed a shift. The following subsections discuss these patterns in detail.

3.4.1.1 Equivalent behaviour of sound categories for features in both languages

This includes instances where a phone category exhibited the same kind of transfer outcome, that is, assimilation or dissimilation, in both languages for a given feature. Within this, the outcomes of assimilation and dissimilation have been discussed below separately.

3.4.1.1.1 Assimilation

The first pattern is that of instances where both native languages have undergone the same kind of transfer in the form of assimilation. This was found for VOT in /t/ and /d/, and RBI in /g/. According to the SLM and SLM-r (Flege, 1995b; Flege & Bohn, 2021), assimilation represents the merging of perceptually linked L1 and L2 categories, where the L1 category shifts in direction of the L2 category in the common phonetic space. This 'composite' L1-L2 category is based on the combined distribution of the respective L1 and L2 sound category tokens that the speaker has encountered. Consistent with this, all instances of assimilation in the present study indicate merged host and native category cues such that the assimilated values are intermediate between Glaswegian and native Indian realisations. Furthermore, among these three cases of assimilation, for RBI in /g/, both languages underwent the same amount of transfer to develop equally similar louder bursts across both languages. This may indicate a phonetic overlap between Hindi and IE for RBI in /g/ in Glaswasian phonology. However, this is not the case for VOT in /t/ and /d/, where IE exhibited higher assimilation than Hindi. That is, IE /t/ and /d/ became aspirated to a greater degree than their Hindi counterparts.

According to Bergmann et al. (2016), the most widely examined feature in L1 attrition/drift research is VOT, which has also been found to be particularly susceptible to assimilation. It is in relation to this claim that one needs to examine existing research on backward transfer on VOT, because in the present study, backward transfer in VOT did not manifest only as assimilation. The categories /t/ and /d/ underwent assimilation in both languages along with /b/ in Hindi; the category /g/ underwent dissimilation in Hindi (along with VDC), whereas in all other cases, VOT remained uninfluenced (/b/ and /g/ in English).

Existing research has examined a variety of language pairs and speaker groups with varying L2 proficiency and ages of L2 acquisition. Additionally, much research has examined voiceless stops, whereas there is limited research on voiced stops.

In line with Bergmann et al.'s claim (2016), in voiceless stops, VOT is indeed a prominently examined feature in L1 attrition studies. However, while there are many cases of assimilation (Flege & Eefting, 1987b; Lev-Ari & Peperkamp, 2013; Major, 1992; Mayr et al., 2012; Sancier & Fowler, 1997; Stoehr et al., 2017), there are also those of no change (Lord, 2008; Stoehr et al., 2017) and dissimilation (Flege, 1987). Even with respect to age of acquisition, the findings were mixed as early bilinguals were found to have assimilated (Harada, 2003), dissimilated (Flege & Eefting, 1987a), or not changed (Kang & Guion, 2006) their L1 categories. The studies were conducted on multiple language pairs which may contribute to findings of such different transfer patterns on the basis of differences in the phonetics of their respective stop series. It also appears that shifts in L1 VOT are subject to factors other than age of L2 acquisition or L2 proficiency.

Limited research on L1 attrition/drift has examined VOT in voiced stops. The measure that is most examined with respect to the voiced stops is pre-voicing. The present study, however, examined Voicing During Closure (VDC) which is a measure of pre-voicing, but relative to the closure duration of the stop. As VDC does not seem to have been examined in any other studies on backward transfer, the findings for VDC in the present study are interpreted with respect to previous findings of backward transfer for pre-voicing in the voiced stops.

The results of these studies are more complicated. While some report no changes in voicing patterns in L1 voiced stops due to L2 influence (Flege & Eefting, 1987a; Mayr et al., 2012; Stoehr et al., 2017), some do (Herd, Walden, Knight, & Alexander, 2015; Huffman & Schuhmann, 2016; Schuhmann & Huffman, 2015). However, there may be a pattern here which is related to the salience of this feature either in the L1 or L2. That is, the studies which reported no change in pre-voicing in L1 voiced stops examined L1-L2 pairs of Spanish-English, Dutch-English and Dutch-German respectively (Flege & Eefting, 1987b; Mayr et al., 2012; Stoehr et al., 2017). Interestingly, here both L1s, Spanish and Dutch, use pre-voicing as a primary cue for voicing contrast (Lisker & Abramson, 1964; Mayr et al., 2012; Williams, 1977) which has the highest weight (Hauser, 2021)), whereas the L2s generally only realise the voiced stops with short-lag VOT. Both Mayr et al. (2012) and Stoehr et al. (2017) argue that pre-voicing functions as a critical cue for the identification of voiced plosives in Dutch. Therefore, greater acoustic salience of pre-voicing in these L1 voiced stops may keep them from exhibiting an influence of the L2. This is further supported by studies that showed a shift in voicing patterns in L1 due to L2 transfer (Herd et al., 2015; Huffman & Schuhmann, 2016; Schuhmann & Huffman, 2015). Herd et al. (2015) examined phonetic drift in voiced stops in L1 English-L2 Spanish speakers at different L2 proficiency levels: beginning, intermediate, advanced and near-native. The results showed that advanced and near-native L2 speakers produced L1 voiced stops with more pre-voicing than beginners, due to L2 Spanish influence. This was also found in another study on L1 English learners of L2 Spanish (Schuhmann & Huffman, 2015). Therefore, it appears that speakers with L1 Spanish, in which pre-voicing is a salient feature, may resist shifting in the face of L2 English (as shown by Flege and Eefting (1987b)), but speakers of L1 English may show a shift towards the more salient feature of pre-voicing by exhibiting higher pre-voicing due to L2 Spanish influence (as shown by Herd et al. (2015); Huffman and Schuhmann (2016); Schuhmann and Huffman (2015)). With reference to short-lag VOT, Chang (2012, 2013) also reported a lack of L2 effects on L1. The one case of assimilation, however, comes from Kang and Guion (2006) who reported the shift of their L1 Korean VOT towards L2 English in late bilinguals.

So, it seems that while pre-voicing patterns in L1 do not seem to be very susceptible to shifting, especially in cases where it is a primary cue to voicing contrast (Flege & Eefting, 1987a; Mayr et al., 2012; E. Simon, 2009; Stoehr et al., 2017), it is possible that short-lag VOT, if not prone to a certain kind of shift, can comparably more easily shift as was found by Kang and Guion (2006).

The present study seems to replicate the findings of previous research of no assimilation in pre-voicing patterns in L1 (Hindi and Indian English) due to the influence of the L2 (Glaswegian English; Table 3.31). For /b/ and /d/, Glaswasians did not differ from Indians in their VDC patterns. For /g/, Glaswasians did not differ from Indians in their VDC patterns for English, but exhibited a dissimilatory shift in Hindi. This dissimilatory shift indicates an exaggeration of the Indic pattern of pre-voicing, as opposed to becoming more Glaswegian-like with reduced percentage of pre-voicing. Thus, this finding seems to confirm that pre-voicing, which is known to be a prominent feature of Indic voiced stops (Davis, 1994; Hauser, 2021; Lisker & Abramson, 1964; Pruitt et al., 2006; Schertz & Khan, 2020), is not quite susceptible to assimilating towards the L2 pattern, but rather was found to be exaggerated to maintain a difference between them in case of Hindi /g/. In terms of short-lag VOT in voiced stops, instances of assimilation and no change were found in the present study (Table 3.31). So it seems that compared to pre-voicing (VDC), short-lag VOT might be easier to undergo assimilation in voiced stops due to L2 influence.

Apart from VOT, the other feature that underwent assimilation in the present study is Relative Burst Intensity (RBI), but only in /g/ in both languages (Table 3.31). In /b/ and /d/, this feature remained unchanged, as Glaswasians had similar RBI patterns for these stops as Indians. However, only rarely has this cue been examined in backward transfer research to be able to draw a pattern about it here. Kirkham (2011) examined RBI, but in relation to hybrid accents exhibited by 2nd and 3rd generation speakers of heritage languages. In terms of actual transfer studies, I examined RBI as part of my M.Sc. thesis (Shaktawat, 2018a), and found instances of assimilation and no change in Glaswasians. On the one hand, the stop /d/ was found to have undergone assimilation in both Hindi and English, and /b/ and /g/ underwent assimilation in Hindi only. On the other hand, both /b/ and /g/ remained unchanged for this cue in English. In any case, in both these studies (Shaktawat, 2018a and the present study), RBI did not undergo dissimilation, and as a cue seems to be more susceptible to assimilation than dissimilation. This indicates a trend towards louder bursts in voiced stops for both Hindi and English, irrespective of how voiced they are.

3.4.1.1.2 Dissimilation

The second pattern identified here is that where both languages have undergone transfer in the form of dissimilation. This is the case of F2-F1 difference in word-initial /l/ (Table 3.31), where Glaswasians were found to have dissimilated or exaggerated the Indic feature of clearer /l/ in both their languages to contrast it from the Glaswegian English darker /l/. Furthermore, though it remains statistically untested, based on Figure 3.14, it seems that Glaswasians have developed a phonetic overlap for their English and Hindi /l/, and are using the same category for both their native languages.

While the examination of /l/ in previous research on backward transfer is not as extensive as that of VOT, some work has examined /l/ in this regard (Barlow, 2014; Bergmann et al., 2016; E. de Leeuw, Mennen, & Scobbie, 2013; Shaktawat, 2018a). An assimilatory shift of L1 /l/ in direction of the L2 was reported in three of these studies (Barlow, 2014; Bergmann et al., 2016; E. de Leeuw, Mennen, & Scobbie, 2013). By contrast, in Glaswasians, Shaktawat (2018a) reported dissimilation in Hindi, but assimilation in Indian English. This suggests that there may be something specific about the Glaswasian group and this combination of languages which is related to this dissimilatory pattern. In the present study as well, transfer occurred in the form of dissimilation, and not just in one, but both native languages.

There is a possible argument for this dissimilatory shift found in Glaswasians in the present study and in Shaktawat (2018a), which has to do with the 'Cross-Sectional Methodology Criticism in Determining L1 Attrition Argument' (E. de Leeuw, Mennen, & Scobbie, 2013) and diachronic language change. This criticism argues that shifts in the L1 may be found not because of L1 attrition or backward transfer, but because the language of the monolingual controls has undergone a change since the bilinguals moved out of the country (E. de Leeuw, Mennen, & Scobbie, 2013). Therefore, in case of /l/, it can be argued that the dissimilatory effects are produced here because the control Indian Hindi /l/ got darker after Glaswasians left for Glasgow. Therefore, when compared with the Indian control group, it is because of this changing nature of /l/ in India, that the Glaswasian /l/ appears clearer and taken to be indicative of dissimilation. This seems reasonable as previous research argues that /l/ in Hindi has a clearer realisation (Gargesh, 2008; Wells, 1982), but in the present study and in Shaktawat (2018a), Hindi /l/ was much darker than its English counterpart (Table 3.32). In the present study, the mean F2-F1 difference in the Indian control group was 1181 Hz in Hindi, but 1277 Hz in English; in Shaktawat (2018a), the mean F2-F1 difference in the Indian control group was 1019 Hz in Hindi, but 1351 Hz in English. So, in the Indian control group, Hindi /l/ is darker than Indian English /l/ in both studies. However, when F2-F1 difference in these two studies are compared like this, it also appears that Indian control /l/ in Hindi is clearer now than it was in 2018, which does not support the assumption that Indian Hindi /l/ is possibly getting darker.

Study	**Language**	**Feature/Measure (Hz)**	**Glaswegian**	**Indian**	**Glaswasian**
Present	English	F1	381	364	359
		F2	1096	1641	1704
		F2-F1	714	1277	1344
	Hindi	F1		376	379
		F2	-	1557	1722

Study	Language	Feature/Measure (Hz)	Glaswegian	Indian	Glaswasian
		F2-F1		1181	1344
Shaktawat (2018a)	English	F1	-	381	365
		F2	-	1732	1637
		F2-F1	-	1351	1272
	Hindi	F1	-	393	367
		F2	-	1412	1497
		F2-F1	-	1019	1130

Table 3.32: Formant frequencies of /l/ by language and speaker group in the present study and in Shaktawat, 2018a. Note: Glaswegians were not recruited in Shaktawat (2018a)

At the same time, the participants in the Indian control group in the present study and in Shaktawat (2018a) are different. The present study has more participants than Shaktawat (2018a) and the number of participants recruited from each Indian state are different in the two studies, and therefore speak different Indo-Aryan regional languages. It was not possible to remove the influence of these different regional languages, some of which like Marathi, Punjabi, Gujarati and Rajasthani are known to also have a retroflex /l/ which is absent in Hindi (Aarti & Kopparapu, 2018; Karamat, 2001; Ohala, 1991). It is possible then that it is the influence of this regional retroflex /l/ which is what we are witnessing in these frequency values. While examining perception of Malayalam (a Dravidian language spoken in South India), Agrawal and Savithri (2005) reported that in Malayalam, the retroflex lateral had lower F2 and F3 than the alveolar lateral, and was also more susceptible to variation based on the vowel context. It is true that the formant frequencies found in Malayalam retroflex /l/ cannot be directly applied to those in Indo-Aryan languages. But due to a lack in research on the acoustic correlates of /l/ based on various Indian regions or languages that the present study is concerned with, the kind of influence of retroflex /l/ on alveolar /l/ cannot be ascertained. But such a change, if it could be confirmed in future work, would switch the pattern observed in /l/ from dissimilation to assimilation to the native realisation.

Furthermore, E. de Leeuw, Mennen, and Scobbie (2013) also presents an argument against the ‘Cross-Sectional Methodology Criticism in Determining L1 Attrition Argument’ on the basis that they found much interpersonal variation in L1 attrition in their group of German-English bilinguals such that some late bilinguals did perform like the control German monolinguals, while others did not. It is this interpersonal variation and similar performance of some bilinguals and monolinguals that E. de Leeuw, Mennen, and Scobbie (2013) take to be the evidence of L1 attrition and not simply the consequence of diachronic language change in the monolinguals. The present study also examines the effect of multiple factors in affecting transfer in Glaswasians, so it may be possible to observe if some Glaswasians are indeed patterning with the Indian controls or not.

3.4.1.2 No change

The next pattern is that of no transfer exhibited by any of the features of a phone category in either language. This was the case of Glaswasians' GOOSE vowel, where all examined formant measures (F1, F2, F3) remained unchanged in both native languages.

Along with VOT in stops, spectral properties of vowels have been examined extensively in research on backward transfer. This research can further be divided into studies that have examined the general L1 vowel space (Chang, 2012, 2013; Guion, 2003; Mayr et al., 2012) and studies that have examined individual L1 vowel/s (Bergmann et al., 2016; Flege, 2003; Flege & Eefting, 1987b; Kartushina, Hervais-Adelman, et al., 2016; Mora & Nadeu, 2012; Oh et al., 2011). However, the findings of all these studies, when taken together, do not indicate consistent backward transfer effects, as there is evidence of assimilation, dissimilation as well as no change.

Of these three examinations of backward transfer in vowels on a global level in the L1-L2 pairs of Quichua-Spanish, Dutch-English and English-Korean respectively, Guion (2003) found evidence of dissimilation, whereas, Mayr et al. (2012) and Chang (2012) found assimilation of the L1 vowel space. Of the studies that examined backward transfer in selected individual L1 vowel categories, Flege (1987) found no change (in French-English bilinguals), Flege, Schirru, and MacKay (2003) reported dissimilation in early bilinguals and assimilation in late Italian-English bilinguals, Oh et al. (2011) found patterns of assimilation, dissimilation as well as no change respectively across three categories in Japanese-English children, but only assimilation across all three categories in adults. Both Kartushina, Hervais-Adelman, et al. (2016) and Bergmann et al. (2016) reported assimilation in some categories and no change in the rest. By contrast, Mora and Nadeu (2012) reported assimilation in both production and perception of two vowel categories. So, it appears that though vowels are susceptible to backward transfer effects, unlike VOT in voiceless stops, this effect may not consistently be that of assimilation.

In relation to the present findings of no change in Glaswasians' GOOSE vowel, two reasons are proposed here. The first can be attributed to the perceived similarity/dissimilarity between L1-L2 counterparts. It is possible that, as suggested by Bergmann et al. (2016), the L1-L2 GOOSE counterparts in these studies were not similar enough to be linked as diaphones and therefore undergo assimilation. This may also be the case if they are perceived as identical. The second identified reason is individual variation among the speaker groups. That is, individual speakers may be shifting in different directions (some assimilating and others dissimilating), which on average, would render the Group effect non-significant.

3.4.1.3 Partial Assimilation: Within the same phonetic category, some cues but not others underwent transfer

The final pattern seen in the findings here is that of 'partial-assimilation' (Romaine, 1989) where some cue(s) within the same phonetic category underwent transfer (assimilation or dissimilation), whereas others did not. This is the case for the voiced stops /b d g/ (Table 3.31): the voiced stops /b d/ remained unchanged for VDC (pre-voicing) and RBI (Relative Burst Intensity) in Hindi and English, but showed assimilation for VOT such that Hindi /b/ underwent assimilation and both English and Hindi /d/ underwent assimilation; the voiced stop /g/ showed assimilation in both languages for RBI, remained unchanged in English for VDC and VOT, and underwent dissimilation in Hindi for VDC and VOT. These findings prompt the important question of why some cues but not others underwent transfer within the same phonetic category. The following discussion highlights three possible reasons behind this finding, which may or may not collaborate with each other.

The first reason is related to the possibility that some cues are probably more susceptible to transfer as compared to others. This is based on the discussion in §3.4.1.1, which argues that VOT in voiceless stops indeed appears to be more susceptible to assimilation (Bergmann et al., 2016). In voiced stops, pre-voicing (VDC) appears to be averse to transfer effects, especially in languages such as Hindi where it is a primary cue to voicing (Bhaskararao, 2011; Hauser, 2021). This is also the case in Dutch. E. Simon (2009) noted that L1 Dutch learners of English applied the prominent and perceptually stronger Dutch feature of pre-voicing to their English stops, instead of omitting it. However, unlike pre-voicing, both VOT (short-lag) and RBI in voiced stops came across as more susceptible to transfer effects based on the available limited research and findings of the present study.

In addition to pre-voicing being a strong and primary cue to voicing contrast in Hindi, another factor can be proposed for it being averse to transfer effects, which has to do with 'salience' (Kerswill & Williams, 2002; Trudgill, 1986). Auer, Barden, and Grosskopf (1998) argue that L2 learners acquire those L2 cues very easily that are perceived as more salient as compared to those cues which are perceived as less salient. This is because "perceptual salience could result in greater attention and, in turn, a higher degree of imitation" (Podlipský & Šimáčková, 2015:2). In this case, it is possible that aspiration in Glaswegian English is more salient than pre-voicing, which may happen if the primary cue to voicing contrast in Glaswegian English is the difference between short and long-lag VOT, which makes aspiration (especially in voiceless stops) easier to perceive and acquire than pre-voicing. These factors together – prominence of pre-voicing in the native languages and salience of aspiration over pre-voicing in Glaswegian English – may have together contributed to the findings. However, what is also interesting here is that there are differences in backward transfer effects across these voiced stops by their places of articulation. This suggests that the process of backward transfer is also affected by the phonetic nature of the sound, and not just overall directional influences.

The second reason is based on SLM's argument that "L1-L2 phonetic relationships exist on a continuum from 'identical' over 'similar' to 'new'..." (Bohn, 2018: 223). The SLM (Bohn, 2018; Flege, 1995b; Flege & Bohn, 2021) predicts that it is the 'very similar' and 'similar' L1-L2 categories which are difficult to discern differences between. The reason behind this is explained by the 'Age Hypothesis' in SLM (Flege, 1995b), which has now been replaced by the 'L1 Category Precision Hypothesis' in the revised SLM (SLM-r; Flege & Bohn, 2021), empirical evidence for which is yet to be found. The latter hypothesis argues that L2 learners will be better able to distinguish between similar L1-L2 categories if their L1 categories are 'more precisely' defined, which will eventually lead to L2 category formation, instead of merging of L1-L2 categories (SLM-r; Flege & Bohn, 2021). When unable to discern the differences between the 'very similar' and 'similar' L1-L2 categories, these categories are merged and then used across both L1 and L2. The 'very dissimilar' and 'new' L1-L2 sound categories do not really pose a problem as their greater dissimilarity is perceived with ease, leading to L2 category formation, with or without a dissimilatory shift. Similar to this, the SLM also proposes that 'identical' L1-L2 categories also do not pose a learning problem as the identical L1 category may be used as the L2 category as well. It is based on this, that I argue that in the present case, it is possible that certain cues were perceived as either much too similar or even identical by Glaswasians across Glaswegian English and the native languages, that they were not perceived as diaphones, fated to undergo transfer. This stands for the case of RBI in /b/ and /d/ in both native languages, VOT in /b/ and /g/ in English, and also the GOOSE vowel in both languages. Therefore, not every cue may be perceived as representative of a foreign accent, and is recognised and dealt with as such (Flege & Bohn, 2021).

In addition to perceived dissimilarity between L1-L2 categories and precision in L1 category distribution, there is a third factor that contributes to L2 category formation according to the SLM-r. This is the quality and quantity of L2 input, which forms the final speculation as to why not every cue underwent transfer in a given phonetic category. Flege and Bohn (2021:19) argue that as monolinguals, based on the input distributions, we develop prototypes that are "multidimensional cue-weighted representations of sound classes residing in long-term memory". This is done via slow distributional learning processes that remain intact during our lifetime and are also involved in L2 learning. Thus, in case of such very similar, perceptually linked L1-L2 categories then, it may be possible that the initiation of transfer processes (assimilation or dissimilation) is reserved until "the distribution of tokens defining the equivalence class has stabilized" (Flege & Bohn, 2021:40). Thus, I argue for the possibility that Glaswasians may require more input in the relevant languages on some cues compared to others, in order to cause their assimilatory or dissimilatory shift. This is supported by the fact that when I previously examined Glaswasians (Shaktawat, 2018a), I found backward transfer in cues that were not found to have undergone transfer in the present study. Table 3.33 presents a comparison between transfer processes found in the present study and Shaktawat (2018a) (both of which examined Glaswasians) for the measures F2-F1 difference in /l/, VDC and RBI in /b d g/, and F1, F2, F3 in GOOSE. However, this difference across results in the present study and Shaktawat (2018a) can also be attributed to the fact that though recruited from the same Glaswasian population, the Glaswasians across these two studies are different, possibly leading to much individual speaker variability in Glaswasians across these studies.

Sound	Study	Measure/ Feature	Backward Transfer		No Change	Amount of Transfer
			Assimilation	Dissimilation		
/l/	Present	**Difference between F1 and F2 (darkness)**	-	English, Hindi	-	Higher dissimilation in Hindi than English
	Shaktawat (2018a)		English	Hindi	-	-
/u/	Present	**F1 (vowel height)**	-	-	English, Hindi	-
	Shaktawat (2018a)		-	Hindi	English	-
	Present	**F2 (vowel frontness/ backness)**	-	-	English, Hindi	-
	Shaktawat (2018a)		English, Hindi	-	-	-
	Present	**F3**	-	-	English, Hindi	-
	Shaktawat (2018a)		English, Hindi	-	-	-
/b/	Present	VOT (aspiration)	Hindi	-	English	-
	Present	**VDC (pre-voicing)**	-	-	English, Hindi	-
	Shaktawat (2018a)		-	-	English, Hindi	-
	Present	**RBI (loudness of the burst)**	-	-	English, Hindi	-
	Shaktawat (2018a)		Hindi	-	English	-
/d/	Present	VOT (aspiration)	English, Hindi	-	-	Higher assimilation in English than in Hindi
	Present	**VDC (pre-voicing)**	-	-	English, Hindi	-

	Shaktawat (2018a)		-	-	English, Hindi	-
	Present	**RBI (loudness of the burst)**	-	-	English, Hindi	-
	Shaktawat (2018a)		English, Hindi	-	-	-
/g/	Present	VOT (aspiration)	-	Hindi	English	-
	Present	**VDC (pre-voicing)**	-	Hindi	English	-
	Shaktawat (2018a)		-	-	English, Hindi	-
	Present	**RBI (loudness of the burst)**	English, Hindi	-	-	Equal amount in both
	Shaktawat (2018a)		Hindi	-	English	-
/t/	Present	VOT (Aspiration)	English, Hindi	-	-	Higher assimilation in English than in Hindi

Table 3.33: Evidence of transfer found in Glaswasians across the present study and Shaktawat (2018a). VOT in /t/ and the voiced stops was not examined in Shaktawat (2018a). The text in bold represents the measures that were examined in both studies.

For example, /b/ in Shaktawat (2018a) underwent assimilation for RBI in Hindi, but remained unchanged in the present study; /d/ in Shaktawat (2018a) underwent assimilation for RBI in both languages, but remained unchanged in the present study; /g/ in the present study underwent assimilation for RBI in both languages, but only in Hindi in Shaktawat (2018a). Similarly, for the GOOSE vowel, while all three formant measures remained unchanged in the present study, they showed strong transfer effects in Shaktawat (2018a). The SLM-r also argues that L2 category formation is a slow and gradual process, and "not a one-time event" (Flege & Bohn, 2021:41). Therefore, transfer processes seen here may or not may not change over time – something that can only be ascertained in a longitudinal study.

The above discussion on the voiced stops also highlights another crucial aspect of the findings: not all members of the given 'natural class' or subsegmental level (Chang, 2012) of voiced stops underwent transfer and of the same kind. For example, for VOT, only /b/ in Hindi and /d/ in both languages showed transfer effects (assimilation), for RBI, only /g/ showed transfer effects (assimilation) in both languages, and for VDC, only /g/ showed transfer effects (dissimilation) in Hindi. This was also highlighted in the case of the GOOSE vowel (§3.4.1.2) where previous research indicated that transfer effects were not limited to a certain level - segmental or general.

It is not clear if the situation is similar as above for stops as well. Most previous research on VOT in voiceless stops has showed generalisation in backward transfer across all three voiceless stops /p t k/ (Flege & Eefting, 1987a; Harada, 2003; Lev-Ari & Peperkamp, 2013; Major, 1992; Mayr et al., 2012; Stoehr et al., 2017). However, there are also studies where there is either a difference in the transfer processes found across these three voiceless stops (Lord, 2008), or a difference in the amount of transfer found across them (Chang, 2012). Lord (2008) found an assimilatory shift in L1 /k/, but no shift in /p/ and /t/. While Chang (2012) reported an assimilatory shift across all three voiceless stops, the shift was found to be bigger in /p/ and /k/, than /t/.

The previous research on VOT and VDC (pre-voicing) in voiced stops has provided evidence of no transfer, which is generalised across /b d g/. The present study, however, does not agree with this as there are instances of assimilation, dissimilation and no transfer, which vary across the three stops and cues. This confirms Chang's (2012) conclusion that depending upon which level the L1-L2 linkages are formed at, transfer can be specific or general.

3.4.2 Difference in transfer by language and dialect: Did Indian English exhibit more transfer from Glaswegian English than Hindi?

This question was based on the idea of 'systemic' or 'objective' distance between languages, according to which, Indian English (IE) and Glaswegian English (GE) are dialects of the same language, and hence more proximate to each other than Hindi (an entirely different language) is to GE. In light of this, I argued that IE would undergo more transfer from GE than Hindi (Trudgill, 1986). So, to answer this question now, findings from the production task have revealed that IE does not show numerically more instances of transfer than Hindi (as was also the case in Shaktawat, 2018a) (Table 3.31). In fact, of the total instances of transfer (assimilation or dissimilation) noted here (seven), it was Hindi in all seven cases, but IE in four cases. Of the total instances of assimilation (four), it was Hindi in all four cases, but IE in three cases, and of the total instances of dissimilation (three), it was Hindi in all three cases, but IE in one case.

The XAB task was designed to allow for this possibility. It examined whether IE is perceptually more similar to GE as compared to Hindi (regardless of the systemic similarity between them), so as to exhibit more transfer from it in production. However, the findings from this task with respect to each measure of the respective phonetic category have to be considered in the light that the similarity judgements were holistically elicited. That is, we cannot be sure that while making the judgement on any given trial, the participants were attending to the same phonetic cues that were later examined in the production task. For example, for the GOOSE vowel, the listeners may have based their judgements on temporal rather than spectral differences across the involved varieties. Therefore, there was a disjoint in the perception and production results (Table 3.34) as temporal differences in this category were not examined for differences in production, and no transfer effects were found for spectral differences for this category.

In any case, the findings from this task revealed that the two participant groups, Glaswegians and Indians, only found IE /b/ and /t/ to be more perceptually similar to the corresponding GE categories. Based on that, I predicted higher transfer to these two IE categories from GE. Table 3.34 compares the findings from the XAB task and the speech production task for each phone category, below which the findings are discussed separately for each phone category.

<table>
<tr><th>Phone Category</th><th>XAB Task Findings</th><th>Features Examined in Production</th><th>Language</th><th>Transfer Outcome</th><th>Amount of Transfer: IE versus H</th><th>Production Results = Perception Results ?</th></tr>
<tr><td>/l/</td><td>IE = H</td><td>F2-F1 Difference</td><td>IE, H</td><td>Dissimilation</td><td>H >IE</td><td>×</td></tr>
<tr><td>/u/</td><td>H >IE</td><td>F1, F2, F3</td><td>IE, H</td><td>No change</td><td>-</td><td>-</td></tr>
<tr><td rowspan="4">/b/</td><td rowspan="4">IE >H</td><td rowspan="2">VOT</td><td>IE</td><td>-</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>H</td><td>Assimilation</td></tr>
<tr><td>VDC</td><td>IE, H</td><td rowspan="2">No change</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>RBI</td><td>IE, H</td></tr>
<tr><td rowspan="3">/d/</td><td rowspan="3">IE = H</td><td>VOT</td><td>IE, H</td><td>Assimilation</td><td>IE >H</td><td>×</td></tr>
<tr><td>VDC</td><td>IE, H</td><td rowspan="2">No change</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>RBI</td><td>IE, H</td></tr>
<tr><td rowspan="3">/g/</td><td rowspan="3">IE = H</td><td rowspan="2">VOT, VDC</td><td>IE</td><td>No change</td><td rowspan="2">-</td><td rowspan="2">-</td></tr>
<tr><td>H</td><td>Dissimilation</td></tr>
<tr><td>RBI</td><td>IE, H</td><td>Assimilation</td><td>IE = H</td><td>✓</td></tr>
<tr><td>/t/</td><td>IE >H</td><td>VOT</td><td>IE, H</td><td>Assimilation</td><td>IE >H</td><td>✓</td></tr>
</table>

Table 3.34: Comparison of findings from XAB similarity judgement task and speech production task (cases where one native language underwent transfer but the other remained unchanged have not been included for comparison in the last column) (IE = Indian English, H = Hindi)

For /l/, results from the XAB task indicated that both control groups (Indians and Glaswegians) found Hindi and IE to be equally perceptually similar to Glaswegian English (GE). Therefore, IE was not perceptually more similar to GE, and was not predicted to undergo more transfer than Hindi. Furthermore, even Hindi was not predicted to show more transfer from GE based on the same finding. However, in the production results, while both IE and Hindi underwent transfer in the form of dissimilation, Hindi showed higher dissimilation than IE.

For /u/, XAB results showed that Indians had a higher probability to perceive Hindi as perceptually similar to GE GOOSE vowel, whereas this probability was equal across Hindi and IE according to Glaswegians. Based on this, then, Hindi /u/ should have undergone more transfer than IE. But this phone category remained uninfluenced in both languages.

For /t/, both groups perceived IE as perceptually more similar to GE /t/ for Place of Articulation and Voicing Contrast. Hindi was found to be perceptually more similar to GE /t/ in terms of Aspiration, by both groups, which indicates their sensitivity to the distinction between short-lag and long-lag VOT. The perceptual results, then, point to more transfer in IE, and the production results confirm this. Both IE and Hindi underwent an assimilatory shift towards GE, but IE showed a bigger shift towards GE, than Hindi.

For /b/, the results from the XAB task did not give information about the judgement of the two groups for each stimulus type, but in general, the results indicated that IE was judged as more perceptually similar to GE. However, this did not translate to the production task, as the only language to undergo transfer (in form of assimilation) for this phone was Hindi for VOT, whereas IE remained unchanged. RBI remained uninfluenced in both IE and Hindi.

For /d/ and /g/, both control groups judged both IE and Hindi to be equally perceptually similar to GE for Place of Articulation and Voicing Contrast, but Hindi to be more perceptually similar to GE for Aspiration. Again, the latter indicates their sensitivity to the difference between short and long-lag VOT. In general, these findings across stimulus type were taken to indicate that IE and Hindi were perceived as equally similar to GE for /d/ and /g/. The results from the acoustic analysis, however, showed that while both Hindi and IE underwent assimilation for VOT in /d/, IE exhibited bigger shift than Hindi which was not predicted by the results of the XAB task. Unlike /d/, the results from the XAB task and the speech production task were in line with each other for /g/ RBI as both IE and Hindi were found to have undergone transfer by assimilation by the same amount for RBI in /g/.

In conclusion, of the four cases where both Hindi and Indian English underwent the same type of transfer (/l/ for F2-F1 difference, /t/ for VOT, /d/ for VOT and /g/ for RBI), for two cases, the results of the XAB and speech production tasks were consistent with each other (/t/ for VOT and /g/ for RBI), whereas for the other two cases, there was an inconsistency between perceptual judgements and production results (/l/ for F2-F1 difference and /d/ for VOT). On the one hand, this seems to indicate that perceptual similarity may not always dictate related shifts in production. On the other hand, this may also mean that Glaswasians are not operating by the perceptual similarity judgements proposed by the control groups. The aim of the XAB task was to objectively assess the perceptual similarity of Hindi and IE with GE. The reason why Glaswasians were not recruited for the XAB task is because their judgement was deemed to be compromised due to their acquaintance with IE, Hindi, GE, which won't be as objective as that of the control groups, who are not acquainted with the 'other' language(s).

Amid such diverse transfer processes, one important aspect has been highlighted: of all the cases where both languages have undergone assimilation (VOT in /t/ and /d/, RBI in /g/), IE showed a bigger assimilatory shift towards GE than Hindi for VOT in /t/ and /d/, but equal amount of shift as Hindi for RBI in /g/. This is to say, and very importantly, that in all cases where both IE and Hindi underwent assimilation, IE never exhibited less amount of transfer than Hindi. This is shown in Table 3.35. So, while IE did not show more instances of assimilation, it certainly showed quantitatively more assimilation for VOT in /t/ and /d/ than Hindi. This was supported by the results from the XAB task for /t/, but not for /d/. Very interestingly, both cases of higher assimilation in IE also are related to the feature of VOT, which could, also be indicative of higher salience of this feature.

Phone Category	**Feature**	**Transfer Type**	**Amount of Transfer**
/l/	F2-F1 Difference (clearer /l/)	Dissimilation	Hindi >Indian English
/g/	RBI (quieter bursts)	Assimilation	Indian English = Hindi
/t/	VOT (more aspiration)	Assimilation	Indian English >Hindi
/d/	VOT (more aspiration)	Assimilation	Indian English >Hindi

Table 3.35: Comparison of amount of transfer by language (Hindi) and dialect (Indian English)

While in the perceptual task, similarity judgement was holistically elicited for targets (phonetic categories) in isolation, in real life conversations, these phonetic categories exist in the context of the entire linguistic system. Glaswasians seem to indicate their awareness of this by maintaining a distinction in the amount of transfer accepted in IE and in Hindi, which is also indicated by a bigger dissimilatory shift in Hindi /l/, as compared to IE /l/, and also numerically more instances of dissimilation in Hindi as compared to IE (VOT and VDC for /g/ underwent dissimilation only in Hindi). So, in addition to perceptual similarity, transfer also seems to be modulated by the linguistic proximity between the various varieties. In conclusion, the amount of transfer and kind of backward transfer process may be modulated by the fact of whether the native variety is a different language than the L2 or a dialect of the same language as the L2 (Table 3.33): there were more cases of dissimilation in Hindi (also greater degree of dissimilation for /l/), and quantitatively bigger assimilatory shift in IE than Hindi in two out of three cases.

Another interesting finding is that in cases where only one language has undergone transfer and the other remained uninfluenced (VOT in /b/ and /g/, VDC in /g/), it is always Hindi which underwent transfer (assimilation for VOT in /b/; dissimilation for VOT and VDC in /g/), whereas IE remained uninfluenced. It would make sense if the transfer process involved in all these three cases was always that of dissimilation, as it is for VOT and VDC in /g/, because that would indicate that Glaswasians are trying to contrast the Hindi category from the GE category, while possibly still reserving judgement for the IE category, or having established it as a separate category. But it is the case of assimilation in /b/ for VOT in Hindi makes this finding surprising.

One possible explanation for these various transfer patterns may lie in the fact that backward transfer does not depend solely on similarity and salience. It can also be modulated by factors such as L2 proficiency (Chang, 2012, 2013; Flege, 1987; Flege & Eefting, 1987b; Lord, 2008; Major, 1992; Mayr et al., 2012; Sancier & Fowler, 1997), inhibitory skills (Lev-Ari & Peperkamp, 2013), age of L2 acquisition (Barlow, 2014; Flege & Eefting, 1987a; Guion, 2003; Harada, 2003; Kang & Guion, 2006; Oh et al., 2011), contact with L1 (Stoehr et al., 2017; Tobin et al., 2017), speech style (Major, 1992), length of residence (Lev-Ari & Peperkamp, 2013), gender (Chang, 2012, 2013). The SLM-r also argues that transfer processes may be influenced by differences in L1 category precision across individuals or individual differences in learning ability (Flege & Bohn, 2021). It is now the aim of the present study to examine the influence of a few of such sociolinguistic and psychometric factors, which can influence backward transfer processes. This has been done in the next chapter of this thesis.

Chapter 4

Backward Transfer as a Function of Sociolinguistic and Psycholinguistic Factors

4.1 Introduction

The previous chapter presented the results of the speech production task which investigated if there was a phonetic backward transfer of the host dominant language Glaswegian English on Glaswasians' production of native languages Indian English and Hindi for multiple phone categories and several corresponding acoustic-phonetic features. The results indicated the presence of backward transfer in both native languages, but this transfer was not generalised across all phone categories and cues. Rather, there was much variation in how different phone categories in either native language behaved in response to Glaswegian English in terms of the degree and direction of transfer. Table 4.1 presents the phones and their respective features that were found to have undergone backward transfer (in Chapter 3) in the specified language.

<table>
<tr><th>Phone</th><th>Feature</th><th>Transfer
(language and type specified)</th></tr>
<tr><td>/l/</td><td>F2-F1 Difference</td><td>Hindi, English (both dissimilation)</td></tr>
<tr><td>/t/</td><td>Voice Onset Time</td><td>Hindi, English (both assimilation)</td></tr>
<tr><td>/b/</td><td>Voice Onset Time</td><td>Hindi (assimilation)</td></tr>
<tr><td>/d/</td><td>Voice Onset Time</td><td>Hindi, English (both assimilation)</td></tr>
<tr><td rowspan="3">/g/</td><td>Voice Onset Time</td><td>Hindi (dissimilation)</td></tr>
<tr><td>Relative Burst Intensity</td><td>Hindi, English (both assimilation)</td></tr>
<tr><td>Voicing During Closure</td><td>Hindi (dissimilation)</td></tr>
</table>

Table 4.1: Phones and features that underwent backward transfer (in Chapter 3) in the specified languages

The present chapter is concerned with examining whether certain sociolinguistic and psycholinguistic factors modulate the degree and direction of transfer found in the above phones and respective cues (Table 4.1). Thus, this analysis will be limited to the phones (and respective features) in languages that they were found to have undergone transfer in (Table 4.1). The GOOSE vowel, which was not found to have undergone transfer in Chapter 3, is not included in this analysis.

So, the question that will be answered in this chapter is:

Which extralinguistic factors play a role in affecting backward transfer of Glaswegian English on Hindi and Indian English.

4.2 Theoretical and Empirical Context on the Factors Involved

Several factors may be involved in influencing the process (amount and direction) of backward transfer. This has been highlighted throughout Chapter 1. These factors may be language-internal (intralinguistic), such as similarity between L1-L2 categories (Best, 1995; Best & Tyler, 2007; Flege, 1995b; Lado, 1957), typological proximity between languages (Rothman, 2010, 2013, 2015), relative stability of L1 categories and order of acquisition (in relation to L1 attrition; Jakobson, 1968), and phonetic contexts and precision in L1-category specification (Flege & Bohn, 2021). The present study accounts for two of these intralinguistic factors. The first is typological proximity between languages. Based on this, it was argued that Indian English may be influenced by Glaswegian English to a greater extent than Hindi. The second is similarity between L1-L2 categories, as the sound categories selected for investigation here were chosen based on the phonemic similarity and acoustic differences between them in the native and host sound systems.

However, even for the same L1-L2 categories, previous research has found much variation within speaker-groups with apparently similar characteristics (E. de Leeuw, 2009; E. de Leeuw, Mennen, & Scobbie, 2013; Major, 1992). Various extralinguistic factors have been implicated to be the cause of this inter- and intra-speaker variation. These are, for example, age of L2 acquisition, L2 proficiency, length of residence in L2 country, cognitive skills, gender. Not only is the process of backward transfer affected by these extralinguistic variables, but their role has also been reported in studies on L1 phonetic accommodation (Babel, 2010, 2012; Lewandowski & Jilka, 2019; Yu et al., 2013).

The phenomenon of backward transfer is generally recognised as psycholinguistic with the focus on understanding the interaction between multiple languages in the bilingual mind. This is reflected in the choice of factors that are examined as affecting transfer between languages, such as age of acquisition of L2 (Ahn et al., 2017; Barlow, 2014; Flege, 1987; Guion, 2003; Harada, 2003; Kang & Guion, 2006; Oh et al., 2011), L1 and L2 proficiency and dominance (Flege & Eefting, 1987a; Lord, 2008; Major, 1992; Mayr et al., 2012; Sancier & Fowler, 1997) and individuals' language inhibitory ability (Lev-Ari & Peperkamp, 2013). At the same time, this phenomenon has been rather neglectful of the role of social factors and psychological motivations in affecting transfer. In contrast, a psycho-social approach to language contact and influence is dominant in research under the L1 phonetic accommodation framework. Such investigations acknowledge that language contact and shift is also influenced by the nature of contact between the host and migrant communities by factors such as amount of contact that the individual has with the native and host communities, their sense of identification with either group or in general, and also their positive or negative experiences in the host country (Giles & Powesland, 1997; Ogay & Giles, 2007; Simard et al., 1976).

The present study acknowledges that especially in the case of migrants and this specific situation of contact which unites the frameworks of backward transfer and L1 phonetic accommodation, the examined language shift is possibly not only psycholinguistic but also sociolinguistic in nature. Therefore, a set of psycholinguistic as well as sociolinguistic variables have been chosen to examine their effect on backward transfer. Additionally, this investigation will observe whether the same predictors that were found to affect transfer in previous research (L2 to L1 phonetic transfer or D1 phonetic accommodation to D2), will also be found to affect backward transfer processes in a situation of linguistic contact which is simultaneously bilingual and bi-dialectal.

As it is beyond the scope of this study to incorporate all the extralinguistic factors identified in previous literature, a subset were selected for the current project, in service of two primary goals:

1. To investigate whether the same predictors that were found to affect transfer in previous research (L2 to L1 phonetic transfer or D1 phonetic accommodation to D2), will also be found to affect backward transfer processes in a situation which represents simultaneous bilingual and bidialectal contact.

2. To account not only for psycholinguistic, but also sociolinguistic factors to examine the process of phonetic transfer from Glaswegian English to Hindi and Indian English.

Based on the above, the following extralinguistic factors were examined in the present study:

1. Age of entry in Glasgow

2. Length of residence in Glasgow

3. Language use/dominance

4. Language proficiency

5. Language inhibitory skills

6. Language switching ability
7. Interaction with the host Glaswegian community (contact, identity, perceived discrimination)
8. Gender

4.2.1 Age of Entry (AoE)

An important factor as recognised by previous research and theoretical models in the field of SLA is the age of L2 acquisition (Piske, MacKay, & Flege, 2001). With respect to migrants, this has also been recognised as ‘age of arrival/entry’ in the host country, ‘age of departure’ from the country of origin, ‘age of reduced L1 contact’ (Ahn et al., 2017; Flege, MacKay, & Meador, 1999; Piske et al., 2001; Yeni-Komshian, Flege, & Liu, 2000). In the present study, a lower value of the predictor ‘Age of Entry’ represents more reduced contact with Hindi and Indian English as spoken in India, increased contact with the Hindi and Indian English spoken by other 1st and so forth generations of Glaswasians in Glasgow, and increased contact with the host dominant language and dialect Glaswegian English.

It is crucial to highlight that most previous studies have treated age of L2 learning/exposure as a categorical predictor which aimed to examine differences in L2 learning in early L2 learners (children) versus late L2 learners (adults) (Barlow, 2014; Flege, 1991, 2003; Flege, MacKay, & Meador, 1999; Guion, 2003, 2005; Mackay & Flege, 2004; Mackay, Flege, & Imai, 2006; McCarthy et al., 2013). But in the present study, this predictor is being applied to Glaswasians who were exposed to Glaswegian English as adults[1]. So, in the present study, instead of being treated as a categorical variable, age of entry in Glasgow (AoE) is a continuous variable which reflects the varying ages at which Glaswasian adults arrived in Glasgow and first established contact with Glaswegian English. Thus, with the previous focus of AoE investigations being children versus adults, examining AoE in this study will give an insight into how backward transfer effects may vary in adults who were exposed to the L2 at different ages.

The reasons behind age effects in L2 learning in early versus late learners are discussed in Chapter 1. The focus of the present section is the implications of exposure to the host dominant language at varying ages during adulthood on backward transfer, which has not been examined much in previous research. Based on the SLM, Piske et al. (2001:196) argue that “age is an index of the state of development of the L1 system. The more fully developed the L1 system is when L2 learning commences, the more strongly the L1 will influence the L2”, and by the same logic, the harder it will be for the L2 to influence the L1 (E. de Leeuw, 2009; Flege, MacKay, & Meador, 1999; MacWhinney, 2008; McCarthy et al., 2013). So, the so-called ‘age effects’ relate primarily to migrants’ state of L1 development – L1 categories that are more stable

[1]With one exception where the speaker was exposed to Glaswegian English since the age of twelve – around the passing of the supposed critical period - according to Scovel, 1988 and Ahn et al., 2017

and fully-developed will be less susceptible to transfer from the L2 (Flege, 1995a; Mackay et al., 2006). In addition to this, early arrivals in Glasgow would have had quantitatively more exposure to Glaswegian English, whereas reduced contact with the native varieties (Flege, 2018), as spoken in India. For some early arrivals, their contact with Glaswegian English may even be through education, employment and communicating with multiple social groups and peer networks. Thus, their exposure to Glaswegian English may even become dominant, since it may be seen as a way to social advancement especially by younger migrants (Hickey, 2010), with the implication of an influence of it on similar Hindi and Indian English categories. Contrary to this, later Glaswasian arrivals are more likely to have fully acquired both Hindi and English in their country of origin, (from speakers of Indian English). Therefore, in later arrivals these factors will be acting on comparatively (in relation to early arrivals) more stable and developed L1 categories.

So, varying ages of arrival in the L2 country can have different implications for backward transfer. Evidence for this was found by E. de Leeuw (2009) who reported that adult German-English bilinguals who arrived early in the host country were more likely to be perceived as having a foreign accent in their L1 German than those who arrived late.

Thus, with respect this predictor, the following prediction is made:

1. Glaswasians with higher AoE will show little to no backward transfer effects, whereas those with lower AoE, will show higher backward transfer effects.

What the above discussion also highlights is that, in addition to the state of L1 categories, AoE effects may also be confounded by multiple factors such as quality and quantity of L1 and L2 use and exposure (Flege, MacKay, & Meador, 1999; Piske et al., 2001), which makes the effects of AoE difficult to interpret (Flege, 1995a). In her study, E. de Leeuw (2009) sums it up nicely, "when investigating age effects, it is of course not the chronological number which is at the route of attrition, but rather an underlying, or potentially numerous underlying and interconnected, factors which determine age effects" (37). So, in addition to AoE, these 'other' factors have also been examined in this study.

4.2.2 Length of Residence (LoR)

This predictor, LoR, reflects the length (in years) for which Glaswasians have resided in the host city of Glasgow since their migration to it, where the host language, Glaswegian English, is used dominantly. Like AoE, this predictor is used to signal the period of contact with the dominant host language. Thus, it is very likely for there to be a high correlation between LoR and AoE (E. de Leeuw, 2009; Flege, 1995a; Piske et al., 2001; Tsukada et al., 2005), as AoE may capture some effects of LoR. As E. de Leeuw (2009) puts it, "a shorter length of residence in childhood may have a more significant impact on L1 attrition than a longer length of residence in adulthood" (38).

An intuitive prediction regarding LoR is that the longer the individual has lived in the host country, the more backward transfer effects will be found in their L1 (Cherciov, 2011; E. de Leeuw, 2009). This is because they will have an earlier AoE and more experience with the L2 (Flege, 1995a). This is supported by evidence from studies in foreign accent perception such as Bergmann et al. (2016), Flege (1995a), and in production such as in Lev-Ari and Peperkamp (2013). However, there are also many studies that have either found no effects of LoR on backward transfer effects or found the effect to be inconsistent or limited (Bergmann et al., 2016; de Bot & Clyne, 1994; E. de Leeuw, 2009; E. de Leeuw et al., 2007, 2010; Flege, 1988; Flege & Fletcher, 1992; Hopp & Schmid, 2011; Köpke & Schmid, 2004; Schmid, 2002; Tsukada et al., 2005; Yagmur, de Bouillé, & Korzilius, 1999). Some other research points to a possible reason behind this.

Sharma and Sankaran (2011) reported that Punjabi-English first-generation Indians in London with a length of residence of three to 12 years in the UK showed a sharp decline in use of the Punjabi feature of t-retroflexion, whereas those with more than 12 years of residence in the UK showed an increase in the use of t-retroflexion, and those who were still in their first three years of residence in the UK, showed no change in their use of this variant. The decline in usage of the native variant in the 3-12 year group can be argued to be due to backward transfer. However, with respect to the ‘past 12-year’ group, the authors speculate that “individuals have often settled with families in very Asian networks and may have less need to accommodate to British English or may have regained confidence in their original variety” (418), whereas the retention of this variant in the < 3-year group may indicate their uncertainty of permanent or long-term settlement in the host country. If these results from Sharma and Sankaran (2011) were to be applied to the present case of Glaswasians then we could expect (1) no backward transfer in Glaswasians with less than 3 years of LoR in Glasgow (such speakers were not recruited for the present study for the same reason), (2) backward transfer to the host dominant languages in Glaswasians with 9-12 years of residence in Glasgow, (3) more stabilised backward transfer effects in direction of the wider and previously established British-Asian population in Glasgow in Glaswasians with over 12 years of residence in Glasgow.

The effect of LoR, as shown by Sharma and Sankaran (2011), was also previously reported by Beganovic (2006). While examining L1 attrition in native speakers of Serbian/Croatian/Bosnian, who had migrated to Netherlands, Beganovic (2006) found greater effect of Dutch (L2) on L1 of migrants who had been living in the host country for less than five years than migrants who had resided there for twelve years or more. This led Beganovic (2006) to argue that L1 attrition appears to be a ‘fluctuating’ process, instead of that of consistent decline (p. 42).

These findings are supported by results from Prescher (2007), who examined German long-term migrants in Netherlands. Prescher (2007) reported that as the LoR in Netherlands increased, the migrants, regardless of whether their original strategy was of superficially assimilating or genuinely integrating with the host community, try to return to their original identity and linguistic practices. This is because a longer stay in the host country makes them "more confident about their origin, culture and mother tongue and...more critical about the culture, language and mentality of the guest country" (201). However, unlike Glaswasians or British-Asians, the German community in Netherlands is not a low prestige ethnolinguistic minority community. As a result of this, it is possible that the mechanisms for shifts across these different communities may be different.

Thus, while LoR specifies an interval of time spent in the host country, it does not account for "what occurred during that interval" (Flege and Bohn, 2021:15), which may be, for example, changes in the quantity or quality of L2 contact and input (Flege, 2018), differences in migrants' experiences leading to changes in their identity, approach towards the host community and their L1 (Cherciov, 2011; Prescher, 2007; Sharma & Sankaran, 2011), or differences in the opportunities to use the L2 on a regular basis (Flege & Liu, 2001). Thus, while an increase in LoR may represent increased opportunity for contact with the host languages and therefore increased chances for backward transfer, it may also represent an emerging confidence in the linguistic characteristics of their community of origin and marks a return to it. So, though it cannot be guaranteed, based on little evidence (Prescher, 2007; Sharma & Sankaran, 2011), it is possible that up to a point, that is, under 12 years of LoR, there may be higher backward transfer effects, which may start declining thereafter (after around 12 years of LoR in the host country), as also noted by E. de Leeuw (2009:38). However, it remains to be seen if this pattern can be found in fine phonetic and acoustic differences.

So, regarding this predictor, the following prediction has been made:

1. In Glaswasians, an increase in LoR will be associated with little to no backward transfer effects.

4.2.3 Language Dominance & Language Proficiency

The predictor Dominance refers to the amount of Hindi and English usage by migrants post-migration; the predictor Proficiency refers to the migrants' skill and fluency in Hindi and English post-migration.

In addition to having to acquire a new language, the L2, another consequence of migration is the change in the relative position and social status of the migrants' native language, the L1, from a dominant and possibly standardised language as in the country of origin to one of the subordinate languages in the host country (J. S. Siegel, 2018). Grosjean's (2015) *Complementarity Principle* argues that for bilinguals, language use is domain-specific, as each language may be used for a 'different social function' (Grosjean, 1985) in communication to different people, thereby restricting its use to certain domains such as home/school/work, etc. The 'dominant' language usually occupies more domains of social activity, therefore is used more frequently and also regulated by standardisation (Matras, 2009). However, by contrast, in the host country, the migrants' native languages are usually restricted to fewer social and public domains and sometimes to none. This naturally reduces the migrants' usage of their native languages (Schmid & Köpke, 2017).

Additionally, the asymmetry in social roles between the native and host language may also affect how these languages are socially evaluated - positively or negatively - in the host country (Robinson, 2005), which may in turn affect the migrants' attitudes and perception towards these languages (Ghuman, 2003). The migrants may be more inclined to turn to the host language (not only in terms of higher usage but also incorporating its features in their native varieties) if it is seen as the key to upward social mobility, better lifestyle, favourable treatment and acceptance by the host community. All of this consequently reduces the use of their native language, especially when it is viewed unfavourably in the host country, which can also lead to the migrants developing negative implicit attitudes towards it (Yagmur et al., 1999). Yılmaz and Schmid (2018:234) also argue that migrants will make very little effort to maintain their L1 if it loses its 'practical and symbolic significance' for them, thereby making it more vulnerable to attrition.

Multiple studies have provided evidence that L1 use is indeed found to be associated with backward transfer effects such that higher L1 use is related to lower backward transfer effects (Bergmann et al., 2016; Keidel, Flege, & Mora, 2015). Not only this, higher use of the L2 has also been found to lead to changes in the L1 (Flege & Eefting, 1987b; Keidel et al., 2015; Mora & Nadeu, 2012). For instance, Mora and Nadeu (2012) reported that Catalan-Spanish bilinguals, who used Spanish more dominantly and frequently, were less accurate in discriminating the /e/-/ɛ/ vowel contrast in Catalan. In addition to changes in L1 perception, the higher use of L2 was also related to changes in L1 production in this study. The role of language dominance was also reported by Piccinini and Arvaniti (2019) using an 'imitation' production task. Spanish-English bilinguals were required to imitate the production of Armenian words. English-dominant bilinguals produced English-like tokens of the stops, while Spanish-dominant bilinguals produced Spanish-like tokens.

In addition to their language use, Grosjean's (2015) Complementarity Principle has implications for the migrants' language proficiency as well. That is, if a language is used less (limited to fewer domains and spoken with fewer people), it will affect its development as well as maintenance as compared to a language which is used more often (Schmid & Köpke, 2017). This is consistent with Paradis' (2001; 2007) Activation Threshold Hypothesis. Activation threshold is the amount of stimulation required by a linguistic unit to get activated and retrieved. It depends upon two main factors: the frequency and recency of activation (Köpke, 2002). So, every time an item is activated, its activation threshold is lowered. Items that are more frequently and recently activated will have a lower activation threshold and will be easily accessible and harder to influence and replace, whereas items that are less frequently and recently activated will have a higher activation threshold and will be harder to retrieve and easy to influence and replace. Therefore, if the L1 is used and activated often, its activation threshold will be lower, thereby making it less susceptible to backward transfer effects.

Grosjean (1982) argues that the proficiency in each language skill depends upon the need for that skill in various domains. As the language use decreases, the slow but very perceptible process of language forgetting sets in (argued for by increasing activation thresholds by Paradis, 2001, 2007), which reduces language proficiency, as evidenced by, for example, the loss of vocabulary, increase in code-switching, changes in pronunciation and forgetting of writing system. Therefore, if not maintained, the less used language is more prone to also becoming the less proficient language, which is more vulnerable to transfer from the more dominant language (Grosjean & Li, 2013; Schmid, 2013). For example, Major (1992) found that increasing L2 proficiency was associated with higher L1 loss, and Flege and Eefting (1987a) reported that Dutch-English bilinguals with higher proficiency in L1 dissimilated their L1 Dutch VOT in /t/. Even the SLM and SLM-r (Flege, 1995b; Flege & Bohn, 2021) argue that L1 and L2 use and proficiency are important factors that affect the interaction between L1-L2 categories in the common phonetic space.

At the same time, there are also studies that have found no link between backward transfer effects and L1 use (Chang, 2012; Flege, 1992; Major, 1992; Mayr, Sánchez, & Mennen, 2020; Schmid, 2007) or L2 use (Chang, 2019; Mayr et al., 2020). Schmid (2007) argues that these inconclusive results may be attributed to an effect of underlying factors such as inhibitory skills, quality of contact and language modes. As mentioned above in §4.2.1, language use may also be confounded by AoE (Yeni-Komshian et al., 2000). Mackay et al. (2006) also reported a high correlation between early AoE and high self-rated proficiency in L2 (English) and low self-rated proficiency in L1 (Italian). Additionally, the relationship between L1 use/proficiency is not strictly inversely proportional to L2 use/proficiency. That is, a decrease in L1 use and proficiency does not mean an increase in L2 use and proficiency. These predictors are partly independent of each other and changes in them, at the same time, may have different implications for backward transfer effects. Therefore, these predictors need to be considered separately for L1 and L2, as has been done in the present study.

According to Grosjean (1982, 2015) and Schmid (2007), language use is much more complicated than how it has usually been approached in previous research, that is, as a dichotomous variable with the levels of ‘high use’ and ‘low use’. This has been explained by Grosjean’s (1982; 2015) *language mode* theory, which describes language use as a continuum for which at one end is the ‘monolingual mode’ and at the other end is the ‘bilingual mode’. When in the monolingual mode, the bilingual selects the language of the monolingual speech partner to communicate in, while deactivating their ‘other’ language. Via this selective use and deactivation of their languages, it is ensured that the interference from one language to the other is kept to a minimum. When in the bilingual mode, both bilingual’s languages are active, and one may be used more dominantly than the other which elevates the chances of interference from one language to the other. Between these two ends is the ‘intermediate’ mode. So then, L1 and L2 use does not seem to be quite as black and white, as both languages remain active to different degrees and may be used alternately by the bilingual during a stretch of conversation and may also depend upon the context of use (Mayr et al., 2020; Schmid, 2007). Therefore, this complex nature of language use may have contributed to the absence of a link between language use and backward transfer effects in previous research (Flege, 1992; Major, 1992), while also being modulated by other factors, as argued by Schmid (2007).

Regarding the present study, given the number of predictors examined here, it was inconvenient for additional predictors accounting for different language modes to be added to the list, which would also increase the total duration of data collection for the participants. Therefore, with respect to language dominance/use and proficiency, separate scores were recorded for English and Hindi. Additionally, despite their complex nature, for now, the predictions for these factors are based on the predictions of the Complementarity Principle (Grosjean, 2015). So here, the following predictions are made with respect to the effect of these predictors:

1. Proficiency: Higher proficiency in Hindi reduces backward transfer effects; higher proficiency in English increases backward transfer effects

2. Dominance: Higher dominance in Hindi reduces backward transfer effects; higher dominance in English increases backward transfer effects

4.2.4 Inhibitory Skills and Language Switching Ability

Grosjean's language mode continuum (1982; 1985; 2015; Soares & Grosjean, 1984) and Paradis' Activation Threshold Hypothesis (2001; 2007) also lead us to our next set of predictors by implying the use of the individuals' cognitive abilities in language processing. Both these hypothesis hold that among other factors, bilingual language processing involves the functions of selecting a language, and inhibiting and activating others as and when required.

Green (1998) united the concept of activation and inhibition of the available L1 and L2 resources for successful bilingual processing in his *Inhibitory Control Model* (ICM). This model assumes two separate stores for L1 and L2 which are both connected to a linguistically-independent conceptualiser which contains conceptual representations which are derived from the information stored in long term memory. The ICM assumes two types of mental networks which facilitate language processing. These are Language Task Schema and the Supervisory Attentional System (SAS). Schemas are networks that are constructed to execute tasks involving long term memory as well to execute new tasks. For a task that has been performed before, the relevant schemas are retrieved and adapted from memory. The schemas which facilitate language processing are language task schemas. The SAS intervenes in language processing for new tasks where schemas prove to be insufficient.

In a bilingual system, each lexical concept is linked to separate L1 and L2 lemma. For production, the selection of a lemma leads to the activation of one of the associated word forms.

Every word has a certain activation threshold which it must reach to get activated and selected, and dominate the other perceptually, structurally and conceptually similar words which also get activated and are inhibited in reaction. However, Green (2000) clarifies that selection of a language is principally about inhibiting the activation of the other language and partially about increasing the activation of the words in the first language. So, there are two types of inhibitions at work– internal suppression (inhibition of a language system from within itself) and external suppression (inhibition of a language system due to the activity of the other).

To produce a word in a specific language, a lemma is specified to the correct conceptual representation with a language tag. Each lemma is specified with an associated L1 or L2 language tag, which plays a crucial part in activation of the correct lemma. There are two procedures which check these links: (1) a binding and checking procedure that checks if a certain activated lemma node is linked to the correct active lexical concept, and (2) a checking procedure that establishes that a particular activated L1 lemma is linked to an active L2 lemma. Inhibitory control acts on the processing network after an activated lemma in a particular language also activates similar concepts as well as lemmas with a different language tag. If there is a similarity between L1 and L2 concepts, then the concept in one language may also activate the lemma in a different language (which is commonly accepted by all models of bilingual lexical access; see Kroll & Tokowicz, 2005). The system inhibits the activation of the related lemmas and also suppresses the lemmas with incorrect language tags. Therefore, inhibition is applied at the language and lemma level to inhibit the irrelevant language. This type of inhibition is automatic, reactive and involuntary, and may even take place when it is undesired (Lev-Ari & Peperkamp, 2013).

ICM makes predictions in relation to two major executive functions: language switching ability and language inhibitory skills. According to ICM, language switching may take more time because it is characterized by not only switching to the task schemas of a different language, but also inhibiting the task schemas of the first language. It involves overcoming the inhibition required for the previous language tags which takes more time. Also, a dominant language will not only require more inhibition, but it will also take more time to switch back to the dominant language in order to overcome the greater inhibition applied to it in the first place, as shown by Meuter and Allport (1999). ICM assumes that effective inhibition and switching skills should prevent within and cross-linguistic interference. However, bilinguals applying lower inhibition to either language category can show instances of interference from it (Lev-Ari & Peperkamp, 2013).

Previous research (in Green, 2000) and theories (Grosjean & Li, 2013) have shown that in bilinguals both languages may be active at the same time, though only one may be selected for processing (Marian & Spivey, 2003). According to Grosjean and Li (2013), bilingual language processing is non-selective. Evidence suggests that during bottom-up processing even the smallest of similarities between L1 and L2 can activate the deactivated language. Marian and Spivey (2003) found this for the lexicon, and Ju and Luce (2004) found it for subtle phonetic cues.

Thus, even while in the monolingual mode, a deactivated language may ‘slip’ through in form of dynamic interference. Thus, the language not being processed can be activated from time to time and intervene in the processing of monolingual speech. Similarly, Green (2000) agrees that this type of joint-activation not only costs more time for retrieval of the target, but also creates more scope for interference. Overcoming this would require more effort from the speaker and avoiding interference may become especially hard in stressful situations. For instance, Mayr et al. (2020) showed that L1 Spanish teachers in the UK whose language use was characterised by more and regular dual activation of their L1 Spanish and L2 English, were judged as having higher global foreign accent and particularly prone to attrition than L1 Spanish speakers who were not teachers. The exposure of these L1 Spanish teachers to the non-native Spanish from the students was also found to contribute to their perceived foreign rating. The authors argued that “it is the very nature of the professional context in which teachers operate, with its requirement to keep both languages active and the need to switch between them, that enhances the likelihood of L1 attrition" (15).

From an exemplar approach (Goldinger, 1998; Pierrehumbert, 2001), which the SLM-r (Flege & Bohn, 2021) also seems to assume, each exemplar has a resting activation which is subject to the recency and frequency of its activation (Paradis, 2001, 2007). Individuals vary in their cognitive capabilities (Boogert, Madden, Morand-Ferron, & Thornton, 2018; Carroll & Maxwell, 1979; Fischer & Silvern, 1985) and therefore, will be differently skilled in processing their languages depending upon their inhibitory and language switching ability. Thus, Lev-Ari and Peperkamp (2013) proposed that bilinguals with poor inhibitory skills will be more likely to have exemplars activated in the irrelevant language. They further argued that “these activated tokens could pull perception and production towards them, leading to non-native perception and production” in the other language (322). Lev-Ari and Peperkamp (2013) provide a singular piece of evidence for the effect of the bilinguals’ inhibitory skills on backward transfer. The authors examined highly proficient late English-French bilinguals who resided in France (L2 environment), and acquired L2 in adolescence or adulthood. The results of the production experiment showed that the lower the applied inhibition, the more French-like the VOT of their L1 English voiceless stops was. The perceptual experiment did not replicate these results but indicated that L2 can influence perception in L1 and that inhibitory skills can affect the degree to which this happens. The study concluded that poorer inhibition skills can lead to greater co-activation of competing categories from the two languages which can ultimately influence production and perception by influencing perceived similarity. Bilinguals who have high inhibitory skills can inhibit the irrelevant languages so that only exemplars of the relevant language get activated, but those with low inhibitory skills are unable to inhibit the irrelevant language thereby activating exemplars from both languages. This could eventually lead to inappropriate activation of exemplars and an inappropriate association between the exemplar and the context which causes interference and backward transfer.

So, with respect to the present study, two predictions are presented:

1. Inhibitory Skills: Higher/better inhibition reduces backward transfer effects
2. Language Switching Ability: Better language switching ability reduces backward transfer effects

4.2.5 Contact, Identity and Perceived Discrimination

Relevant to examining backward transfer effects are also the kind of social experiences that the migrants have while living in the host country. Three such experiences are relevant to the present study that have been shown to affect language variation in first-generation adult immigrants (for example, in L2 English Iraqi-Arab speakers in Glasgow and London, as shown by Al-Asiri, 2023) and which may intersect with each other. These are: (1) contact, that is, the kinds of social and linguistic groups that the migrants interact with dominantly, (2) identity, that is, if they identify themselves more or less as being a part of the host country or country of origin, and (3) their personal experiences (positive or negative) in the host country. The importance of these factors is especially highlighted in the literature on L1 speech accommodation in Chapter 1.

4.2.5.1 Contact

This predictor refers to 'interethnic contact', that is, the contact that Glaswasians have with members of their own ethnolinguistic minority community and with members of the socially dominant Glaswegian community, and by extension with the languages of the respective communities. The amount of interethnic contact may be influenced by the migrants' personal motivations. On the one hand, migrants who wish to improve their social mobility and economic standing as members of an ethnolinguistic minority may attempt more contact with the host community, and even adopt and converge to the host languages to signal their affiliation (Giles, 1973; Kerswill, 2006; Sachdev et al., 2012; Whaley & Samter, 2006). On the other hand, migrants may be motivated by the fear of extinction of their minority ethnolinguistic group or to preserve their ethnolinguistic/cultural/religious identity (Kerswill, 2006; Medvedeva, 2010), leading them to attempt minimal contact with the host community, their culture and language.

In relation to their own ethnolinguistic minority group, the experimental group of Glaswasians (1st generation bilingual Indian migrants in Glasgow) form a part of the wider Glaswasian community whose establishment was initiated in Glasgow as early as 1930s when the original immigrants started arriving in the UK from the Indian sub-continent (Maan, 1992). These original migrants (hereforth, 'long-term Glaswasians') were the source of much chain migration to Glasgow, with new migrants either settling in Glasgow or dispersing to other areas from Glasgow. Most of these migrants were from the North-Indian state of Punjab, were Sikhs or Muslims by religion, and spoke Punjabi and/or Urdu. In 1947, following the creation of Pakistan, the migration was separate from India (usually Sikh and Hindu speakers of Punjabi/Urdu/Hindi) and Pakistan (usually Muslim speakers of Punjabi/Urdu).

As it stands now, migrant groups from various Asian countries have established themselves as ethnolinguistic minority communities in the UK and also in Glasgow. According to the Office for National Statistics (2023), in England and Wales, in 2021, the largest ethnic minority was Asian (9.3%) comprising Indians, Bangladeshi, Chinese, Pakistani and Other Asians. Of this, Indians formed the biggest ethnic minority (3.1%), followed by Pakistani (2.7%). In Scotland, according to the 2011 census, 4% of the total population comprised ethnic minorities, with Asian being the biggest ethnic minority (3%). Of this, 17.3% ethnic minorities were based in Glasgow. One of these groups is the Indian minority comprising 1.5 % of the minorities (33,000 Indians), while the largest minority in Scotland is that of Scottish Pakistani. According to Scotland Census (2011) (*Census 2011: Key results on Population, Ethnicity, Identity, Language, Religion, Health, Housing and Accommodation in Scotland – Release 2A*, 2013), these numbers have grown from the last census in 2001 and the community must have further grown in 2021 (awaiting latest Census results).

Alam (2015) proposed the term ‘Glaswasian’ to refer to these various ethnolinguistic heritage groups from South-Asian countries such as Pakistan, India, Bangladesh and Sri Lanka who had migrated to Glasgow. To Alam (Alam, 2006, 2015), this term signified the integration of Glaswegian and Asian heritage (Stuart-Smith et al., 2011) in culture as well as accent. Previous sociophonetic and sociolinguistic investigations of members of this community (Urdu or Punjabi speaking Pakistani 2nd or 3rd generation adolescent girls in Alam, 2015 and Pakistani or Indian 2nd generation speakers in Lambert, 2004) have provided evidence of this hybrid Glaswasian accent. This Glaswasian English accent is characterised by an integration of Glaswegian and Asian features at the phonetic level such that the Glaswasian values are intermediate to the values exhibited by the Glaswegian and the respective Asian control group. For example, knowing that Asian /l/ is relatively clear and Glaswegian English is known to have a darker realisation (Gargesh, 2008; Stuart-Smith, 2004; Stuart-Smith et al., 2011; Wells, 1982), Stuart-Smith et al. (2011) reported that Glaswasian English /l/ was darker than other accents of English (like RP), but was still clearer than Glaswegian English /l/. So, as part of the wider Glaswasian community, the experimental group is also in contact with this hybrid Glaswasian English accent spoken by the long-term Glaswasians.

Unlike the Glaswasians previously examined (Alam, 2006, 2015; Alam & Stuart-Smith, 2014; Lambert, Alam, & Stuart-Smith, 2007; Stuart-Smith et al., 2011), in the present study, the experimental group consists of 1st generation Indian migrants (not 2nd and so forth generations), who speak Hindi and Indian English as their native languages. While Glaswasian contact could also include contact with other South Asian groups such as Pakistani or Bangladeshi, in this study, as was also made clear to the participants, contact with one’s ethnolinguistic minority group meant contact specifically with members of the Indian minority ethnic group. So, with respect to this experimental group, it is not hard to maintain contact with other long-term Indian Glaswasians as there is already a comparatively smaller but well-established Indian community in Glasgow. The connection between members is sustained by way of social media, common languages, cultural practices and beliefs. Very importantly, their religion allows them to physically meet each other regularly at their centres of worship (like the Glasgow Hindu Temple or Gurudwara (Sikh Temple)), and also celebrate various festivals together. There is also a radio station called 'Awaz FM' exclusively for Scotland's Asian ethnic minorities which broadcasts in languages such as Urdu, Hindi, Pashtu, English, Latin, Malayalam and Persian. The community also has several general and grocery stores, catering and tiffin services. When asked in reference to this study, the members of this Indian Glaswasian community reported certain residential areas in Glasgow such as the west end, Newton Mearns, Bearsden and East Kilbride to have higher concentration of Indian residents. They proposed two main reasons behind this. First, prospective and new migrants usually seek advice and recommendations on residence and schooling (for children) from the pre-established Indian community in Glasgow. Second, they are motivated to be closer to the existing Indian population, places of worship, and areas which act as hubs for celebration of various festivals.

So, with the help of advances in technology as well as the pre-existing long-term Indian Glaswasian community, it is not hard for the experimental group to maintain contact with members and culture of their ethnolinguistic minority both back in India and in Glasgow. Through contact with Indians in India, they are in contact with Indian English and Hindi as spoken in India and through contact with the long-term Indian Glaswasian community, they are in contact with the hybrid Glaswasian English accent which represents an integration of Glaswegian and Asian features (Alam, 2015; Alam & Stuart-Smith, 2014; Stuart-Smith et al., 2011). Given the large number of variables examined in this study, it was not practical to create two 'Indian Contact' predictors separately representing contact with Indians in India and contact with Indian long-term Glaswasians. So for now, Indian Contact represents both these contacts. Therefore, high 'Indian Contact' can mean high contact with Indians back home, 1st generation Indians in Glasgow like themselves, or with long-term Glaswasians.

At the same time, the experimental group may have other motivations to assimilate to the host Glaswegian community and maintain contact with it in various degrees. For instance, in a study on 1st and forth generations of Indians in London, Sharma and Sankaran (2011:417) reported that,

"individuals are often negotiating work situations with British English speakers and struggling to find a place in their new environment. Many explicitly express a desire to acquire a British style of speaking, and their disfavoring of /ʈ/ seems clearly related to a change of status of /ʈ/ from indicator to marker following contact with a new dialect:

(2) Mala (3–12 year resident, Gen 1 woman, age 27 years, talking about her Gen 2 hus-

band): He encouraged me to speak more like like bri[t]ish accent he said don't [t^h]alk like pehndus.['villagers' in Punjabi; pronounced with a British accent]"

Interestingly in the above instance from the 1st generation Indian immigrant, the Punjabi word for 'villagers' was spoken with a British accent. This indicates that the influence of the host dominant accent may not remain limited to the native dialect (that is, Indian English spoken by this immigrant), but may also spill over to the native language (Punjabi, in this case). Thus, while there certainly may be a higher influence of British English on Indian English (given the social motivations), Punjabi is not immune to this influence. The same can be applied to the present case of Glaswasians and influence of Glaswegian English on their Hindi.

From a psycholinguistic perspective, the concept of interethnic contact can be related to the Activation Threshold Hypothesis (Köpke, 2002; Paradis, 2001, 2007). Higher contact with one's ethnolinguistic community, here, represents higher contact with the native languages Hindi (and other cognate Indic languages like Urdu and also Punjabi) and Indian English, which will ensure regular activation of units in these native languages, thus making them harder to be influenced by Glaswegian English. Similarly, higher contact with the host community represents higher and regular contact with the host language, that is, Glaswegian English, and higher possibility of influence from it. Britain (2010) argues that the acquisition of variants during "accommodatory behavior gradually stabilize and become more durable characteristics of that person's linguistic repertoire. Such stabilization is assumed, also, to occur more readily in social contexts where people have developed strong networks in the post-contact community" (209).

The amount of contact with different speech communities also has an effect on the phonetic variants used by the speakers. For instance, S. Fox (2010) and Torgersen, Kerswill, and Fox (2006) investigated PRICE and FACE vowels in Bangladeshi, mixed-race and British youth in East End of London. They found that British males, who were in higher contact with Bangladeshi males used more Bangladeshi variants, whereas British females, who were not in contact with Bangladeshi males, did not use Bangladeshi variants for these two vowels. Furthermore, in an acoustic investigation of /l/ in 2nd and 3rd generation Glaswasians (Pakistani heritage speakers of Punjabi and Urdu in Glasgow), Stuart-Smith et al. (2011) found that the Glaswasian speaker with highest number of Asian friends had Asian-like clear /l/, whereas a Glaswasian speaker with lowest number of Asian friends showed Glaswegian-like darker /l/. Similarly, Stoehr et al. (2017) reported that late German-Dutch bilinguals who were in reduced contact with their L1 German showed backward transfer of Dutch on their L1, whereas late Dutch-German bilinguals who were in frequent and direct contact with their L1 showed no influence of L2 German of their L1. This led to Stoehr et al. (2017) concluding that contact with the native language is an important aspect to L1 maintenance. The effect of contact has also been found in perception. In her study, E. de Leeuw (2009) found that German migrants in Canada who had more contact with their native language, were less likely to be perceived as having a foreign accent in their L1 by native speakers of German in Germany.

With respect to the role of contact in the present study, two predictors are proposed – Indian Contact and Glaswegian Contact, as the both are at least partly independent and an increase or decrease in one does not necessarily signify an increase or decrease in the other. Thus, two predictions are made:

1. Indian Contact: Glaswasians with higher Indian contact will show little to no backward transfer effects

2. Glaswegian Contact: Glaswasians with higher Glaswegian contact will show higher backward transfer effects

4.2.5.2 Identity

This predictor refers to Glaswasians' recognition of themselves as members of the given ethnic groups (Indian or Scottish). It can be related to Hazen's (2002:241) concept of 'cultural identity' which is "how speakers conceive of themselves in relation to their local and larger regional communities". According to Grosjean (2015), the formation of cultural identity in such migrants is based on their "personal history, their identity needs, their knowledge of the languages and cultures involved. . . their own coping skills, tolerance for ambiguity (versus rigidity) and other individual factors" (582). Movements across international borders, such as in the Glaswasians' case, often exposes the migrants to new cultures, lifestyles and languages that may be in stark contrast with their own, which can lead them to reassess their identity by adopting elements of the host culture, increasing contact with them and also learning their language in order to fit better in the new community (Gnitiev, 2021; Polek et al., 2010). One reflection of one's identity is in the speaker's development and choice of linguistic resources which they use to indicate their distance or belongingness to certain social groups (Bowie, 2009; Gnitiev, 2021; Hickey, 2010; Joseph, 2009), as also proposed by the Accommodation Theory (Giles, 1973; Sachdev et al., 2012).

Cultural identity, according to Berry (2001:621) is based on two dimensions: (1) identification with one's heritage or ethnocultural group, and (2) identification with the larger or dominant community, where both dimensions are not only independent of each other, but also nested, such that one's heritage identity is contained within the larger national identity. This gives rise to hyphenated labels such as 'Scottish-Indians' or 'Glasgow-Indians' or 'Glasgow-Asians' (Alam, 2006, 2015) to represent their biculturalism and 'hyphenated identities' (Robinson, 2005). Yoshizawa Meaders (1997) proposed three types of immigrant sub-groups (as also found by Gnitiev (2021) in Russian immigrants in Hungary). The first group employs an 'assimilation' strategy (Berry, 2001) where members are quicker to superficially assimilate to the new environment, language and culture, with a neglect of their original culture and languages. The second groups consists of migrants who are unwilling to assimilate and choose to cling to their original culture, identity and languages; this is the ‘separation’ strategy (Berry, 2001). Finally, members of the third group employ an ‘integrative’ strategy (Berry, 2001) by being open to assimilation to the host culture and languages, but also trying to retain their original culture, languages and identity. Berry (2001) also proposes a fourth ‘marginalisation’ strategy where migrants reject not only their own, but also other cultures. Medvedeva (2010) argues that heritage language maintenance is associated with stronger ethnic identity – immigrants who feel strongly affiliated with their ethnic and cultural identity may maintain their heritage language as it forms a big part of their ethnic and cultural identity. This may cause them to turn inwards (Polek et al., 2010) to maintain their languages and avoid influence from the host dominant language.

An example for this comes from Labov’s (1963) now classic investigation of the PRICE and MOUTH diphthongs on the island of Martha’s Vineyard. The examination revealed that the locals who strongly identified as ‘vineyarders’ and wished to continue to reside there had a more centralised first element of these diphthongs: “it is apparent that the immediate meaning of this phonetic feature is Vineyarder. When a man says [rɐɪt] or [hɐus], he is unconsciously establishing the fact that he belongs to the island: that he is one of the natives to whom the island really belongs” (304). This is in contrast to the more open realisations of these diphthongs with the mainlander ‘summer people’. The results also revealed a strong correlation between vineyarder’s expression of contempt and resistance towards the mainlanders and their high centralisation of the first element of these two diphthongs.

Researchers have also investigated and reported features of a hybrid ‘Brasian’ (Harris, 2006) accent of 2nd and so forth generation of Asians from the Indian sub-continent in England, which is seen as a reflection of their hybrid British-Asian identity (Heselwood & Mcchrystal, 2000; Hirson & Sohail, 2007; Kirkham, 2011, 2017; Kirkham & McCarthy, 2021; Sharma, 2011; Sharma & Sankaran, 2011; Wormald, 2015). Alam and Stuart-Smith (2014) also found a hybrid ‘Glaswasian’ accent in second generation adolescent school girls of Pakistani heritage in Glasgow, reporting that “at the phonological level, subtle differences in phonetic characteristics may index locally-situated social/ ethnic identities" (p. 29). The authors used the Communities of Practice (CoP) framework which located the girls on a continuum representing their affiliation from more western/British to more eastern or traditional ideologies, values and practices. The results showed fine variations in the realisation of /t/ across the various CoPs and provided evidence of a hybrid Glasgow-Asian accent which was representative of the ‘Glaswasian’ identity of these 2nd generation speakers (Alam, 2006, 2015; Lambert, 2004; Lambert et al., 2007; Stuart-Smith et al., 2011). However, most of this research on hybrid accents in the UK is concentrated on 2nd and following generations and speakers of Punjabi and/or Urdu. The effect of identity is still unknown with respect to backward transfer and in first-generation ethnolinguistic minorities.

Based on Yoshizawa Meaders (1997), three types of identities are identified in the present study with respect to Glaswasians: (1) Indian Identity, that is, recognition of the self as Indian (including Indians in India and Indian Glaswasians) (2) Glaswegian Identity, that is, recognition of the self as Glaswegian, and (3) Both Identity, that is, recognition of the self as both Glaswegian and Indian. With respect to these three predictors, three predictions are made:

1. Indian Identity: Those with higher Indian Identity, will show reduced backward transfer effects

2. Glaswegian Identity: Those with higher Glaswegian Identity will show increased backward transfer effects

3. Both Identity: Those with higher Both Identity will show moderate transfer effects, or higher transfer effects in some phone categories or language

4.2.5.3 Perceived Discrimination

Migrants' experiences in the host country may also be shaped by how they are perceived and treated by the host community, and how migrants perceive their treatment by the hosts. The arrival of large numbers of new immigrants who speak foreign languages and especially those that are visually and culturally more distinct (Jasinskaja-Lahti et al., 2006), may stir various emotions within the host community. Some members of the host community may be more welcoming and view migrants as adding to the community economically, culturally and linguistically. However, some members may also view migration as a source of 'contamination' (J. S. Siegel, 2018), which can become the basis of racial and ethnic conflict, stir up xenophobic attitudes, and give rise to opposition to immigrants and immigration, leading to restrictive immigration legislation (J. S. Siegel, 2018).

Such perceived discrimination, which is defined as "a behavioral manifestation of a negative attitude, judgment, or unfair treatment toward members of a group" (Williams, 1999; quoted in Szaflarski & Bauldry, 2019) has been found to not only affect immigrants' physical and mental health (Buchanan, Abu-Rayya, Kashima, Paxton, & Sam, 2018; Medvedeva, 2010; Pisarenko, 2006; Szaflarski & Bauldry, 2019), but also their perception about their own identity as well as linguistic practices and attitudes (Medvedeva, 2010).

In such a situation then, previous research has found migrants to be adopting two strategies. First, they can limit contact with the host community and by extension the host culture and languages (Robinson, 2005). This 'separation' strategy has been found to be employed in face of higher perceived discrimination in multiple studies (Jasinskaja-Lahti et al., 2006; Neto, 2002; Pisarenko, 2006). Despite wishing to improve their abilities in the host language, immigrants who feel discriminated against may not be included in domains where the host dominant language is heavily used, and may rather consciously avoid such domains instead (Medvedeva, 2010). Thus, failed convergence towards the host language, acceptance by the host community, or a fear of rejection (Berry, 2001) can also reflect this dissonance in their desires and circumstances. In a study on the relationship between self-reported proficiency in second-generation immigrant adolescents in the US, Medvedeva (2010) found that participants who felt discriminated against by their fellow students, reported lower proficiency in English, possibly indicating their discomfort with the host language, English. It is also possible that in face of perceived discrimination, the migrants try even harder to assimilate. In the same study, Medvedeva (2010) reported that adolescents who felt discriminated against by teachers and counselors at school or reported perceived societal discrimination were more likely to report their proficiency in English as ‘very well’.

So then, with respect to this predictor in the present study, two predictions have been made. Glaswasians with higher rating for perceived discrimination may either show,

1. more Indian-like values (reduced backward transfer effects) to indicate a ‘separation’ strategy, or

2. more Glaswegian-like values (increased backward transfer effects) to indicate an ‘assimilation’ strategy.

4.2.6 Gender

The final sociolinguistic predictor to be examined in this study is Gender.

Previous sociolinguistic research argues that female speakers are leaders of linguistic change (Labov, 2001) and multiple reasons have been cited for this such as increased sensitivity to the social evaluation of language in female speakers as compared to male speakers (Labov, 2001), and higher usage of more symbolic linguistic resources to establish membership and status by female speakers (Eckert, 1989, 1998). But more current research on backward transfer and L1 phonetic accommodation neither confirms nor denies this generalisation.

One set of studies shows that female speakers generally converge more than male speakers (Babel, 2010; Babel et al., 2014; Namy et al., 2002; Nygaard & Queen, 2000) because “a lifetime of differences in social experience and social reinforcement renders women more sensitive to indexical information in vocal communication than men” (Namy et al., 2002:424). Another set of studies shows that it may be the other way round as male speakers were found to converge more than female speakers (Pardo, 2006; Pardo et al., 2010). More recently, Pardo (2016) reported no differences in convergence patterns between male and female speakers in the vowel space on average, but female speakers were found to have converged to front vowels more than male speakers, whereas male speakers were found to have converged more to back vowels than female speakers. Thus, the effect of Gender does not seem to be very straightforward and consistent, and understandably so, as it is a complex social identity constructed with reference to the context of the communities that one is a part of (Eckert & McConnell-Ginet, 2003).

In SLA, particularly in studies investigating backward transfer, the effect of Gender remains rather understudied. One of the reasons behind this is methodological in nature. Most datasets have an unbalanced number of male and female participants (Chang, 2012, 2013; Jarvis

& Pavlenko, 2008; Pavlenko & Jarvis, 2002; Stoehr et al., 2017). An instance of the effect of Gender in backward transfer comes from Chang (2012), followed up by Chang (2013). While examining L1 phonetic drift in native English learners of Korean, Chang (2012) reported differences in gender across stops and vowels. For VOT, while both genders underwent assimilation, males showed a greater place effect on VOT than females (that is, the difference between velars and other places of articulation overall was greater for males than for females). Finally, for the general vowel space, in females, the L1 vowels generally drifted upwards (that is, showed a decrease in F1), while for male learners, they drifted downward (increase in F1) and also forward to some degree. These differences across VOT, F0 and F1-F2 according to Gender were replicated in Chang (2013), but which between- and within- gender differences also modulated by experience with L2 Korean. From both studies, it is noticeable that, in fact, nothing conclusive can be argued about the differences between females and males.

Historically, the original South-Asian migrants in Glasgow were usually males, who were the link for their families to migrate to the UK as dependents (Maan, 1992). So previously, male and female Glaswasians may have differed in their social roles, responsibility and contact with various social groups which may have caused variation in their linguistic practices. But as it stands now, there does not seem to be a big divide with respect to the social roles and responsibilities of male and female Indian migrants. In addition to migrating as a family, now, both male and female Indians are also migrating to and settling in the UK independently in search for opportunities in education and employment, as also supported by the data provided by the experimental group in this study. Based on this, there does not seem to a reason to expect any gender-based differences in backward transfer effects in this community. Therefore, with respect to the present analysis, no predictions are proposed for this variable.

4.3 Methodology

4.3.1 Questionnaire Task

In the present study, a questionnaire was used to elicit information on the Glaswasians' demographics (age, gender, Indian ethnicity, occupation) and sociolinguistic profile (ethnic and national identity, ethnic and peer contact, perceived discrimination, language proficiency and use/dominance) (Appendix I). It is based on the acculturation questionnaire introduced by Berry et al. (2010) to examine acculturation and psychological and socio-cultural adaptation processes in immigrant youth (ages 13-18) from 26 different cultural backgrounds settled across thirteen countries.

According to Berry et al. (2010:305), acculturation is "the process of cultural and psychological change that follows intercultural contact". They describe cultural changes as "alterations in a group's customs, and in their economic and political life" (305), whereas psychological changes are “alterations in individuals’ attitudes towards… their cultural identities and their social behaviours in relation to the groups in contact” (305). Using the aforementioned questionnaire, Berry et al. (2010) collected data on multiple variables that could contribute to understanding the acculturation and adaptation processes in immigrant youth across different countries. These variables were acculturation attitudes, cultural identity (ethnic and national), language use and proficiency, ethnic and national peer contact, family relationship values, perceived discrimination, psychological adaptation (life satisfaction, psychological problems, self-esteem) and socio-cultural adaptation (school adjustment, behaviour problems).

The present study asks whether these cultural and psychological changes in immigrants can affect the extent to which backward transfer from Glaswegian English will be present in their native languages. So, for the present study, which examines adult immigrants, the data collection for the sociolinguistic variables was based on relevant elements of cultural identity, language use and proficiency, ethnic and national peer contact and perceived discrimination. Thus, the adapted acculturation questionnaire collected data on the following variables:

1. **Demographic Information:** Data was collected on participant’s
   (a) Date of Birth
   (b) Length of Residence in Glasgow
   (c) Gender
2. **Language Proficiency:** Participants self-rated their proficiency in English and Hindi on a scale from 1 to 10 in four domains in each language: Reading, Writing, Speaking, Understanding. They were informed that the points on the scale meant the following in terms of proficiency: 0-None, 1- low, 2- very low, 3-fair, 4- slightly less than adequate, 5- adequate, 6- slightly more than adequate, 7- good, 8- very good, 9- perfect, 10-excellent. Final scores for ‘Proficiency English’ and ‘Proficiency Hindi’ were calculated for each participant separately by adding up the self-rated score on each of the four domains for each language. The highest score could be 40 and the lowest 0. A higher score represented relatively higher proficiency.
3. **Language Use (Dominance):** In context of the present study, ‘language use’ refers to the extent to which immigrants used either of their languages (Hindi or English) when interacting in multiple scenarios like communicating with friends, family, siblings, children, or while consuming different media like radio, television, and social media. An example of a question from this section of the questionnaire is: “How often do you speak with your close friends in Hindi?”. The questionnaire measured their English and Hindi use on a 5-point scale running from ‘not at all’ (1) to ‘all the time’ (5). Higher scores indicate relatively more frequent usage of the national language. There were total of 7 questions each for English and Hindi. The individual scores on each question were then summed up

separately for Hindi and English. A higher score would indicate relatively higher use of either language.

This variable will henceforth be referred to as 'Dominance English' and 'Dominance Hindi'.

4. **Identity:** Scores were collected separately on the extent to which Glaswasians identified as (1) Indians, (2) Glaswegians and, (3) both Indians and Glaswegians, using only one question. For example, to elicit data on the participants' 'Indian Identity', the following question was used: "How do you identify yourself? : I think of myself as an Indian". Participants responded using a 5-point scale running from 'not at all' (1) to 'very well' (5). In the above question, the statement was changed to "I think of myself as a Glaswegian" and "I think of myself as both Indian and Glaswegian" to elicit identity scores on 'Glaswegian Identity' and 'Both Identity'.

5. **Ethnic and Peer Contact:** The questionnaire assessed the frequency of interaction with peers from (1) one's own ethnic group (Indian) in Glasgow (Indian Glaswasians) as well as back in India, and (2) the host community in Glasgow (Glaswegians). An example of a question from this section of the questionnaire is: "How often do you spend free time with your close Indian friends?". Here, the participants were instructed that 'Indian friends' referred to those of Indian heritage only. Participants responded on a scale ranging from 'never' (1) to 'almost always' (5). There was a total of 11 questions to assess 'Indian Contact' and a total of 5 questions to assess 'Glaswegian Contact'. The individual scores on each of these questions were summed up to form a final score separately for Indian Contact and Glaswegian Contact.

6. **Perceived Discrimination:** The questionnaire assessed Glaswasians' perceived frequency of being treated unfairly or negatively or feeling unaccepted in Glasgow ("I think that others behave in an unfair or negative way towards my ethnic group".) Participants responded on a scale ranging from 'strongly disagree' (1) to 'strongly agree' (5). There were a total of 4 questions in this section and individual scores from these were summed up to form the final score on 'Perceived Discrimination'.

Participants were reminded that they could refrain from answering any of the questions.

4.3.2 Psychometric Tasks

Executive Functions (EFs) are "general purpose control mechanisms that modulate the operation of various cognitive sub-processes and thereby regulate the dynamics of human cognition" (Miyake et al., 2000:50). The literature on executive functions generally recognizes and considers important three core EFs (Diamond, 2013; Miyake et al., 2000): (1) inhibitory control (inhibition), (2) working memory (updating), and (3) cognitive flexibility (shifting) (Diamond, 2013; Miyake & Friedman, 2012). The psychometric tasks used in this study were aimed at examining two of these three core EFS: *Inhibitory Control* and *Cognitive Flexibility*. Inhibitory Control manages our ability to inhibit dominant responses, whereas Cognitive Flexibility manages the ability to switch to or between perspectives or tasks and efficiently adapt to changes. These EFs also underlie linguistic processing (Kaushanskaya, Park, Gangopadhyay, Davidson, & Ellis, 2017). Especially in bilinguals, there is a need to control the many languages and avoid interference from the one irrelevant in any given situation. This is referred to as *language control* (Branzi, Della Rosa, Canini, Costa, & Abutalebi, 2016).

4.3.2.1 Inhibitory Skills

Friedman and Miyake (2004) have classified three potentially separable inhibition-related functions. These are *Prepotent Response Inhibiton*, *Resistance to Distractor Interference*, and *Resistance to Proactive Interference*. Prepotent Response Inhibition involves the ability to suppress a dominant, automatic, prepotent response. An instance of this would be suppressing the dominant tendency of reading a word in order to name the color that the word is written in (Stroop, 1935). Resistance to Distractor Interference is the ability to resolve interference from competing stimuli. An example for this is ignoring the surrounding noise shapes in order to select the target shape. Resistance to Proactive Interference is the ability to resist interference from information that was previously relevant to the task but has since become irrelevant. An example for this is suppressing memory intrusions of similar lexical items to focus on the relevant lexical items. This is said to result directly from language processing.

According to Miyake et al. (2000), Prepotent Response Inhibition and Resistance to Distractor Interference involve relatively conscious and effortful control processes that lead to the active suppression of a response; whereas Resistance to Proactive Interference results directly from language processing. However, it is not clear as to which type of inhibition is employed by bilinguals for multiple language processing (Lev-Ari & Peperkamp, 2013). But it is possible that all these three types of functions may be used at various stages of L2 acquisition and bilingual language processing (Daidone, Mora, & Darcy, 2016).

Therefore, in this study, both non-linguistic as well as linguistic tasks are used to examine these three types of functions which are all possibly involved in bilingual language processing at various stages. The Simon Task (J. Simon & Wolf, 1963) will be used to examine Prepotent Response Inhibition; two types of Flanker Tasks, Non-Linguistic and Linguistic (Erikson & Erikson, 1974), will be used to measure Resistance to Distractor Interference; Cued-Recall Inhibition Tasks (Lev-Ari & Peperkamp, 2013; Veling & Knippenberg, 2004) will be used to measure Resistance to Proactive Interference. The following sub-sections describe the methodology of these various tasks selected to examine the three types of inhibitory skills.

4.3.2.1.1 Simon Task

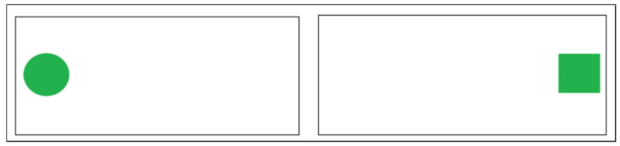
The Simon Task (J. Simon & Wolf, 1963) is a non-linguistic task that targets prepotent response inhibition (Diamond, 2013). It measures how well the participants can resist interference from the dominant spatial positioning cue.

This task involves two response keys which are located on opposite sides (left and right). Each response key is associated with a particular stimulus and is to be pressed when that stimulus occurs on the screen regardless of its position on the screen. J. Simon and Wolf (1963) found that participants performed well and took less time to respond when a stimulus occurred on the same side as its associated response key (congruent trials) but performed worse when the stimulus and the associated response key were on the opposite sides (incongruent trials). They were the first to demonstrate this effect by placing two lights which acted as stimuli on a horizontal circular board which kept rotating at different degrees in different trials. The lights corresponded to two response keys. The results showed that the response time was influenced by the location of the stimulus and the response button– when the light position did not indicate the appropriate response, the response time increased. This task is based on our prepotent or automatic tendency to respond on the same side as the presented stimulus. This tendency must be inhibited when the locations of stimuli and response are incompatible, leading people to respond more slowly. This delay in response accuracy and speed between congruent and incongruent trials is the Simon Effect. It is the difference between response time for incongruent and congruent trials. This task is mainly used as a non-linguistic measure of inhibitory control (Linck, Hoshino, & Kroll, 2008a; Linck, Schwieter, & Sunderman, 2012).

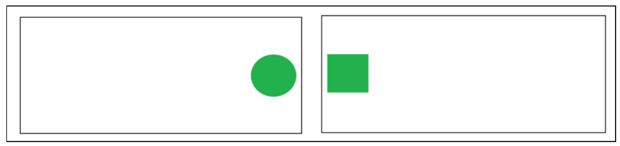
Instead of lights on circular boards (J. Simon & Wolf, 1963), now computers are used to perform the Simon Task where lights have been replaced by shapes shown on the computer screen and response buttons by keyboard keys (Bialystok et al., 2005; Bialystok & DePape, 2009; Bialystok, Klein, Craik, & Viswanathan, 2004; Goral, Campanelli, & Spiro III, 2015; Linck et al., 2008a; Tiego, Testa, Bellgrove, Pantelis, & Whittle, 2018). The methodology of this task in the present study is based on these more recent studies, with a few changes as will be indicated. In the present study, the stimuli consisted of two shapes (square and circle) in four different colours (red, blue, grey, green).

To ensure that the reaction time was not a result of the participants being better at using one hand than the other, the mapping of the stimulus type and the response key was counterbalanced across participants by creating two versions of this task (Bialystok et al., 2005). In one version of the task, the participants were instructed to press the ‘f’ key when a circle appeared and the ‘j’ key when a square appeared regardless of their colour or positioning on the screen. In the second version, the participants were instructed to press the ‘j’ key when a circle appeared and the ‘f’ key when a square appeared. The two versions were counterbalanced across participants.

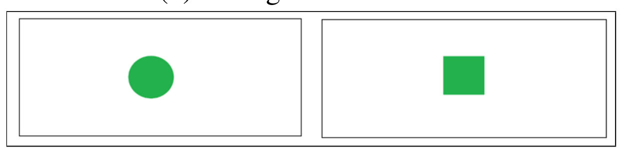
There were three types of trials– congruent, incongruent and neutral. In congruent trials (Figure 4.1a), the stimuli appeared on the same side as the corresponding response key, whereas in incongruent trials (Figure 4.1b) the stimuli appeared on the opposite side of the corresponding response key. The third type of trials were neutral (Figure 4.1c), where the stimuli appeared in the centre of the screen. These represented no-conflict trials.



(a) Congruent Condition



(b) Incongruent Condition



(c) Neutral Condition

Figure 4.1: Three types of trial conditions in version 1 of Simon Task (press ‘f’ for circle and ‘j’ for square). The two rectangular panes represent two separate displays, rather than a single wide display.

Each trial began with a fixation cross (+) on the centre of the screen (font: Open Sans, font size 30 pixels or 22.5 points). It disappeared after 250 milliseconds to be replaced by the stimulus (circle/square) on the left, right or centre of the screen depending upon the trial type. As soon as a response was made, the stimulus disappeared followed by a blank screen (inter-trial gap) of 250 milliseconds. After this, the next trial began immediately.

Ten practice trials were presented at the beginning of the task. In order to be able to move to the test trials, the participants had to correctly answer at least eight practice trials to make sure that they understood the instructions (Bialystok et al., 2004). The practice trials were repeated if the participants made more than two mistakes.

A total of 92 main trials were presented in two blocks separated by a break. However, the first 4 trials in each block were removed to account for the priming effect and a break in participants’ flow due to the break. This left a total of 84 main trials, 42 in each block. These 42 trials comprised of 16 congruent trials, 16 incongruent trials and 10 neutral trials. Each condition had equal number of square and circle stimuli. The presentation of trials within both blocks was randomized. The end of the first block was marked by a break and the participants were instructed to press any key when ready to resume the task. There was a gap of 1000 milliseconds between this key press and the beginning of the first trial of the second block. The reaction time was calculated from the onset of the stimulus to the pressing of the response key.

The Simon Effect is calculated by subtracting the response time on congruent trials from the response time on incongruent trials. In this study, Simon Effect was calculated per subject in two steps in R. First, mean response time on congruent trials and mean response time on incongruent trials was calculated separately for each participant. Then, Simon Effect was calculated by subtracting the mean response time on congruent trials from the mean response time on incongruent trials separately for each participant.

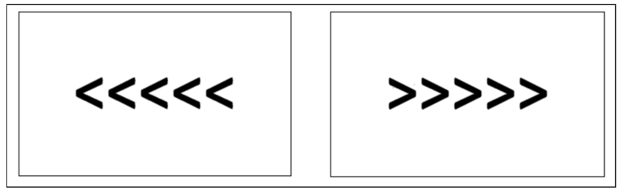
4.3.2.1.2 Flanker Task

The Erikson Flanker Task (Erikson & Erikson, 1974; Mullane, Corkum, Klein, & McLaughlin, 2009) targets resistance to distractor interference. It measures how well the participants can focus on and respond to a target stimuli by ignoring distraction from the flanking noise stimuli (Diamond, 2013). It was first introduced by Erikson and Erikson (1974) in order to study the effect of noise on identification of the target. Participants were required to search a target letter which would be placed anywhere on a display containing noise letters. To eliminate the effects of the visual search, Erikson and Erikson (1974) fixed the location of the target letter and flanked it with noise letters, which were compatible to the target or incompatible to it. The participants were instructed to respond to the target letter and ignore the flanking letters. They were supposed to press a lever in one direction if the target was H or K and in the other direction if the target was S or C.

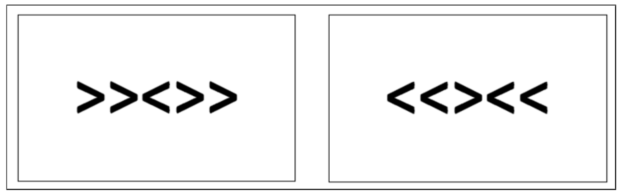
In bilingual linguistic research, the Erikson Flanker Task has been used multiple times to examine bilingual advantage (Dash & Kar, 2014; Declerck, Eben, & Grainger, 2019; Eben & Declerck, 2019) and to study the distinction between domain-general and linguistically specialised cognitive processes (Dash & Kar, 2014; Emmorey, Luk, Pyers, & Bialystok, 2008; Karlsson, 2017; Kaushanskaya et al., 2017; von Bastian, Souza, & Gade, 2016). Among these instances, the use of stimuli in these task has been both non-linguistic (Dash & Kar, 2014; Declerck et al., 2019; E. de Leeuw & Bogulski, 2016; Eben & Declerck, 2019; Emmorey et al., 2008) and linguistic (Dash & Kar, 2014; Declerck et al., 2019; Eben & Declerck, 2019; Karlsson, 2017; von Bastian et al., 2016) in nature. In the present study, both non-linguistic and linguistic versions of the flanker task have been used.

1. **Non-linguistic Flanker Task** Participants were presented with a sequence of five arrowheads (see Figure 4.2). They were instructed to indicate the direction of the middle arrowhead (target stimulus) quickly and accurately, while ignoring the direction of the flanking arrowheads (distractor stimuli) on either side of the target stimulus. Two versions of this task were created. In version one, participants had to press the ‘f’ key if the target stimulus was pointing left and ‘j’ if it was pointing right. In version two, they had to press ‘j’ key if the target stimulus was pointing left and ‘f’ if pointing right. Version was counterbalanced across participants. There were three types of trials– congruent, incongruent and neutral. In congruent trials, the middle and all the distractor stimuli pointed in the same direction (Figure 4.2a). In incongruent trials, the middle and all the distractor stimuli pointed in the

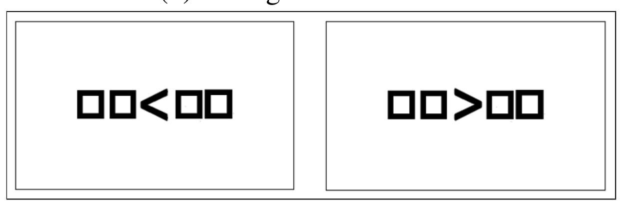
opposite direction (Figure 4.2b). The neutral trials represented no-conflict situation and functioned as fillers where the distractor stimuli were replaced by square boxes (Figure 4.2c).



(a) Congruent Condition



(b) Incongruent Condition



(c) Neutral Condition

Figure 4.2: The three types of trial conditions in Non-Linguistic Flanker Task

Each trial began with a fixation cross (+) displayed on the centre of the screen (font: Open Sans, font size 30 pixels or 22.5 points). After 250 milliseconds, it was replaced by the stimulus. The trial ended as soon as a response key was pressed. After a blank screen representing an inter-trial gap of 250 milliseconds, the next trial began immediately. A set of ten practice trials initiated the task: 4 trials each in congruent and incongruent condition, and 2 trials in neutral condition. To move to the test trials, the participants had to answer correctly on at least eight trials to make sure that they understood the instructions. If they failed to do this, the practice trials were repeated until they answered at least eight trials correctly.

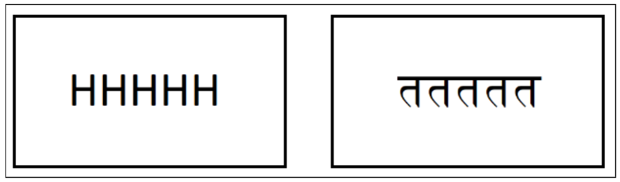
The test trials consisted of a total of 84 trials divided equally into two blocks separated by a break. Out of these 84 trials, the first four trials in each block were not included in data analysis. This left a total of 76 trials, 38 in each block. These 38 trials in each block consisted of 16 congruent trials, 16 incongruent trials and 10 neutral trials (each condition had equal number of left and right pointing target stimuli). There was a break after the first block and participants were instructed to press any key to move to the final block. There was a gap of 1000 milliseconds between this keypress and beginning of the first trial of the second block.

The Flanker effect is calculated by subtracting the response time on congruent trials from the response time on incongruent trials. In this study, flanker effect (called Flanker Arrow Effect henceforth) was calculated per subject in two steps in R. First, mean response time on congruent trials and mean response time on incongruent trials was calculated separately for each participant. Then, a Flanker Arrow Effect was calculated by subtracting the mean response time on congruent trials from the mean response time on incongruent trials separately for each participant.

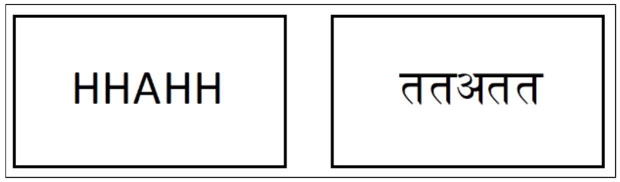
2. **Linguistic Flanker Task**

In this Bilingual Linguistic Flanker Task, the arrowhead stimuli were replaced by letters in two languages– English and Hindi, which are known to Glaswasians. Like the non-linguistic flanker task, the participants were supposed to ignore the flanker letters and indicate the language in which the target letter was written. As in the arrow flanker task, the assignment of response keys to targets was counterbalanced across participants.

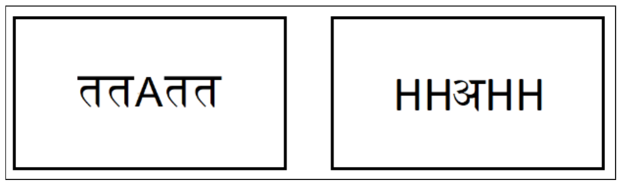
However, the design of this task is slightly more complicated than the non-linguistic version because it has an additional condition. In the 'Compatible Within Language' condition ('Compatible' henceforth), the target middle letter was the same letter in the same language as the flanker letters. Refer to Figure 4.3a for this condition in English (on the left) and Hindi (on the right). In the 'Incompatible Within Language' condition ('Within' henceforth), the target letter was a different letter but in the same language as the flanker letters (Figure 4.3b). In the 'Incompatible Across Language' condition ('Across' henceforth), the target letter was in a different language than the flanker letters (Figure 4.3c). The neutral condition represented no-conflict trial as the flankers were replaced by square boxes (Figure 4.3d).



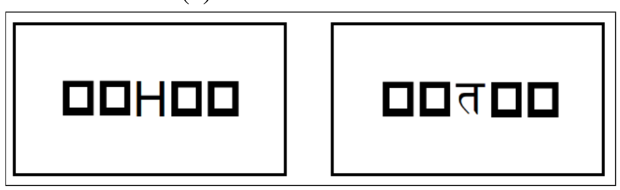
(a) ‘Compatible’ Condition



(b) ‘Within’ Condition



(c) ‘Across’ Condition



(d) ‘Neutral’ Condition

Figure 4.3: The four types of trial conditions in Non-Linguistic Flanker Task. In each sub-figure, the trials on the left are for English and those on the right are for Hindi

Each trial began with a fixation cross (+) which was displayed on the centre of the screen for 250 milliseconds. This cross was immediately replaced by the stimuli and it was presented on the screen until a response was made. As soon as a response was made, a blank screen was shown for 250 milliseconds, immediately followed by the next trial. The task began with a set of ten practice trials– 2 trials each in ‘Compatible’, ‘Within’ and neutral conditions, and 4 trials in ‘Across’ condition. Participants had to correctly answer at least eight trials to make sure that they had understood the instructions. If they failed to do this, the practice trials were repeated until they answered at least eight trials correctly.

The test trials consisted of a total of 84 trials divided equally into two blocks which were separated by a break. The participants were instructed to press any key to move to block two. There was a gap of 1000 milliseconds between this key press and beginning of the first trial of block two. Each block consisted of 12 trials each in ‘Compatible’, ‘Within’, ‘Across’ conditions and 6 neutral trials (each condition had equal number of English and Hindi target trials). The order of trials was randomized within each block. Out of these 84 trials, the first 4 trials in each block were excluded from analysis. This will leave a total of 76 main trials.

Linguistic Flanker effects were calculated in the same way as in the non-linguistic flanker task. However, there were two different linguistic flanker effects: ‘Within Flanker Effect’ and ‘Across Flanker Effects’. ‘Within Flanker Effect’ was calculated by subtracting the mean response time on ‘Compatible’ trials from the mean response time on ‘Within’ trials separately for each participant. ‘Across Flanker Effect’ was calculated by subtracting the mean response time on ‘Compatible’ trials from the mean response time on ‘Across’ trials separately for each participant.

4.3.2.1.3 Cued-Recall Inhibition Task (English and Hindi)

The Cued Recall Inhibition Task or *Retrieval-Induced Inhibition Task* is a linguistic task that targets resistance to proactive interference. It is a type of lexical retrieval task in which competing lexical items need to be inhibited to be able to access the target lexical item and measures that inhibitory skill.

Participants were subjected to two versions of this task– English and Hindi. The design of both versions was the same; however, different stimuli were used in them (described below). In this study, this task (stimuli, design and procedure) is based on Lev-Ari and Peperkamp (2013) who in turn based their task on Veling and Knippenberg (2004). Certain changes were made to the present task. First, more stimuli were added based on a suggestion from Lev-Ari (Lev-Ari, p.c.). This was done to make the inhibitory measure more reliable. Second, to offset the effect of extra stimuli on the duration of the task, the duration of the stimulus display was adjusted, as described below.

Stimuli This task is carried out in three phases: Learning, Cued-Recall and Recognition. For the ‘Learning Phase’, I created a list of thirty words: ten words each belonging to three different lexical categories. In the English version, these lexical categories were ‘sport’, ‘fruit’ and ‘occupation’. In the Hindi version, these categories were ‘vegetable’, ‘animal’ and ‘body parts’. This choice of lexical categories is slightly different from the categories used by Lev-Ari and Peperkamp (2013) which were ‘vegetable’, ‘occupation’ and ‘sport’ in English, and ‘fruit’, ‘disciplines’ and ‘hobbies’ in French. In the present study, the lexical categories for each language were chosen based on the availability of at least 18 commonly known items within it. The items within each lexical category in the present study are shown in Figure 4.4. All these items were presented in the ‘Learning’ Phase to be learnt by the participants.

Task Version	Lexical Categories (10 items within each category)		
English	Sport	Fruit	Occupation
	hockey, karate, baseball, archery, judo, gymnastics, sailing, cycling, rugby, tennis	plum, mango, apricot, guava, strawberry, orange, blackberry, coconut, lime, tomato	nurse, soldier, journalist, pilot, waiter, astronaut, farmer, electrician, broker, tailor
Hindi	**सबजी** (Vegetable)	**जानवर** (Animal)	**अंग** (Body Part)
	गाजर (carrot), मटर (peas), ककड़ी (cucumber), गोभी (cauliflower), पालक (spinach), अदरक (ginger), बैंगन (brinjal), मिर्च (chilli), लहसुन (garlic), धनिया (coriander)	भालू (bear), मगरमच्छ (crocodile), चींटी (ant), सूअर (pig), बंदर (monkey), हिरण (deer), बकरी (goat), शेर (tiger), घोड़ा (horse), खरगोश (rabbit)	कान (ear), बाल (hair), उंगली (finger), पेट (stomach), कमर (waist), जीभ (tongue), दांत (teeth), गाल (cheek), हाथ (hand), गर्दन (neck)

Figure 4.4: The lexical categories and items within each category in English and Hindi versions of the Cued-Recall Inhibition Task

For the second stage, the 'Cued Recall' Phase, a list of lexical items was created. This list consisted of a total of 10 items: half of the items (that is, five words) each from two lexical categories and none from the third category. Six such counterbalanced lists were created (refer to Appendix J for the lists from the English version and Appendix K for the lists from the Hindi version) and each participant was presented with only one of these lists. The items within these lists were made to be practiced by the participants in this 'Cued-Recall' Phase. This type of presentation of items in Phase 2 led to the creation of three types of stimuli: (1) half the items that were practiced from any two lexical categories ('RP+'), (2) half the items that were not practiced from the same two lexical categories ('RP-'), and (3) all the items that were not practiced from the third lexical category ('NRP'). Therefore, in Phase 2, every single one of the total thirty items acted as an RP+ item in two counterbalanced lists, RP- item in the other two lists and NRP item in the remaining two lists.

For the third and final 'Recognition' phase, all thirty items from the 'Learning' phase were then mixed with twenty-four filler items, eight filler words each from the same three lexical categories in the respective linguistic version of the task. Figure 4.5 presents the filler items contained within these lexical categories.

Task Version	Lexical Categories (8 filler items within each category)		
English	**Sport**	**Fruit**	**Occupation**
	football, swimming, shooting, wrestling, figure skating, golf, volleyball, badminton	cherry, pear, kiwifruit, apple, lemon, grapes, banana, melon	doctor, mechanic, scientist, lawyer, teacher, secretary, singer, architect
Hindi	**सबजी (Vegetable)**	**जानवर (Animal)**	**अंग (Body Part)**
	मूली (radish), प्याज़ (onion), आलू (potato), भिन्डी (ladyfinger), कद्दू (pumpkin), राजमा (kidney beans), करेला (bitter gourd), लौकी (bottle gourd)	बैल (ox), ऊँट (camel), चूहा (rat), मेंडक (frog), गधा (donkey), सांप (snake), कछुआ (tortoise), भेड़ (sheep)	छाती (chest), अंगूठा (thumb), माथा (forehead), नाख़ून (nails), कोनी (elbow), पैर (leg), हड्डी (bone), नस (vein)

Figure 4.5: The lexical categories and filler items within each category in English and Hindi versions of the Cued-Recall Inhibition Task

Procedure Participants were informed that the task would take place in different stages. In the first 'learning' phase (Figure 4.6a), participants were instructed to memorise all the thirty items that were displayed on the screen along with their lexical category. For example, SPORT-hockey. The learning phase began with a fixation cross (+) (font: Open Sans, font size 30 pixels or 22.5 points) which was displayed at the centre of the screen for 1000 milliseconds. It was then replaced by the lexical category and item. Every lexical category and item were displayed on the screen for 3000 milliseconds (font: Open Sans, font size 40 pixels/30 points). It was then immediately replaced by the fixation cross again which marked the beginning of the next trial. The cross disappeared after 250 milliseconds to display the next pair of lexical category and item. This continued till every one of the thirty lexical category-item pair was presented.

In stage two, the 'Cued-Recall' phase (Figure 4.6b), one of the six counterbalanced lists, containing ten items, was presented to the participant. The participants were presented with the lexical category name along with the first letter of the item. For example, SPORT- h____. Due to this aspect of this 'Cued-Recall' phase, it was ensured that every item within a category began with a unique letter in English and unique orthographic syllable in Hindi. The latter is due to the reason that in Hindi, a vowel sign is combined with the consonant to express a vowel. The participants were instructed to recall the item that they had memorised in the 'Learning' phase and fill the blank. Every pair was shown three times and their presentation was randomised. For the last stage, the 'Recognition' phase (Figure 4.6c), all the thirty test items from the 'Learning' phase were mixed with filler items. The participants were instructed to determine if they had memorised or practiced any item presented to them earlier in phase 1 or 2 as quickly and accurately as possible. They had to press 'f' if they had seen the word earlier and ‘j’ if it was a new word. The item was displayed on the screen until a response key was pressed, after which it was immediately replaced by the next item.

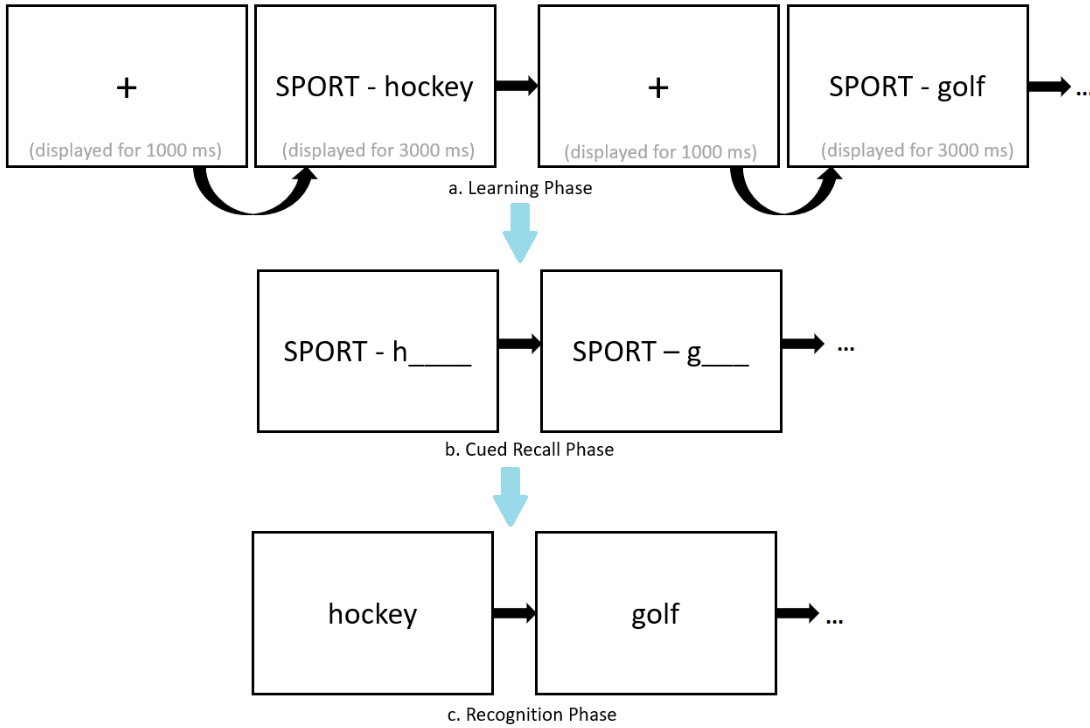


Figure 4.6: The three stages of the Cued Recall Inhibition Task in English

The participants’ inhibitory skill score was the ratio between their median response time to RP- items and their median response time to NRP items. A higher ratio would represent higher inhibition. The idea behind this is that items that were practiced in stage 2 will inhibit the retrieval of the unpractised items from the same category. This is because facilitating retrieval of RP+ items in this stage requires the inhibition of the practiced items from the same category which are irrelevant at this phase of the task. Therefore, it should take the least time for the participants to recognise the RP+ items in the last ‘Recognition’ phase, followed by NRP items. It would take them most time to access the RP- items because they were inhibited in the second phase, whereas no inhibition was applied to NRP items. This is shown in Figure 4.7. Two language-specific inhibitory scores were calculated: (1) Inhibitory Skill Score in English, and (2) Inhibitory Skill Score in Hindi.

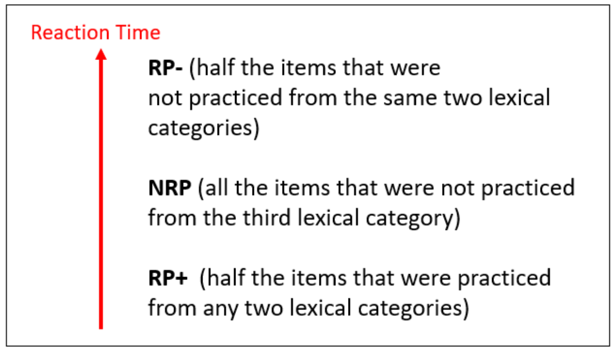


Figure 4.7: Reaction time to RP-, RP+, NRP items

4.3.2.2 Cognitive Flexibility

In bilinguals, an instance of application of cognitive flexibility is switching between their languages. This ability to switch between language was measured in a bilingual picture naming task.

4.3.2.2.1 Bilingual Picture Naming Task

The aim of this task was to see how efficiently the bilinguals were able to switch between their languages on cue.

Stimuli Twelve coloured pictures were used for this task which were taken from Montoro and Moreno-Martinez (2012) (can be downloaded from `https://doi.org/10.1371/journal.pone.0037527.s001`) (Appendix L). These pictures were banana, bird, cat, chair, cloud, eye, flower, grapes, moon, ring, tree, spider. Out of these twelve pictures, two pictures (grapes and flower) were used as filler pictures. This task used bivalent stimuli, that is, the same stimuli were named in both languages.

Design and Procedure The design and procedure of this task in this study has been influenced by other studies that have previously used this task (Linck et al., 2012; Meuter & Allport, 1999). Nine lists were created that ranged from 5-12 pictures in length, based on Linck et al. (2012) and Meuter and Allport (1999). However, Meuter and Allport (1999) had 60 and Linck et al. (2012) had 200 lists ranging from 5-14 pictures in length. The number of lists and their range had to be cut down for this study to shorten the duration of this task. The lists were separated by breaks that informed the participants that a given list had ended. They were instructed to hit ‘continue’ to begin the next list. Within each list, individual pictures were presented on the screen for 3500 milliseconds paired with a cue indicating which language the picture had to be named in. Instead of using shapes as cue, as has been done previously (Meuter & Allport, 1999), the letters ‘E’ and ‘H’ were paired with pictures, to relieve some load off the working memory. If the picture was paired with ‘E’ it was supposed to be named in English and if the picture was paired with the letter ‘H’ it was supposed to be named in Hindi. A change in cue from that in the preceding trial corresponded to a switch from one language to the other. A ‘switch’ trial, therefore, is one which immediately follows a switch in the cue, for example, a trial with the cue ‘E’ followed by a trial with the cue ‘H’. In this case, the latter trial is a ‘switch’ trial. A ‘non-switch’ trial is the one in which the cue of the following trial is same as the cue of the preceding trial. For example, a trial with the cue ‘E’ followed by another trial with the cue ‘E’. In this case, the latter trial is a non-switch trial. There are two variables: response language and trial type. Response language has two levels– English and Hindi, and trial type also has two levels– switch and non-switch. Based on this, there were 4 experimental conditions– English switch, Hindi switch, English non-switch and Hindi non-switch. Every one of the 10 test stimuli appeared 8 times and at least once in all these four experimental conditions. There was a total of 80 trials (excluding filler trials) divided across the 9 lists, with a total of 24 switch and 56 non-switch trials. Based on Meuter and Allport (1999), the lists were designed in a manner that on any given trial, the probability of a switch trial was 0.3 and that of a non-switch trial was 0.7. Based on this, in the nine lists the number of switches ranged from 1 to 4, and non-switches ranged from 4 to 8.

The items within each list were uniquely organised according to the four experimental conditions. This unique sequencing of items within the list was consistent and same for all participants. The order of the lists within this experiment was randomised except for list 1 (which was the very first list in the testing phase and began with a filler picture) and list 7 (which had a filler item in a switch condition as the first trial).

The task began with the browser prompting the participant to allow microphone access to the software. The participants were made to test their microphone to confirm that their audio was being recorded. They were then instructed that they will be showed pictures on the screen one by one. If the picture was paired with the letter ‘E’, they should name it in English and in Hindi if it was accompanied by the letter ‘H’ as quickly as possible. They were told that they will have three seconds to respond, their audio will be recorded automatically and that they did not have to press anything to move to the next trial. There were four practice trials which used the filler pictures. After the practice block, the instructions were repeated, and the test block began. Each trial started with the display of the picture stimuli and the cue simultaneously. The microphone for capturing participants’ audio response to every picture got automatically activated when the stimuli was presented. The picture and cue were shown, and audio was recorded for 3500 milliseconds. The trial ended after 3500 milliseconds and was replaced by a blank screen for 1000 milliseconds. After this, the next trial began immediately. The end of every list was marked by a break which required the participants to click ‘continue’ to move to the next trial.

The Language Switching Cost was calculated by subtracting the mean non-switch RTs from the mean switch RTs separately for each participant (Meuter & Allport, 1999). Furthermore, two language specific switch costs were also calculated separately for each participant based on the 4 experimental conditions (English switch, Hindi switch, English non-switch and Hindi non-switch): (1) Switch Cost into English, and (2) Switch Cost into Hindi. 'Switch Cost into English' was calculated by subtracting the mean English non-switch RT from the mean English switch RT separately for each participant. 'Switch Cost into Hindi' was calculated by subtracting the mean Hindi non-switch RT from the mean Hindi switch RT separately for each participant.

4.3.3 Experimental Procedure

The University of Glasgow College of Arts Ethics Committee granted the ethical clearance for data collection for this part of the study. Only GDPR-compliant software were used for data collection in this study as a whole. Data collection began in mid-March 2021 and finished in March 2022. All participants were paid for their participation, and many of them chose to donate the amount to a charity of their choice.

Two online software were used to collect data. These were jsPsych and Gorilla Experiment Builder. The first tool, jsPsych (J. R. de Leeuw, 2015), is a javascript library that allows to write scripts for tasks and run them on web browsers. It is free for use. Gorilla Experiment Builder (`https://app.gorilla.sc`) is an online experiment builder and host that allows to build a huge variety of tasks. However, it was still relatively new when data was collected for this study, with some features still under development. Several tasks can be combined as a single experiment very efficiently using Gorilla Experiment Builder.

The Glaswasian questionnaire and psychometric tasks were hosted on Gorilla Experiment Builder. For all psychometric tasks except the picture naming task, the scripts were first written in jsPsych. These scripts were then imported to Gorilla Experiment Builder. The bilingual picture naming task and the questionnaire task were built on Gorilla from scratch. All these tasks were then combined into one experiment on Gorilla Experiment Builder. A link to this experiment was then generated, clicking on which this experiment would open up on the web browser.

Figure 4.8 shows the complete experimental procedure in eliciting data on the relevant predictors from Glaswasians using the various tasks mentioned above. The order in which these various tasks were presented is also shown in this figure.

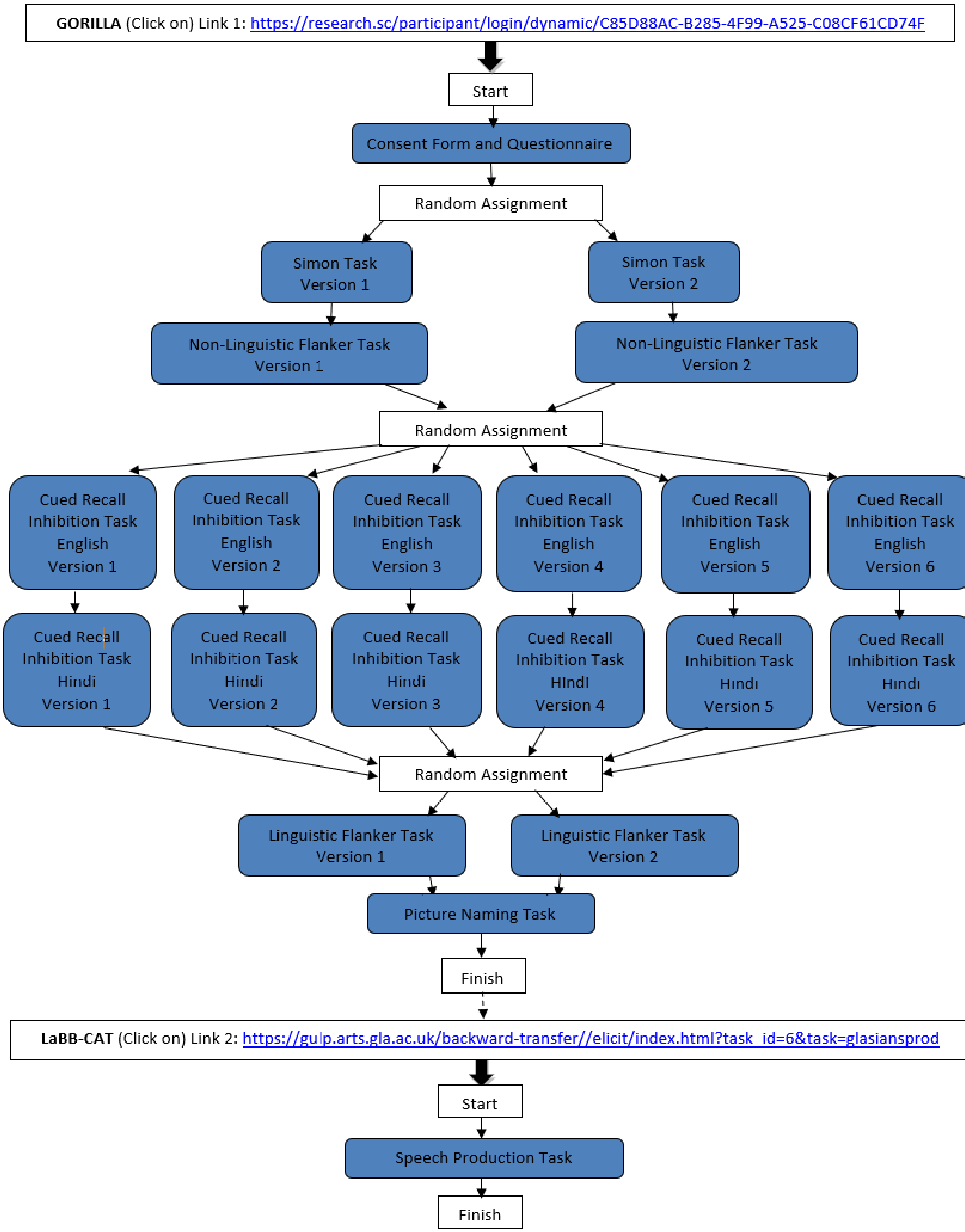


Figure 4.8: Flowchart showing the experiment design for collection of data on psycholinguistic and sociolinguistic factors from Glaswasians

It took the participants anywhere from thirty to forty-five minutes to finish this entire experiment, depending upon their speed.

4.4 Results

In the following sections, the various sociolinguistic and psycholinguistic factors involved in this analysis are introduced and examined for correlations between them. This is followed by regression analysis (separately for each phone) to examine the effect of these factors on the degree of transfer.

4.4.1 Predictor Variables

The following sociolinguistic and psychometric factors were considered as predictor variables in this analysis:

1. **Sociolinguistic/Psycholinguistic Variables**:

   (a) **Age**: The age of the participant at data collection (*min.* = 21, *max.* 83, *mean* = 45.17, *SD* = 17.2).

   (b) **Length of Residence (LoR)**: The years for which a participant has resided in Glasgow (*min.* = 3, *max.* 63, *mean* = 18.98, *SD* = 20.89).

   (c) **Age of Entry (AoE)**: The age at which the participant arrived in Glasgow (*min.* = 12, *max.* 36, *mean* = 26.19, *SD* = 6.38).

   (d) **Gender**: The self-reported gender of the participant (Categorical variable with two levels: Male/ Female; treatment-coded with reference level = female)

   (e) **Proficiency English**: Proficiency in English as self-rated by the participant. The higher the value, the higher the proficiency in English (*min.* = 27, *max.* 40, *mean* = 35.32, *SD* = 3.65; out of 40).

   (f) **Proficiency Hindi**: Proficiency in Hindi as self-rated by the participant. The higher the value, the higher the proficiency in Hindi (*min.* = 28, *max.* 40, *mean* = 36.88, *SD* = 3.91; out of 40).

   (g) **Dominance English**: The amount of English used/consumed in daily life in various domains. The higher the value, the higher the dominance in English (*min.* = 12, *max.* 32, *mean* = 21.96, *SD* = 4.86; out of 35).

   (h) **Dominance Hindi**: The amount of Hindi used/consumed in daily life in various domains. The higher the value, the higher the dominance in Hindi (*min.* = 11, *max.* 33, *mean* = 23, *SD* = 5.92; out of 35).

   (i) **Indian Contact**: The amount of contact with the participants' own ethnic group which is Indian. The higher the value, the higher the contact with Indians (*min.* = 20, *max.* 50, *mean* = 37.16, *SD* = 7.35; out of 57).

(j) **Glaswegian Contact**: The amount of contact with the host community (Glaswegians). The higher the value, the higher the contact with Glaswegians (*min.* = 5, *max.* 20, *mean* = 11.2, *SD* = 4.97; out of 27).

(k) **Indian Identity**: Participants' identification of themselves as Indian. The higher the value, the more highly the participant identified themselves as Indian (*min.* = 4, *max.* 5, *mean* = 4.88, *SD* = .331; out of 5).

(l) **Glaswegian Identity**: Participants' identification of themselves as Glaswegian. The higher the value, the more highly the participant identified as Glaswegian (*min.* = 1, *max.* 4, *mean* = 2.2, *SD* = 1.19; out of 5).

(m) **Both Identity**: Participants' identification of themselves as Indian as well as Glaswegian. The higher the value, the more highly the participant identified as Indian as well as Glaswegian (*min.* = 1, *max.* 5, *mean* = 3, *SD* = 1.5; out of 5).

(n) **Perceived Discrimination**: The frequency with which the participants felt discriminated against in the host society. The higher the value, the highly the participant felt discriminated against (*min.* = 4, *max.* 14, *mean* = 7.04, *SD* = 3.23; out of 20).

2. **Psychometric Variables**: For all psychometric variables below (except Inhibitory Skill Score English and Inhibitory Skill Score Hindi), the scale was reversed by multiplying the value of the variable by -1 (Linck, Schwieter, & Sunderman, 2020). This was done so that a higher value would represent better score and ability. By contrast, if the original values were retained, a higher score would mean poorer ability for some psychometric variables (Simon Effect, Flanker Effects, Switch Costs) and higher inhibition for others (Inhibitory Skill Scores). So, after reverse-scaling, all psychometric variables represented with higher scores. For this reason, henceforth, the effects that were reverse-scaled will be called 'Inverse' effects (for example, 'Inverse Simon Effect').

(a) **Inverse Simon Effect**: Measured performance on the Simon Task. It was calculated by subtracting the mean reaction time on congruent trials from the mean reaction time on incongruent trials separately for each participant. A higher Simon effect value would indicate better ability to inhibit interference (*min.* = -61.7, *max.* 75.4, *mean* = 19.11, *SD* = 36.62).

(b) **Inverse Flanker Arrow Effect**: Measured performance on the (Non-linguistic) Flanker Arrow Task. It was calculated by subtracting the mean reaction time on congruent trials from the mean reaction time on incongruent trials separately for each participant. A higher Flanker Arrow effect score would indicate better ability to inhibit interference (*min.* = -14.81, *max.* 145.66, *mean* = 67.26, *SD* = 50.8).

(c) **Inverse IWL Flanker Effect English**: Measured performance on the (Linguistic) Flanker Arrow Task. It was calculated by subtracting the mean reaction time on

CWL (Compatible Within Language) trials in English from the mean reaction time on IWL (Incompatible Within Language) in English separately for each participant. A higher score would indicate better ability to inhibit interference (*min.* = -140.778, *max.* 139.9, *mean* = -2.103, *SD* = 70.24).

(d) **Inverse IAL Flanker Effect English**: Measured performance on the (Linguistic) Flanker Arrow Task. It was calculated by subtracting the mean reaction time on CWL trials in English from the mean reaction time on IAL (Incompatible Across Language) trials in English separately for each participant. A higher score would indicate better ability to inhibit interference (*min.* = -105.27, *max.* 265.44, *mean* = 51.2, *SD* = 91.21).

(e) **Inverse IWL Flanker Effect Hindi**: Measured performance on the (Linguistic) Flanker Arrow Task. It was calculated by subtracting the mean reaction time on CWL trials in Hindi from the mean reaction time on IWL (Incompatible Within Language) trials in Hindi separately for each participant. A higher score would indicate better ability to inhibit interference (*min.* = -119.75, *max.* 75.6, *mean* = -16.4, *SD* = 62.7).

(f) **Inverse IAL Flanker Effect Hindi**: Measured performance on the (Linguistic) Flanker Arrow Task. It was calculated by subtracting the mean reaction time on CWL trials in Hindi from the mean reaction time on IAL (Incompatible Across Language) trials in Hindi separately for each participant. A higher score would indicate better ability to inhibit interference (*min.* = -145.3, *max.* 105.76, *mean* = -24.08, *SD* = 65.2).

(g) **Inhibitory Skill Score English**: Measured performance on the Cued Recall Task (English). It was calculated by taking the ratio between the median reaction time to inhibited items (RP-) and the median reaction time to control items (NRP). A higher score represented higher inhibition (*min.* = .7, *max.* 1.5, *mean* = 1.03, *SD* = .19).

(h) **Inhibitory Skill Score Hindi**: Measured performance on the Cued Recall Task (Hindi). It was calculated by taking the ratio between the median reaction time to inhibited items (RP-) and the median reaction time to control items (NRP). A higher score represented higher inhibition (*min.* = .7, *max.* 1.6, *mean* = 1, *SD* = .22).

(i) **Inverse Mean Switch Cost**: Measured performance on the Language Switching Task. It was calculated by subtracting the mean reaction time on non-switch trials (averaged across languages) from the mean reaction time on switch trials (averaged across languages). A higher score would indicate better switching ability (*min.* = .012, *max.* .28, *mean* = .13, *SD* = .07).

(j) **Inverse Mean Switch Cost Hindi**: Measured performance on the Language Switching Task. It was calculated by subtracting the mean reaction time on non-switch trials (into Hindi) from the mean reaction time on switch trials (into Hindi). A higher score would indicate better switching ability (*min.* = -.053, *max.* .32, *mean* = .11, *SD* = .1).

(k) **Inverse Mean Switch Cost English**: Measured performance on the Language Switching Task. It was calculated by subtracting the mean reaction time on non-switch trials (into English) from the mean reaction time on switch trials (into English). A higher score would indicate better switching ability (*min.* = .003, *max.* .36, *mean* = .16, *SD* = .1).

In addition to these sociolinguistic and psychometric variables, **four other linguistic variables** (which are the same variables that were included in the acoustic analysis in Chapter 3) were added in the analysis. These are:

- ***Language***: Determined the language of the phone. This has two levels: English/ Hindi. It was treatment-coded with the reference level English (unless specified otherwise).
- ***Vowel Height***: Determined the height of the vowel following the target initial phone. Only applicable to /b d g t l/.This has two levels: High/ Non-High. It was treatment-coded with the reference level High.
- ***Log Phone Duration***: Determined the duration of the target phone and was converted to z-scores for this analysis. Only applicable to /l/ (will be applied to other categories for later publications).
- ***Phone***: Determined the place of articulation for the voiced stops. In the present analysis, this variable is only applicable to the analysis of /b/ and /g/ for log VOT, as the category /d/ was analysed separately. Thus, Phone has two levels: b/ g. It was treatment-coded with the reference level of b.

In addition to the above, the following variables were included as random intercepts:

- ***Speaker***: Identifier code for the 40 Glaswasian participants in Model I and 25 Glaswasian participants in Models II and III.
- ***Word***: The stimuli produced by the participant. There were 10 words per phone and 6 phones in total.

All the above continuous variables were converted to z-scores using the `scale()` function in R. This function centres and scales each value in two steps: by subtracting the mean from each value in the distribution, then dividing each result by the standard deviation.

4.4.2 Checking for Correlation between Predictor Variables

All the above twenty-five predictor variables were tested for collinearity. A correlation matrix was plotted for all the above predictor variables using the `corrplot()` function in the `corrplot` package (Wei & Simko, 2021; version .92) in R (R Core Team, 2022; version 3.6.3). This plot was derived from Spearman correlations calculated with the `rcorr()` function in the `Hmisc` package (Harrell Jr, with contributions from Charles Dupont, & many others., 2021; version 4.5.0) For this test, the entire data set for a participant was removed if they had missing values for even any one of these twenty-five predictors. This resulted in a total of 25 participants whose data was tested for correlations.

In correlation analysis, a coefficient of +1 represents that as one variable increases, the other increases by the same amount. A coefficient of -1 represents that as one variable increases, the other decreases by the same amount. A coefficient of 0 represents that there is no relationship between change in one variable and change in another. In this study, all correlations at or above ± .5 are evaluated as they represent a large effect size (Field et al., 2012).

Figure 4.9 presents the correlation matrix for the twenty-five predictors in this analysis.

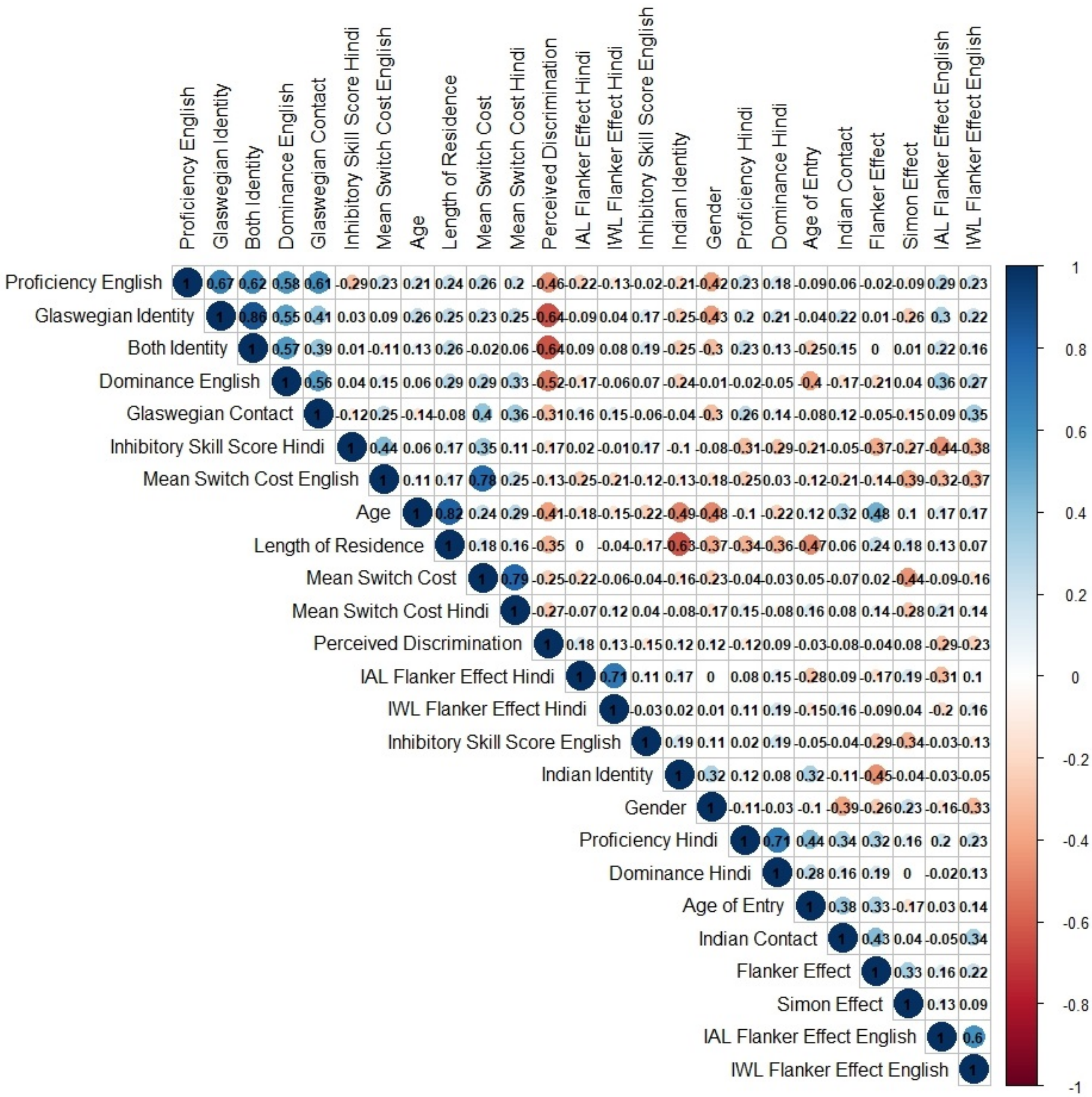


Figure 4.9: Correlation Matrix for Predictor Variables in Section 1

The correlation analysis presented multiple instances of collinearity between variables. These were addressed by removing one of the collinear variables, according to the following logic:

1. **Age and Length of Residence (.82)**: To solve this, Age was replaced by the variable Age of Entry which is not correlated with any other variable.

2. **Proficiency English and Dominance English (.58)** The data on proficiency consisted of self-rated scores on the four domains of reading, writing, understanding and speaking.

However, the questionnaire assessed overall language use in multiple domains to get the data on dominance. Thus, the data for dominance seems to be more reliable than the data for proficiency. Therefore, Proficiency English was removed. This also solves the correlations of Proficiency English with Glaswegian Identity (.67), Both Identity (.62) and Glaswegian Contact (.61).

3. **Proficiency Hindi and Dominance Hindi (.71)**: For the same reason as above, Proficiency Hindi was removed.

4. **Inverse Mean Switch Cost with Inverse Mean Switch Cost English (.78) and Inverse Mean Switch Cost Hindi (.79)**: Here, variables with higher standard deviation (prior to scaling), that is, more variability were selected to be included in the analysis. Inverse Mean Switch Cost English (*SD* = .098) and Inverse Mean Switch Cost Hindi (.091) had higher SD than Inverse Mean Switch Cost (*SD* = .073). Therefore, Inverse Mean Switch Cost was removed.

5. **Inverse IWL Flanker Effect English and Inverse IAL Flanker Effect English (.60)**: Using the same logic as in (4), Inverse IWL Flanker Effect English (*SD* = 70.241) was removed as it had lower SD than Inverse IAL Flanker Effect English (*SD* = 91.214).

6. **Inverse IWL Flanker Effect Hindi and Inverse IAL Flanker Effect Hindi (.71)**: Using the same logic as in (4), Inverse IWL Flanker Effect Hindi (*SD* = 62.662) was removed as it had lower SD than Inverse IAL Flanker Effect Hindi (*SD* = 65.299).

7. **Glaswegian Identity and Both Identity (.86)**: Both Identity was removed as Glaswegian Identity captures its essence. This also solves the correlations of Both Identity with Dominance English (.57) and Perceived Discrimination (-.64).

8. **Length of Residence and Indian Identity (-.63)**: Two separate regression models will be created to separate these two correlated variables. One model will consist of the variable Length of Residence and the other model will consist of the variable Indian Identity.

9. **Dominance English and Glaswegian Contact (.56)**: To separate these variables, Glaswegian Contact will be added to one model and Dominance English to the other.

10. **Dominance English and Glaswegian Identity (.55)**: Glaswegian Identity will be added to one model to separate it from Dominance English in the other model.

11. **Glaswegian Identity and Perceived Discrimination (-.64)**: Glaswegian Identity captures the essence of Perceived Discrimination: the higher the Glaswegian Identity, the lower the perceived discrimination. Moreover, it is not possible to add Perceived Discrimination to either Model 1 or Model 2. This is because Model 1 will contain Glaswegian Identity which it is correlated with. On the other hand, Model 2 will contain the variable

Dominance English which it is also correlated with (-.52). With this in sight, Perceived Discrimination was removed.

Based on the above reasoning, the following eight variables were removed from further analysis: Age, Proficiency English, Proficiency Hindi, Inverse Mean Switch Cost, Inverse IWL Flanker Effect English, Inverse IWL Flanker Effect Hindi, Both Identity and Perceived Discrimination.

4.4.3 Statistical Analysis

The data was subjected to linear mixed effects modelling using `lmer()` function in `lme4` package (version 1.1.29) in R (version 3.6.3). The model summary and p-values were generated using the `summary()` function in the `lmerTest` package (Kuznetsova et al., 2017; version 3.1.3).

The same dependent variable was analysed in three models due to the issues of missing values and collinearity. This is explained below with the descriptions of the relevant models:

1. **Model I:** For all 40 participants, data was available for the predictors Age of Entry, Gender and Length of Residence only. However, data for all predictors was only available for 25 participants. Regression analysis on all variables would have required that missing values be removed from the analysis. This would have meant removing the data on Age of Entry, Gender and Length of Residence for those 15 participants who have missing values for the rest of the variables. To avoid this, a model was created which consisted of the predictors Age of Entry, Gender and Length of Residence only and included data for all 40 participants.

   Next, the 25 participants for which full data was available were then included in the next two models, Model II and Model III. These two models were constructed separately to address the collinearity problems described above in §4.4.2.

2. **Model II:** This model consisted of the following predictors: Length of Residence (LoR), Age of Entry (AoE), Dominance Hindi, Indian Contact, Glaswegian Contact, Glaswegian Identity, Gender, Inhibitory Skill Score English, Inhibitory Skill Score Hindi, Inverse IAL Flanker Effect English, Inverse IAL Flanker Effect Hindi, Inverse Arrow Flanker Effect, Inverse Simon Effect, Inverse Mean Switch Cost English, Inverse Mean Switch Cost Hindi.

3. **Model III:** This model consisted of the following predictors that were correlated with certain predictors in Model II: Indian Identity and Dominance English. Additionally, the variable Age of Entry (AoE) was included in this model as part of an interaction term. The variable Length of Residence (LoR) was not included in interactions as it is correlated with Indian Identity.

Forwards stepwise regression was used to create all models. In forwards stepwise regression, a null model is created. Then variables are added to it one by one, and those that do not make the model better are not retained in the model. Stepwise regression was performed in R using the `step()` function in the `stats` package (version 3.6.2) in R, with the direction specified as either 'forward' or 'backward'. However, this function is most efficient with a bigger data set and less multicollinearity among variables, which the present dataset can not be said to have. Therefore, to overcome this, model specifications were also constructed manually, and compared to the output of step().

For the **manually-constructed model**, a null model was created, and variables were manually added to this model one by one on a hierarchical basis in the following sequence:

1. linguistic control variables
2. known variables based on previous research
3. variables addressing present research questions
4. theoretically important interactions between variables

If adding a variable significantly improved the fit of the model, as determined by a log-likelihood ratio test, then that variable was retained, otherwise not. All variables were tested in this manner, until a final model was created. Next, a **second model** was created using the `step()` function. Based on the same hierarchical sequence as mentioned above, all variables and interactions were included to create a fully saturated model. The step() function returned a **final model specification**, containing significantly important variables. It was ensured that these two models (manually-created model and step()-generated model) were strictly nested using the `is_nested_models()` function in the `insight` package (version 0.19.1; Lüdecke, Waggoner, & Makowski, 2019). Finally, the fit of these two models were compared using the `anova()` function in the `car` package (version 3.1-1; J. Fox & Weisberg, 2019). Of these two models, the model of the best fit was selected as the final model. This is how Model I and III were generated.

For model II, due to the large number of predictors in the model, and only one value per participant for each variable, creating a fully saturated model with the `step()` function was problematic. This is also the reason why forwards, not backwards stepwise regression was employed in this analysis. Therefore, only one model was created for Model II by manually adding variables and interactions using the same hierarchical strategy as in Models I and III.

The results for the three phone categories (the lateral /l/, the voiceless stop /t/, the voiced stops /b d g/) are presented separately in the following sub-sections. The spectral properties of the GOOSE vowel - F1, F2, F3 - were not found to have undergone transfer in the speech production task, and therefore are not included in the present analysis.

4.4.3.1 Phone /l/

For /l/, the dependent variable was F2-F1 difference (Hz). The acoustic analysis (speech production task; Chapter 3) showed that, in general, Glaswasian Hindi and English /l/ had similarly higher F2-F1 difference (therefore, clearer /l/). In terms of transfer, both English and Hindi underwent dissimilation, that is, in both languages Glaswasian /l/ had developed exaggerated native characteristics leading to a significantly clearer /l/ than the native Indian /l/. Furthermore, Hindi underwent more dissimilation than English. So, an increase in F2-F1 difference is related to higher dissimilation, whereas a decrease in F2-F1 difference is related to lower dissimilation.

To simplify for the present analysis, **higher F2-F1 difference indicates more transfer, lower F2-F1 difference indicates less transfer**.

4.4.3.1.1 Model I

The formula for the linear mixed model of the best fit was:

```
lmer(F2-F1 difference ~ Vowel Height + Scaled Log Phone Duration
+ Language + Gender + AoE + Language:Gender + Language:AoE + (1 |
speaker))
```

Table 4.2 presents the summary of this model.

Table 4.2: Model I summary for F2-F1 difference in /l/

	Dependent variable:
	F2-F1 difference
Intercept	1,424.047*** (22.924)
Vowel Height Non High	−47.449*** (13.663)
Scaled Log Phone Duration	33.351*** (8.998)
Language Hindi	7.610 (15.832)
Gender Male	−143.146** (45.441)
AoE	45.804* (21.957)
Language Hindi:Gender Male	−105.693** (32.307)
Language Hindi:AoE	−49.228** (15.631)
Observations	462
Log Likelihood	−2,978.098
Akaike Inf. Crit.	5,976.196
Bayesian Inf. Crit.	6,017.552
Note:	*p<0.05; **p<0.01; ***p<0.001

There was a significant effect of Vowel Height ($\beta = -47.45, t(452) = -3.47, p < .001$) indicating that the F2-F1 difference in English was lowered by 47 Hz when /l/ preceded a non-high vowel than when it was followed by a high vowel. There was a positive effect of Log Phone Duration ($\beta = 33.35, t(452) = 3.71, p < .001$) which indicated that F2-F1 difference in English increased with the duration of the lateral.

Another significant effect emerged for Gender ($\beta = -143.15, t(452) = -3.15, p = .002$). This indicated that F2-F1 difference in English was lowered by 143 Hz when produced by males than when produced by females. Thus, males showed less transfer in English as compared to females. Gender also interacted with Language to indicate a significantly more negative effect of male Gender on Hindi as compared to English ($\beta = -105.69, t(452) = -3.27, p = .001$). Figure 4.10 depicts that the difference between males and females for F2-F1 difference was bigger in Hindi as compared to English. Thus, males underwent less transfer than females in Hindi than in English.

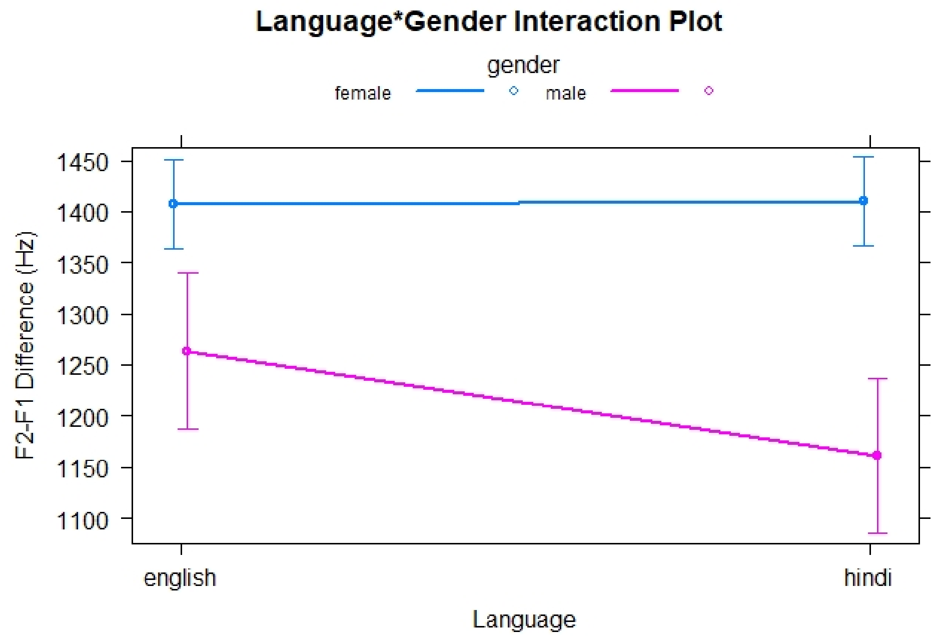


Figure 4.10: Model effect depicting the interaction between Language and Gender on F2-F1 Difference in /l/ in Table 4.2

The significant effect of AoE, applying only to F2-F1 difference in English ($\beta = 45.80, t(452) = 2.09, p = .038$) showed that F2-F1 difference increased with increasing age of entry, that is, higher transfer in those with higher age of entry. It also interacted with Language, such that Hindi showed a significantly more negative effect of AoE than English ($\beta = -47.31, t(565) = -2.74, p = .006$). However, the magnitude of the interaction undoes this coefficient entirely, because of which AoE does not affect Hindi, as seen in Figure 4.11. So while increasing AoE does not seem to be affecting Hindi, it increased F2-F1 difference, that is more transfer, in English (Figure 4.11).

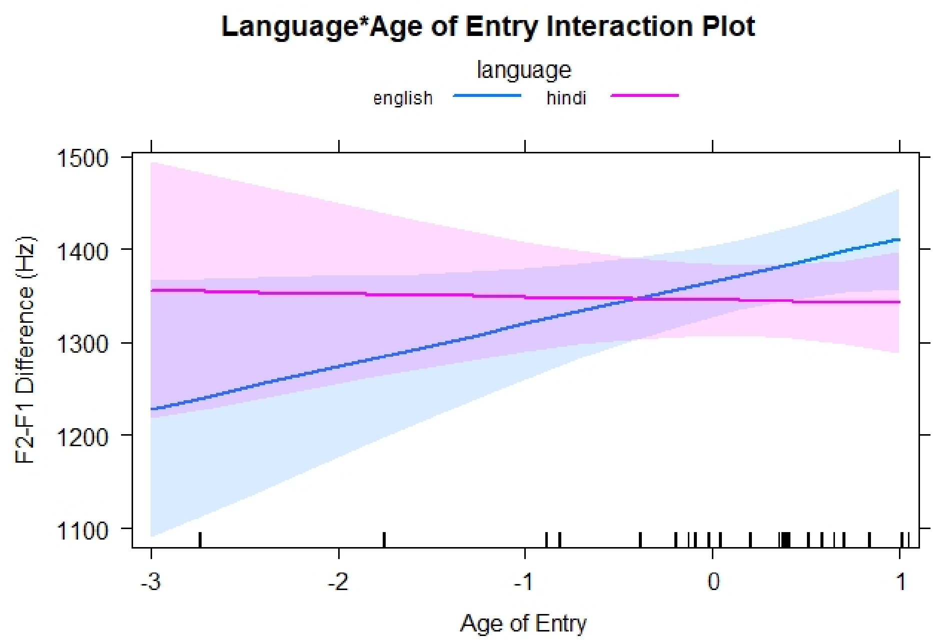


Figure 4.11: Model effect depicting the interaction between Language and AoE on F2-F1 Difference in /l/ in Table 4.2

4.4.3.1.2 Model II

The formula for the linear mixed model of the best fit was:

```
lmer(F2-F1 Difference ~ Vowel Height + Scaled Log Phone Duration + Gender + Language + Indian Contact + Inverse Simon Effect + Inverse Arrow Flanker Effect + Dominance Hin + LoR + Inhibitory Skill Score Hin + Inhibitory Skill Score Eng + Inverse IAL Flanker Effect Eng + Language:Indian Contact + Language:Inverse Simon Effect + Language:Dominance Hin + Language:LoR + Language:Inhibitory Skill Score Hin + LoR:Inhibitory Skill Score Hin + Language:Inhibitory Skill Score Eng + Language:Inverse IAL Flanker Effect + LoR:Inverse IAL Flanker Effect + Language:LoR:Inhibitory Skill Score Hin + (1 | speaker))
```

Table 4.3 presents the summary of this model.

Table 4.3: Model II summary for F2-F1 difference in /l/

	Dependent variable:
	F2-F1 difference
Intercept	1,414.905*** (21.319)

Vowel Height Non High	-49.114^{***} (12.537)
Scaled Log Phone Duration	31.442^{***} (8.277)
Gender Male	-209.145^{***} (34.559)
Language Hindi	-55.888^{***} (14.415)
Indian Contact	19.097 (15.745)
Inverse Simon Effect	-50.419^{**} (17.425)
Inverse Arrow Flanker Effect	37.042^{*} (15.901)
Dominance Hin	25.708 (16.752)
LoR	−47.432 (48.548)
Inhibitory Skill Score Hin	4.652 (23.551)
Inhibitory Skill Score Eng	29.155 (18.096)
Inverse IAL Flanker Effect Eng	59.747^{*} (23.258)
Language Hindi:Indian Contact	-81.197^{***} (12.863)
Language Hindi:Inverse Simon Effect	106.701^{***} (15.247)
Language Hindi:Dominance Hin	24.277 (15.762)
Language Hindi:LoR	-231.518^{***} (39.771)
Language Hindi:Inhibitory Skill Score Hin	145.662^{***} (22.313)
LoR:Inhibitory Skill Score Hin	139.547^{*} (65.406)
Language Hindi:Inhibitory Skill Score Eng	-74.495^{***} (16.211)
Language Hindi:Inverse IAL Flanker Effect Eng	33.347^{*} (15.725)
LoR:Inverse IAL Flanker Effect Eng	220.422^{***} (66.758)
Language Hindi:LoR:Inhibitory Skill Score Hin	249.169^{***} (51.181)
Observations	462
Log Likelihood	−2,929.729
Akaike Inf. Crit.	5,909.458
Bayesian Inf. Crit.	6,012.847
Note:	*p<0.05; **p<0.01; ***p<0.001

The effects of Vowel Height, Log Phone Duration and Gender in this model were similarly significant as in Model 4.2 (Vowel Height: ($\beta = -49.11, t(437) = -3.92, p < .001$); Log Phone Duration: ($\beta = 31.44, t(437) = 3.80, p < .001$); Gender: ($\beta = -209.15, t(437) = -6.05, p < .001$)). Additionally, there was a significantly negative effect of Language on Hindi ($\beta = -55.89, t(437) = -3.88, p < .001$), such that Hindi had lower F2-F1 difference (reduced transfer) than English.

A significantly positive effect of Inverse Arrow Flanker Effect emerged for F2-F1 difference in English ($\beta = 37.04, t(437) = 2.33, p = .020$) such that with increasing Inverse Arrow Flanker Effect (better inhibitory skill), F2-F1 difference increased (more transfer) in English.

Inverse Simon Effect had a significantly negative effect on F2-F1 difference in English ($\beta =$

$-50.42, t(437) = -2.89, p = .004$). This was qualified by a two-way interaction with Language which had a more positive effect on Hindi than English ($\beta = 106.70, t(437) = 7.00, p < .001$). Figure 4.12 indicates that with an increase in Inverse Simon Effect (better inhibitory ability), Hindi F2-F1 difference increased (more transfer), whereas English F2-F1 difference decreased (reduced transfer).

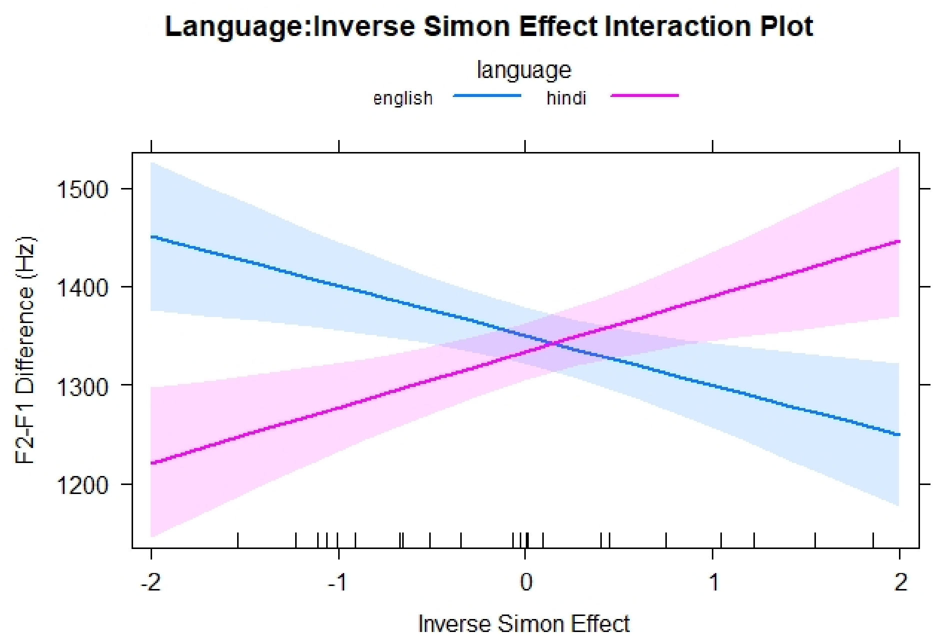


Figure 4.12: Model interaction effect between Language and Inverse Simon Effect on F2-F1 Difference in Table 4.3

The effect of Inverse IAL Flanker Effect English, applying to English only, was significantly positive ($\beta = 59.75, t(437) = 2.57, p = .011$). That is, higher Inverse IAL Flanker Effect English (better inhibitory ability) was associated with an increase in F2-F1 difference (more transfer) in English. This effect was qualified by a two-way interaction with LoR ($\beta = 220.42, t(437) = 3.30, p = .001$), such that the effect of Inverse IAL Flanker Effect English on LoR was significantly positive (Figure 4.13). As LoR increased, those with lowest (poor) Inverse IAL Flanker Effect showed the most decrease in F2-F1 difference (less transfer), whereas those with higher (better) Inverse IAL Flanker Effect did not seem to have an Effect of LoR on their F2-F1 difference.

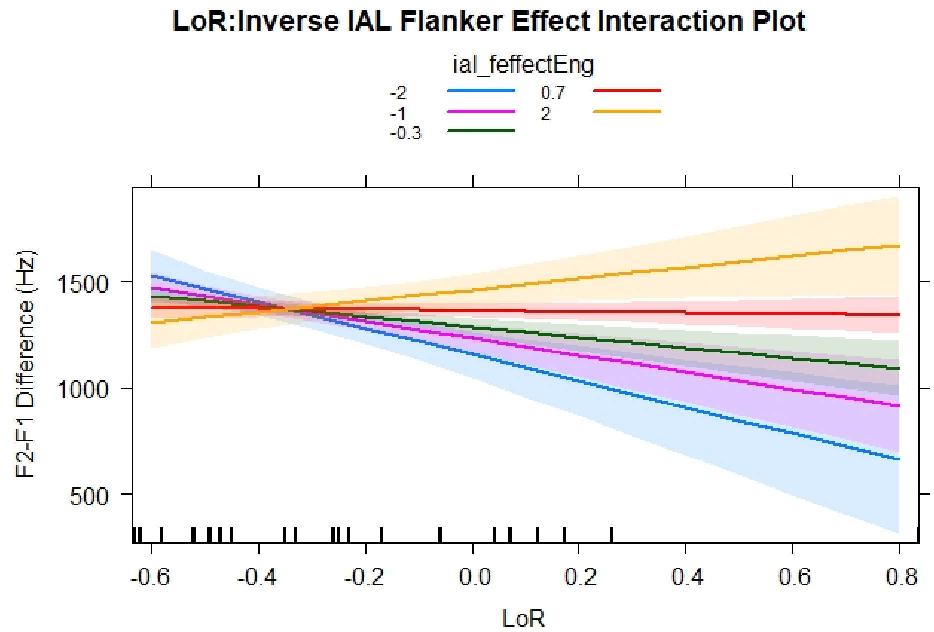


Figure 4.13: Model interaction between LoR and inverse IAL Flanker Effect English on F2-F1 Difference in Table 4.3

Inverse IAL Flanker Effect English also interacted with Language to have a more positive effect on Hindi than English ($\beta = 33.35, t(437) = 2.12, p = .035$). This meant that there was a steeper increase in F2-F1 difference (more transfer) with increasing (better) Inverse IAL Flanker Effect in Hindi than in English, as shown in Figure 4.14.

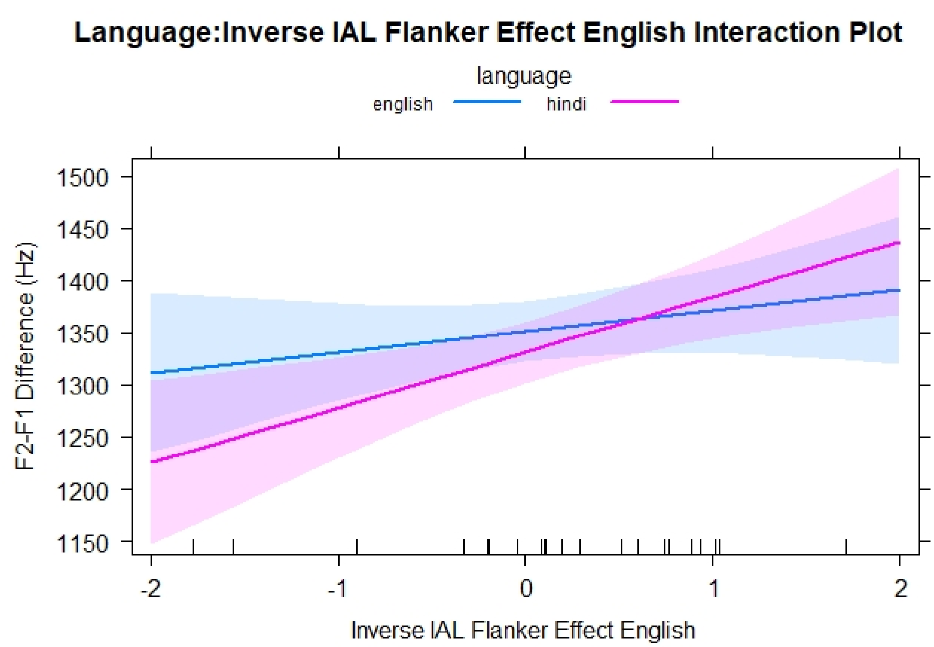


Figure 4.14: Model interaction between Language and Inverse IAL Flanker Effect English on F2-F1 Difference in Table 4.3

Additionally, the interaction effect of Inhibitory Skill Score (Hindi) on Language was more positive for Hindi than for English ($\beta = 145.66, t(437) = 6.53, p < .001$). Figure 4.15 shows that an increase in Inhibitory Skill Score (Hindi) (higher inhibition in Hindi) was associated with an increase in F2-F1 difference in Hindi (more transfer), but not in English.

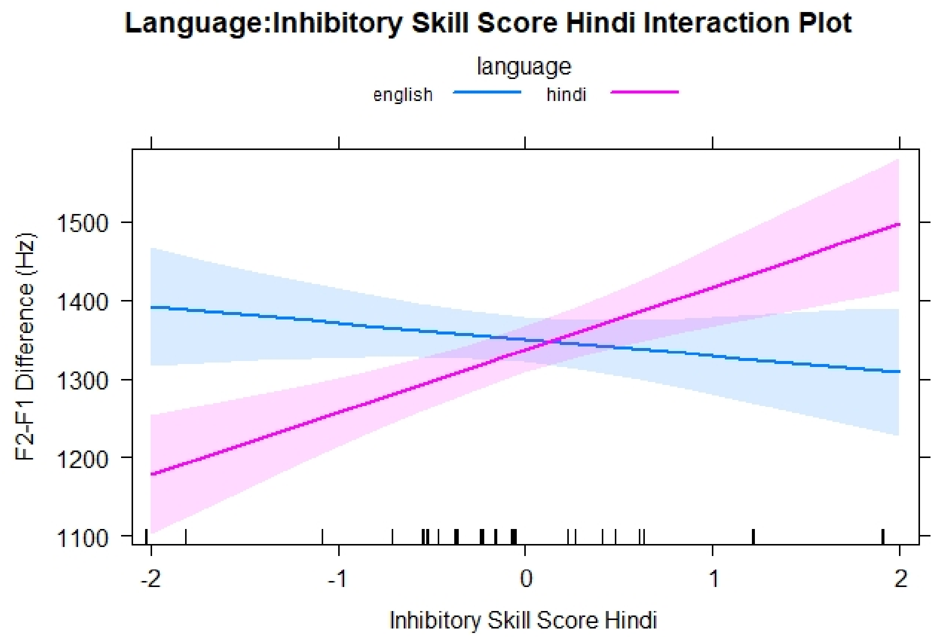


Figure 4.15: Model interaction effect between Language and Inhibitory Skill Score (Hindi) on F2-F1 Difference in Table 4.3

However, the interaction effect of Inhibitory Skill Score (English) on Language was more negative for Hindi than for English ($\beta = -74.50, t(437) = -4.60, p < .001$). As shown in Figure 4.16, an increase in Inhibitory Skill Score (English), that is, higher inhibition, was associated with a decrease in F2-F1 difference (less transfer) in Hindi.

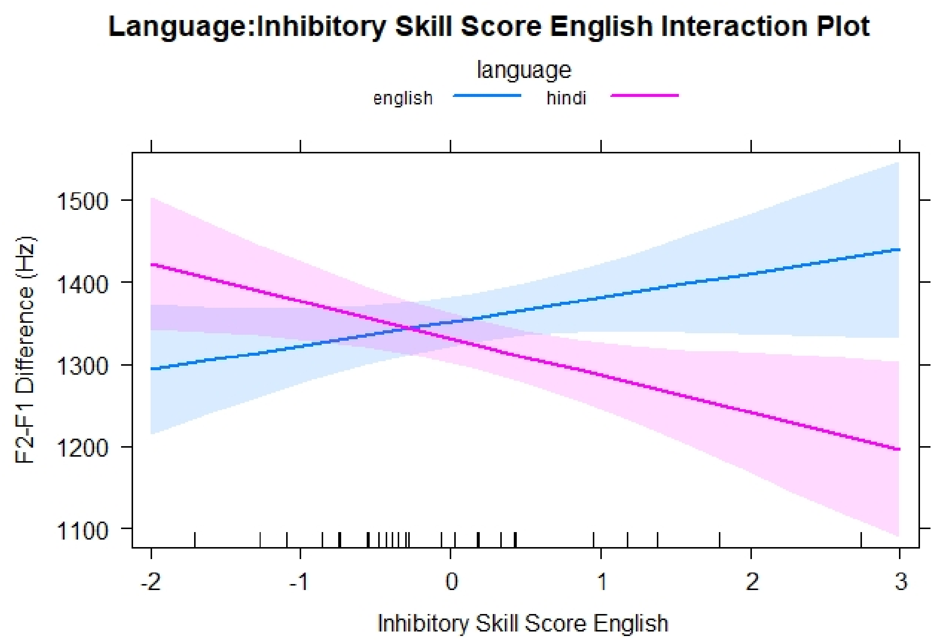


Figure 4.16: Model interaction effect between Language and Inhibitory Skill Score (English) on F2-F1 Difference in Table 4.3

An interaction effect between Indian Contact and Language also emerged that had a more negative effect on Hindi than English ($\beta = -81.20, t(437) = -6.31, p < .001$). Figure 4.17 shows that higher Indian Contact led to a decrease in F2-F1 difference (less transfer) in Hindi, but no effect in English.

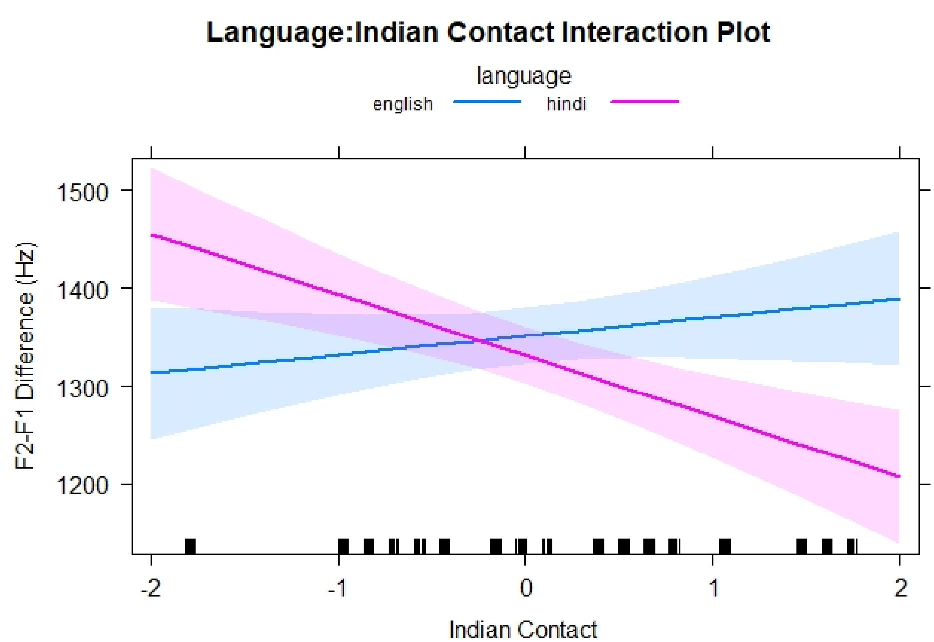


Figure 4.17: Model interaction effect between Language and Indian Contact on F2-F1 Difference in Table 4.3

Similarly, the interaction effect of LoR on Language was more negative for Hindi as compared to English ($\beta = -231.52, t(437) = -5.82, p < .001$). As LoR increased, Hindi showed a steeper decrease in F2-F1 difference (less transfer), whereas F2-F1 difference in English was not affected. This is shown in Figure 4.18.

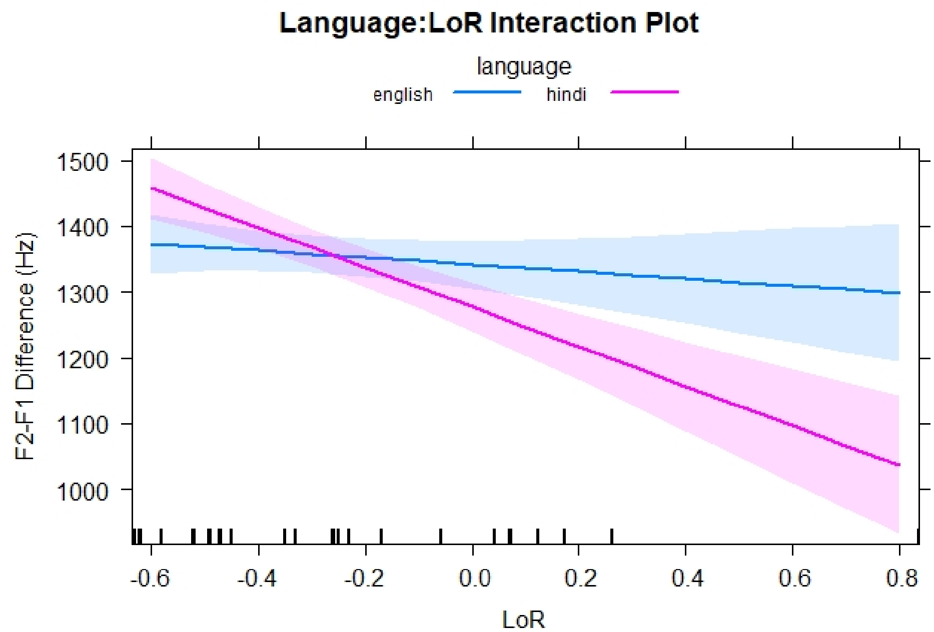


Figure 4.18: Model interaction effect between Language and LoR on F2-F1 Difference in Table 4.3

Another two-way interaction emerged between LoR and Inhibitory Skill Score Hindi which was significantly positive ($\beta = 139.55, t(437) = 2.13, p = .033$). This was qualified by a three-way interaction with Language such that the effect of Inhibitory Skill Score Hindi on Language and LoR was significantly more positive for Hindi than English ($\beta = 249.17, t(437) = 4.87, p < .001$). Figure 4.19 shows that increasing Inhibitory Skill Score Hindi (higher inhibition) was associated with increasing F2-F1 difference (more transfer), which is modulated by LoR such that increasing LoR is related to a steeper increase in Hindi than English.

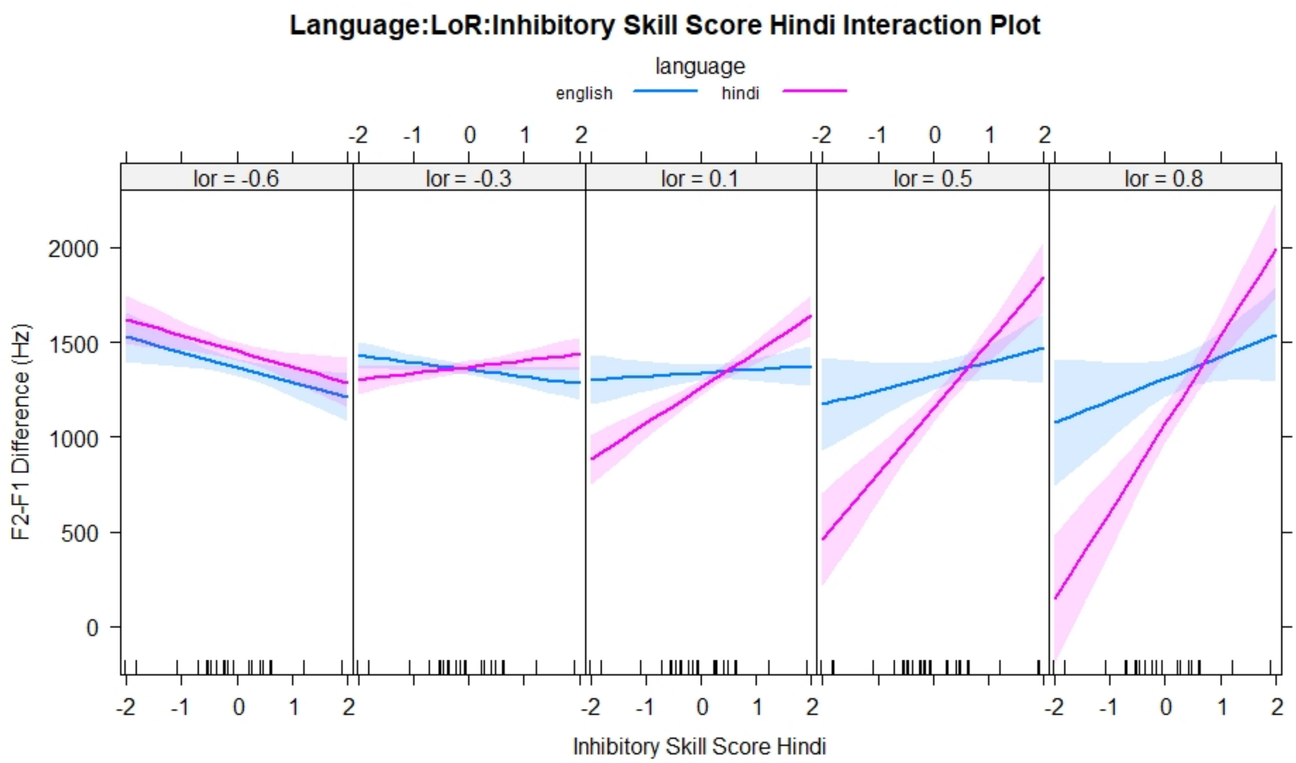


Figure 4.19: Model interaction effect between Language, LoR and Inhibitory Skill Score (Hindi) on F2-F1 Difference in Table 4.3

4.4.3.1.3 Model III

The formula for the linear mixed model of the best fit was:

```
lmer(F2-F1 difference ~ Vowel Height + Scaled Log Phone Duration
+ Language + AoE + Language:AoE + (1 | speaker))
```

Table 4.4 presents the summary of this model.

Table 4.4: Model III summary for F2-F1 difference in /l/

	Dependent variable:
	F2-F1 difference
Intercept	1,390.047*** (26.225)
Vowel Height Non High	−47.292*** (13.839)
Scaled Log Phone Duration	32.793*** (9.305)
Language Hindi	−18.348 (13.849)
AoE	26.272 (28.017)
Language Hindi:AoE	−64.096*** (15.152)
Observations	462
Log Likelihood	−2,991.053
Akaike Inf. Crit.	5,998.107
Bayesian Inf. Crit.	6,031.191
Note:	*p<0.05; **p<0.01; ***p<0.001

In this model, Vowel Height $(\beta = -47.29, t(454) = -3.42, p < .001)$ and Scaled Log Phone Duration $(\beta = 32.79, t(454) = 3.52, p < .001)$ were significant to the same effect as in Model I (Table 4.2). This was also the case for the significant interaction between AoE and Language $(\beta = -64.10, t(454) = -4.23, p < .001)$.

4.4.3.1.4 Summary

To summarise, multiple factors were found to affect transfer effects in /l/ differentially across Hindi and English.

In Model II (25 non-elderly Glaswasians), Inhibitory Skill Score Hindi, Inverse IAL Flanker Effect English, Inverse Simon Effect and Inverse Arrow Flanker Effect were associated with higher transfer (increased dissimilation; exaggeratedly Indian-like values) in /l/, whereas in the same group, Indian Contact, LoR, Inhibitory Skill Score English, Inverse Simon Effect were associated with lower transfer (decreased dissimilation; more Indian-like values in /l/).

4.4.3.2 Phone /t/

For /t/, the dependent variable was log VOT. Acoustic analysis (in Chapter III) showed that, Glaswasian /t/ had higher (less negative) log VOT than the Indian control group, that is longer VOT (in direction of Glaswegians) in English as well as Hindi. Thus, in terms of transfer, both English and Hindi underwent assimilation. Additionally, English underwent more assimilation than Hindi. Higher log VOT (less negative) indicates longer VOT and higher assimilation. On the other hand, lower log VOT (more negative) indicates lower assimilation.

To simplify for the present analysis, **shorter VOT indicates less transfer, longer VOT indicates more transfer**.

4.4.3.2.1 Model I

The formula for the linear mixed model of the best fit is:

```
logVOT ~ Vowel Height + Language + AoE + LoR + Language:AoE +
(1 | speaker)
```

Table 4.5 presents the summary of this model.

Table 4.5: Model I summary for log VOT in /t/

	Dependent variable:
	Log VOT
Intercept	-4.095^{***} (0.070)
Vowel Height Non High	-0.131^{**} (0.041)
Language Hindi	-0.199^{***} (0.041)
AoE	-0.297^{***} (0.068)
LoR	0.418^{**} (0.143)
Language Hindi:AoE	0.286^{***} (0.044)
Observations	435
Log Likelihood	-267.520
Akaike Inf. Crit.	551.039
Bayesian Inf. Crit.	583.642
Note:	*p<0.05; **p<0.01; ***p<0.001

The effect of Vowel Height was more negative for Non High vowels ($\beta = -0.13, t(427) = -3.16, p = .002$). That is, when followed by a non-high vowel, VOT was shorter than when followed by a high vowel. Another significantly negative effect emerged for Hindi ($\beta = -0.20, t(427) = -4.83, p < .001$), which indicates that Hindi had shorter VOT than English.

The effect of AoE, applying only to English, was also significantly negative ($\beta = -0.30, t(427) = -4.39, p < .001$). Therefore, an increase in AoE was associated with increasingly shorter VOT, which is indicative of less transfer in English. This simple effect was qualified by a significantly positive interaction effect of AoE on Language (Hindi) ($\beta = 0.29, t(427) = 6.52, p < .001$). However, the magnitude of the interaction undoes this coefficient entirely, because of which

AoE did not affect Hindi, as seen in Figure 4.20. So, as the AoE increased, VOT in English had a steeper decrease, whereas it was flatter for Hindi. In other words, there was less transfer in English as the AoE increased, but no change in Hindi. This is shown in Figure 4.20.

Finally, there was a significantly positive effect of LoR which applied only to log VOT in English ($\beta = 0.42, t(427) = 2.92, p = .004$). This indicated that an increase in LoR was associated with an increase in VOT, that is more transfer in English.

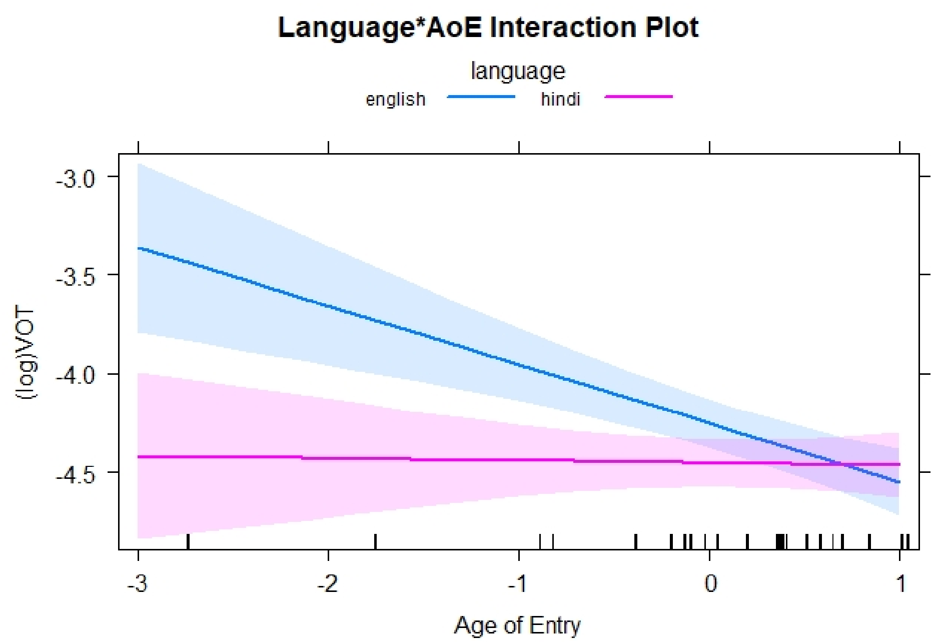


Figure 4.20: Model interaction effect between Language and AoE on log VOT in Table 4.5

4.4.3.2.2 Model II

The linear mixed model of the best fit is shown below. Table 4.6 presents the summary of this model.

`logVOT ~ (1 | speaker) + Vowel Height + Language + AoE + Glaswegian Identity + Inverse IAL Flanker Effect English + Inverse Arrow Flanker Effect + Inverse Simon Effect + Inhibitory Skill Score English + Language:Indian Contact + Language:AoE + Language:Inverse Simon Effect + Language:Inhibitory Skill Score Hindi + Language:Dominance Hindi + Language:Inverse IAL Flanker Effect Hindi + Language:LoR:Dominance Hindi + Language:AoE:Indian Contact`

Table 4.6: Model II summary for log VOT in /t/

	Dependent variable:

	Log VOT
Intercept	-3.965^{***} (0.064)
Vowel Height Non High	-0.133^{***} (0.036)
Language Hindi	-0.697^{***} (0.068)
AoE	-0.503^{***} (0.063)
Glaswegian Identity	0.166^{***} (0.030)
Inverse IAL Flanker Effect Eng	0.149^{***} (0.032)
Inverse Arrow Flanker Effect	0.198^{***} (0.038)
Inverse Simon Effect	0.100^{*} (0.043)
Inhibitory Skill Score English	-0.093^{***} (0.028)
Language English:Indian Contact	0.089 (0.071)
Language Hindi:Indian Contact	-0.645^{***} (0.067)
Language Hindi:AoE	0.800^{***} (0.071)
Language Hindi:Inverse Simon Effect	-0.137^{**} (0.048)
Language English:Inhibitory Skill Score Hindi	0.065 (0.045)
Language Hindi:Inhibitory Skill Score Hindi	0.226^{***} (0.043)
Language English:Dominance Hindi	−0.190 (0.139)
Language Hindi:Dominance Hindi	0.399^{**} (0.136)
Language English:Inverse IAL Flanker Effect Hindi	−0.036 (0.063)
Language Hindi:Inverse IAL Flanker Effect Hindi	0.393^{***} (0.061)
Language English:Dominance Hindi:LoR	−0.202 (0.225)
Language Hindi:Dominance Hindi:LoR	0.547^{*} (0.219)
Language English:AoE:Indian Contact	−0.079 (0.088)
Language Hindi:AoE:Indian Contact	0.640^{***} (0.085)
Observations	435
Log Likelihood	−188.691
Akaike Inf. Crit.	427.382
Bayesian Inf. Crit.	529.266
Note:	*p<0.05; **p<0.01; ***p<0.001

To begin with, there were multiple significant simple effects applying to English only.

Vowel Height, Language and AoE had similarly significant effects as in Model I (Table 4.5) (Vowel Height: $(\beta = -0.13, t(410) = -3.72, p < .001)$; Language: $(\beta = -0.70, t(410) = -10.28, p < .001)$; AoE: $(\beta = -0.50, t(410) = -7.95, p < .001)$). The interaction effect of AoE on Hindi was also positive as in Model I (Table 4.5) $(\beta = 0.80, t(410) = 11.22, p < .001)$.

The effect of Glaswegian Identity on log VOT in English emerged to be significantly positive $(\beta = 0.17, t(410) = 5.49, p < .001)$. This is to say that an increase in Glaswegian Identity was associated with longer VOT, that is more transfer, in English.

The effect of Inverse IAL Flanker Effect (English) on log VOT in English was also significantly positive ($\beta = 0.15, t(410) = 4.75, p < .001$). That is, an increase in Inverse IAL Flanker Effect (English), or better inhibitory skill, was associated with longer VOT, that is more transfer, in English.

The effect of Inverse Arrow Flanker Effect on log VOT in English was also significantly positive ($\beta = 0.20, t(410) = 5.24, p < .001$). Higher inverse arrow Flanker Effect (better inhibitory ability) was linked with longer VOT, that is more transfer, in English.

However, the effect of Inhibitory Skill Score (English) ($\beta = -0.09, t(410) = -3.35, p < .001$) on log VOT in English was significantly negative. This indicates that an increase in Inhibitory Skill Score English (higher inhibition) was linked with shorter VOT, that is less transfer, in English.

Inverse Simon Effect had a significantly positive effect on log VOT in English ($\beta = 0.10, t(410) = 2.36, p = .019$). This suggests that an increase in Inverse Simon Effect, or better inhibitory skill, was associated with longer VOT, that is more transfer, in English. This was qualified by an interaction with Language such that Inverse Simon Effect had a more negative effect on Hindi than English ($\beta = -0.14, t(410) = -2.87, p = .004$). This indicates that comparative to English VOT, Hindi remained rather unaffected by an increase in this inhibitory skill.

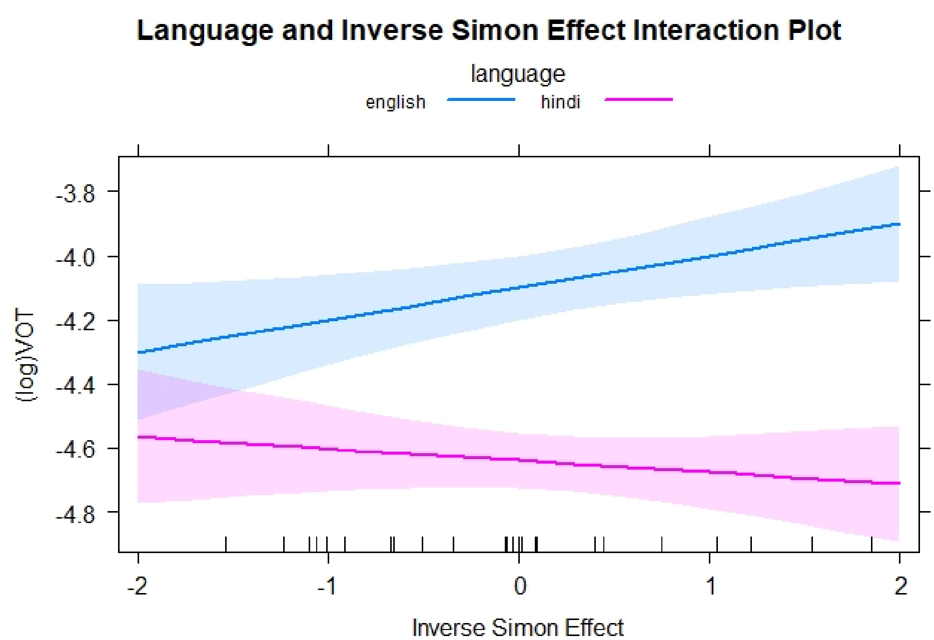


Figure 4.21: Model interaction effect between Language and Inverse Simon Effect on log VOT in Table 4.6

Other interaction effects on log VOT also emerged as significant.

The interaction effect of Inhibitory Skill Score Hindi on Language was more positive for Hindi, than for English ($\beta = 0.23, t(410) = 5.29, p < .001$). This means that higher inhibition was associated with more Glaswegian-like VOT in Hindi /t/ (more transfer), whereas English VOT remained unaffected by this (Figure 4.22). The interaction between Inverse IAL Flanker Effect (Hindi) and Language had a similar effect ($\beta = 0.39, t(410) = 6.46, p < .001$), as shown in Figure 4.23.

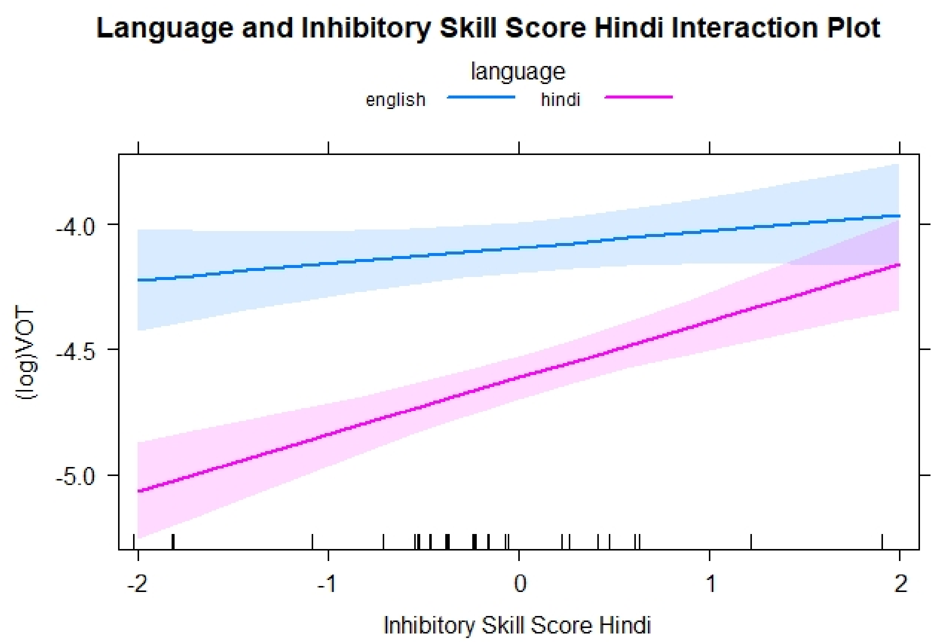


Figure 4.22: Model interaction effect between Language and Inhibitory Skill Score (Hindi) on log VOT in Table 4.6

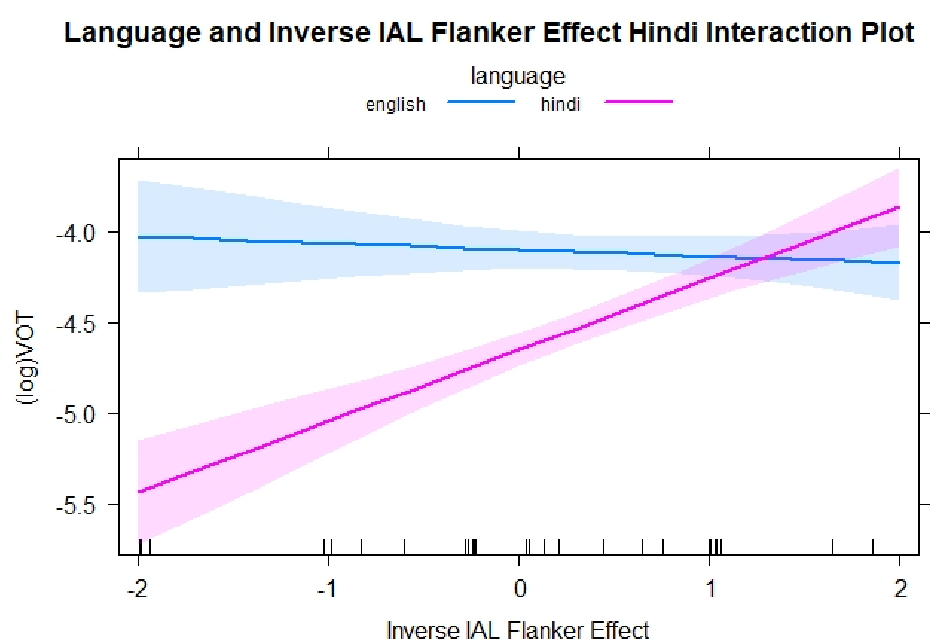


Figure 4.23: Model interaction effect between Language and Inverse IAL Flanker Effect (Hindi) on log VOT in Table 4.6

Another two-way interaction emerged between Indian Contact and Language, such that the effect of Indian Contact was more negative for Hindi ($\beta = -0.64, t(410) = -9.60, p < .001$). This indicated that higher Indian Contact had no effect on VOT in English, whereas it led to a steeper decrease in VOT (less transfer) in Hindi. This was qualified by a three way interaction with AoE, such that the effect of Indian Contact on Language and AoE was more positive for Hindi than English ($\beta = 0.64, t(410) = 7.52, p < .001$). With increasing Indian Contact, Hindi VOT became more Indian-like (so less transfer) exaggeratedly so for early AoE than late AoE. English VOT, on the other hand, became longer (more transfer) with increasing Indian Contact - an effect that subsided with increasing AoE. This is depicted in Figure 4.24.

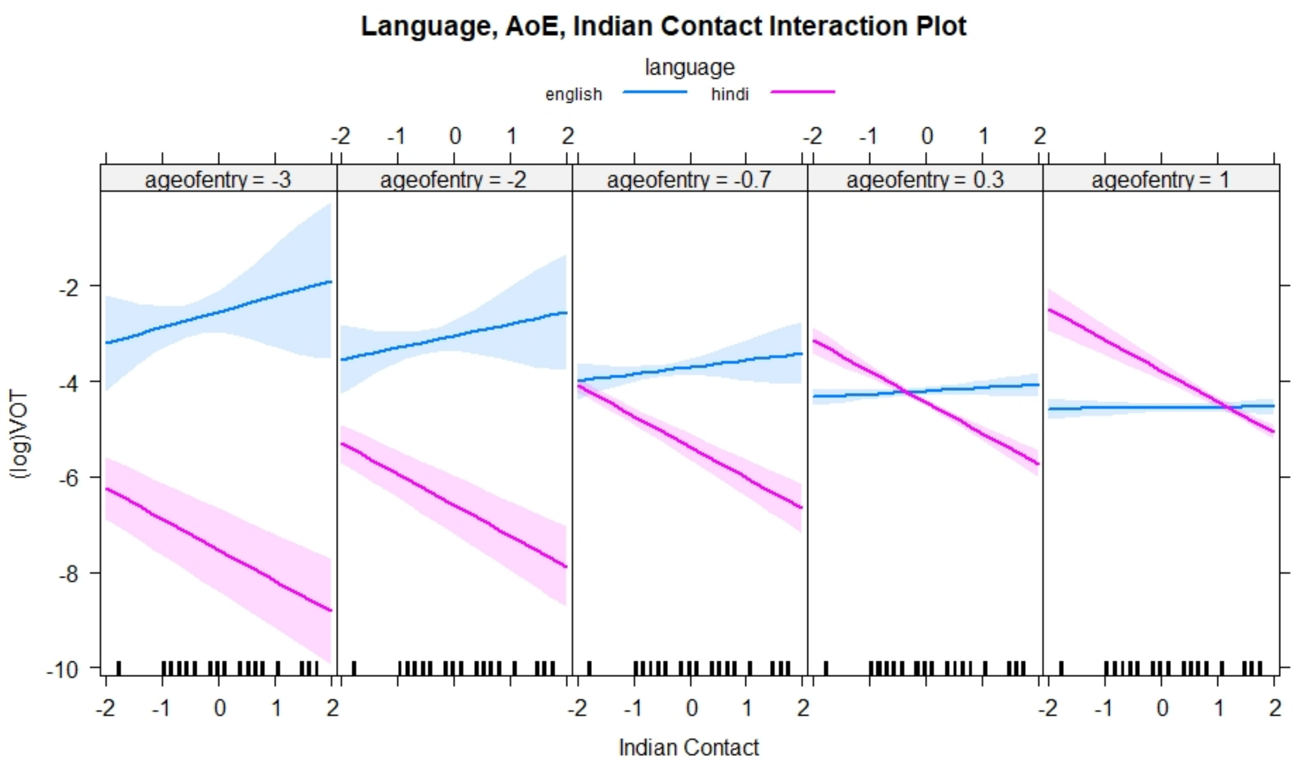


Figure 4.24: Model interaction effect between Language, AoE and Indian Contact on log VOT in Table 4.6

Finally, the two-way interaction between Dominance Hindi and Language had a more positive effect on Hindi than English ($\beta = 0.40, t(410) = 2.93, p = .004$). This was further qualified by a three-way interaction with LoR, where the effect of LoR and Dominance Hindi was significantly more positive for Hindi than English ($\beta = 0.55, t(410) = 2.50, p = .013$). As Figure 4.25 shows, an increase in Dominance Hindi was associated with an increase in VOT in Hindi (more transfer), an effect that was exaggerated by increasing LoR.

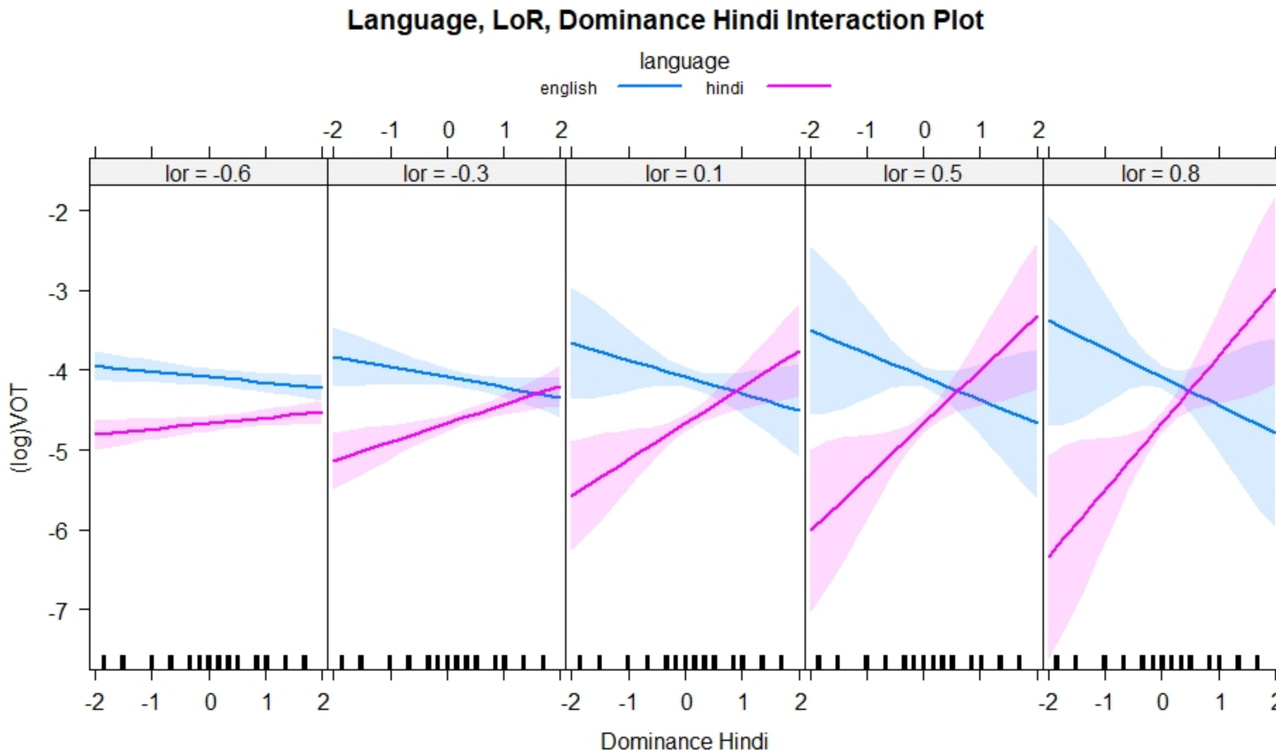


Figure 4.25: Model interaction effect between Language, LoR and Dominance Hindi on log VOT in Table 4.6

4.4.3.2.3 Model III

The formula for the linear mixed model of the best fit was:

```
lmer(logVOT ~ Vowel Height + Language + Dominance English +
Indian Identity + (1 | speaker) + Language:Dominance English +
Language:Indian Identity + Dominance English:AoE +
Indian Identity:AoE + Language:Dominance English:AoE +
Language:Indian Identity:AoE)
```

Table 4.7 presents the summary of this model.

Table 4.7: Model III Summary for log VOT in /t/

	Dependent variable:
	Log VOT
Intercept	-4.175^{***} (0.072)
Vowel Height Non High	-0.132^{**} (0.042)
Language Hindi	-0.256^{***} (0.048)
Dominance English	0.175^{**} (0.059)
Indian Identity	-0.215^{**} (0.077)
Language Hindi:Dominance English	-0.022 (0.041)
Language Hindi:Indian Identity	0.133^{*} (0.052)
Dominance English:AoE	-0.031 (0.084)
Indian Identity:AoE	-0.185 (0.119)
Language Hindi:Dominance English:AoE	-0.142^{*} (0.059)
Language Hindi:Indian Identity:AoE	0.224^{**} (0.081)
Observations	435
Log Likelihood	-275.730
Akaike Inf. Crit.	577.460
Bayesian Inf. Crit.	630.439
Note:	*p<0.05; **p<0.01; ***p<0.001

In this model, Vowel Height and Language had similarly significant effects as in Model I (Table 4.5) (Vowel Height: $(\beta = -0.13, t(420) = -3.35, p < .001)$; Language $(\beta = -0.26, t(422) = -5.39, p < .001)$).

An effect of Indian Identity, applicable to log VOT in English, emerged as significantly negative $(\beta = -0.21, t(422) = -2.80, p = .005)$. This is to say VOT in English got increasingly shorter (less transfer) with higher Indian Identity. This effect was qualified by a two-way interaction with Language $(\beta = 0.13, t(422) = 2.54, p = .011)$ and a three-way interaction with Language and AoE $(\beta = 0.22, t(422) = 2.77, p = .006)$. Figure 4.26 shows this three-way interaction where the effect of AoE on Language and Indian Identity was significantly more positive for Hindi than for English. The effect of this is such that increasing Indian Identity increases VOT (more transfer) for those with lower AoE, but the effect flattens for Hindi as AoE increases, and even reverses for English. Importantly, in Hindi, the flattening effect still ends up with the highest VOT for the highest levels of AoE.

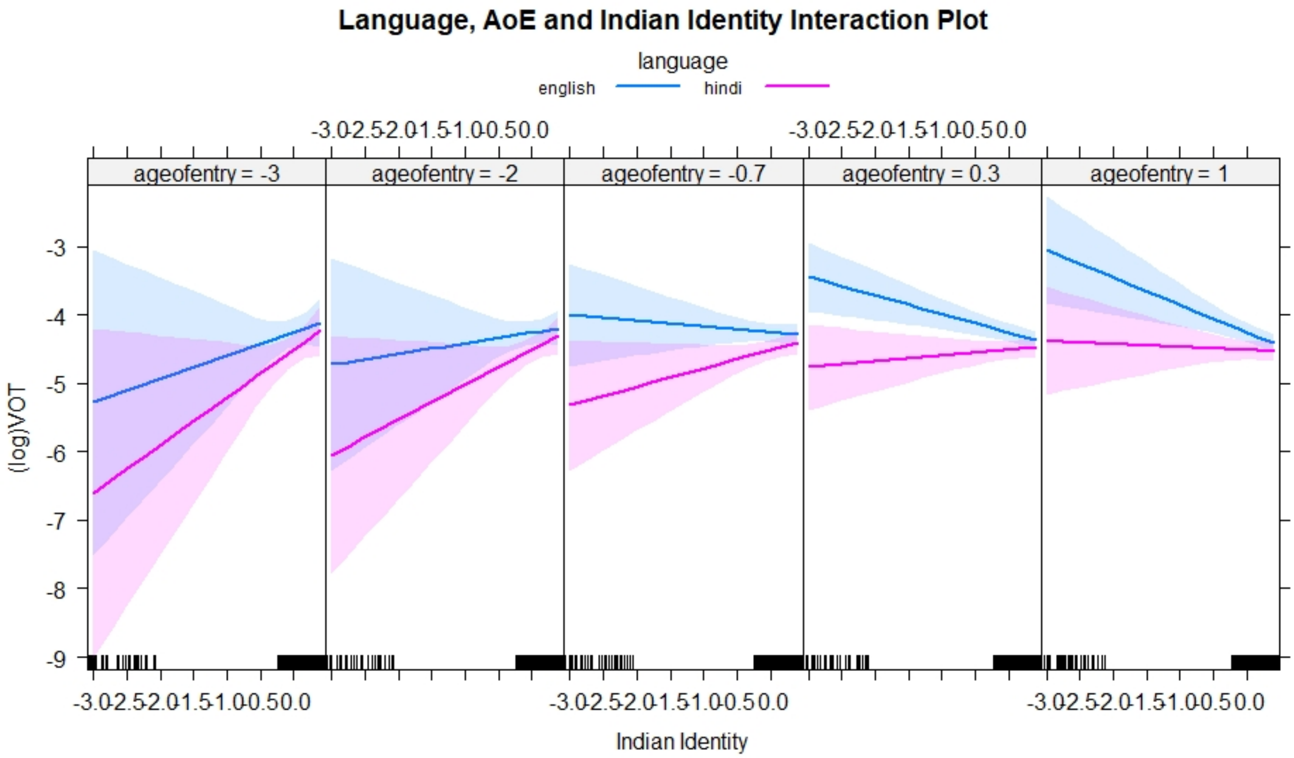


Figure 4.26: Model interaction effect between Language, AoE and Indian Identity on log VOT in Table 4.7

Another significantly positive effect emerged for Dominance English applicable only to English VOT ($\beta = 0.17, t(422) = 2.95, p = .003$). This was such that an increase in Dominance English was associated with longer VOT, that is, more transfer. This effect was qualified by a three-way interaction such that the effect of AoE on Language and Dominance English was significantly more negative for Hindi, than for English ($\beta = -0.14, t(422) = -2.43, p = .016$). As seen in Figure 4.27, an increase in Dominance English is associated with steeper increase in English than in Hindi (more transfer), but this is modulated by AoE - an increase in which decreases this effect in English and even flattens it for Hindi.

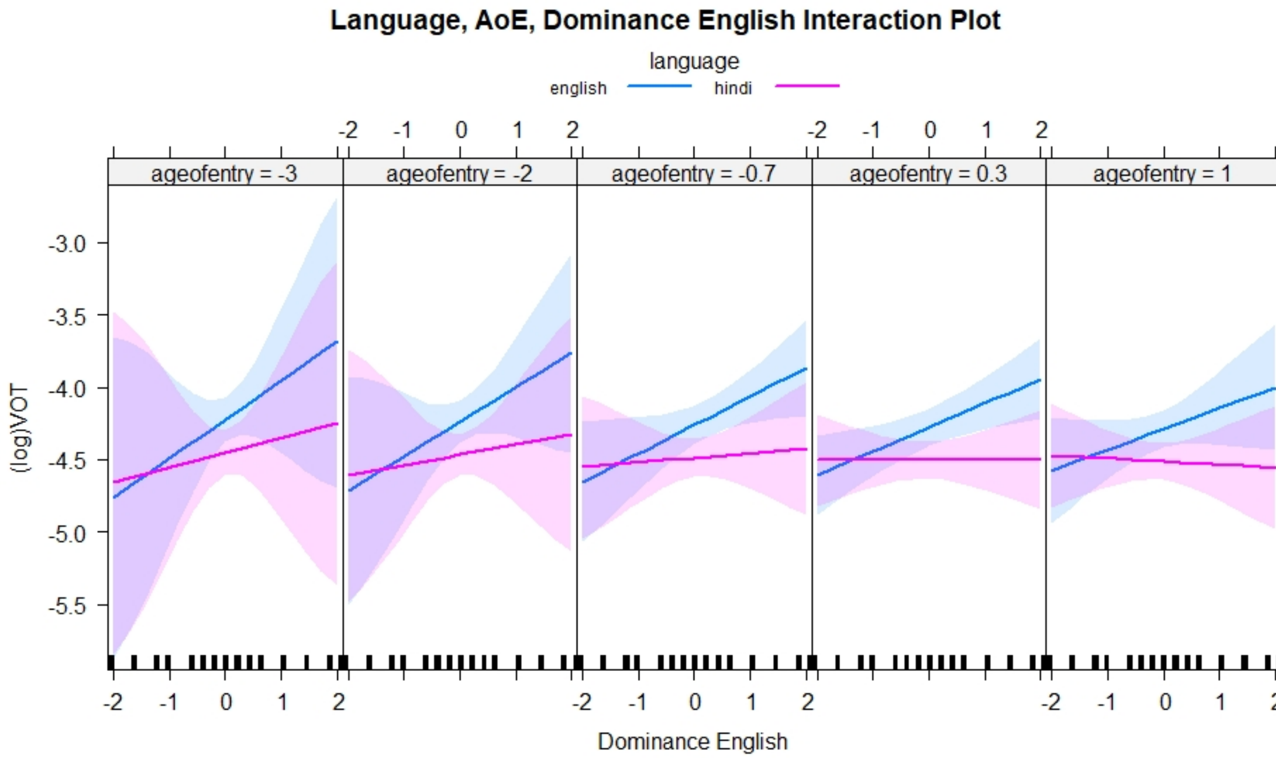


Figure 4.27: Model interaction effect between Language, AoE and Dominance English on log VOT in Table 4.7

4.4.3.2.4 Summary

Multiple factors were found to affect transfer effects in VOT in /t/ differentially across Hindi and English.

On one hand, AoE (for all 40 young and elderly participants and also 25 young participants), Glaswegian Identity, Dominance English, LoR, Inverse IAL Flanker Effect English, Inhibitory Skill Score Hindi, Inverse IAL Flanker Effect Hindi, Inverse Simon Effect, and Dominance Hindi (all for 25 young participants only) were associated with higher transfer (increased assimilation; more Glaswegian-like values) in VOT in /t/. On the other hand, Indian Contact and AoE (for the 25 young participants) were associated with lower transfer (decreased assimilation; more Indian-like values) in VOT in /t/.

4.4.4 Voiced Stops /b d g/

As shown in Table 4.1, not every voiced stop underwent transfer for every feature and language. Therefore, while the three stops were analysed together in the acoustic analysis, a different strategy was adopted for the present analysis to make sure that, wherever possible, the analysis did not include languages (and phone categories) where transfer did not happen. In doing so, care was taken that any given model was not left with too little data to analyse.

For VOT, both Glaswasian /b/ and /g/ underwent transfer in Hindi, but not in English, whereas, /d/ underwent transfer in both languages. With this in mind, two strategies were determined for the analysis of VOT: (1) /b/ and /g/ were analysed together in Hindi only. As a result, the variable Language does not apply to this analysis (since only Hindi was examined), but the variable Phone does (treatment-coded, reference level = b), (2) /d/ was analysed separately for both languages in the same model. Therefore, the variable Phone does not apply to this analysis, but Language does (treatment-coded, reference level = English).

For Relative Burst Intensity (RBI), only /g/ underwent transfer in both languages (assimilation in English and Hindi). Therefore, /g/ was analysed separately for both languages in the same model. Therefore, the variable Phone does not apply to this analysis, but Language does (treatment-coded, reference level = English).

For Voicing During Closure (VDC), only /g/ underwent transfer in Hindi (dissimilation). However, to ascertain that the model was not left with too little data to analyse if /g/ for VDC was analysed separately from /b d/ and if the other language (English) was removed from this analysis, it was decided to analyse /g/ separately, but for both languages in the same model. Therefore, the variable Phone does not apply to this analysis, but Language does (treatment-coded, reference level = English).

4.4.4.1 VOT: /b g/

In this section, the phones /b/ and /g/ were analysed for the dependent variable log VOT in Hindi only. As a reminder, the variable Language does not apply to this analysis, but Phone does.

Acoustic analysis showed that for VOT, Glaswasian /b/ showed longer VOT in Hindi (assimilation). Therefore, longer VOT indicates more transfer, whereas, shorter VOT indicates less transfer. In contrast with this, Glaswasian /g/ showed shorter VOT in Hindi (dissimilation). Therefore, longer VOT indicates less transfer, whereas, shorter VOT indicates more transfer. Table 4.8 presents a key to identifying transfer associated with changes in VOT in Hindi in /b/ and /g/. In both phones, English did not undergo transfer for log VOT.

Phone	**Longer VOT**	**Shorter VOT**
/b/	More transfer (higher assimilation)	Less transfer (lesser assimilation)
/g/	Less transfer (lesser dissimilation)	More transfer (higher dissimilation)

Table 4.8: Association between transfer and VOT changes in Hindi /b/ and /g/ as found in Chapter 3

4.4.4.1.1 Model I

The formula for the linear mixed model of the best fit was:

`logVOT ~ Phone + Gender + LoR + Phone:Gender + Phone:LoR + (1 | Speaker)`

Table 4.9 presents the summary of this model.

Table 4.9: Model I summary for log VOT in /b/ and /g/

	Dependent variable:
	Log VOT
Intercept	-4.685^{***} (0.067)
Phone g	0.665^{***} (0.048)
Gender Male	0.145 (0.121)
LoR	-0.036 (0.133)
Phone g:Gender Male	-0.189^{*} (0.084)
Phone g:LoR	0.258^{**} (0.096)
Observations	411
Log Likelihood	-194.472
Akaike Inf. Crit.	404.945
Bayesian Inf. Crit.	437.094
Note:	*p<0.05; **p<0.01; ***p<0.001

To begin with, the effect of Phone on log VOT was significantly positive for /g/ ($\beta = 0.67, t(403) = 13.78, p < .001$) which indicates that /g/ had longer VOT than /b/. That is, /g/ had longer VOT than /b/. This effect was qualified by a significant two-way interaction with Gender ($\beta = -0.19, t(403) = -2.26, p = .024$) (Figure 4.28) and LoR ($\beta = 0.26, t(403) = 2.70, p = .007$)

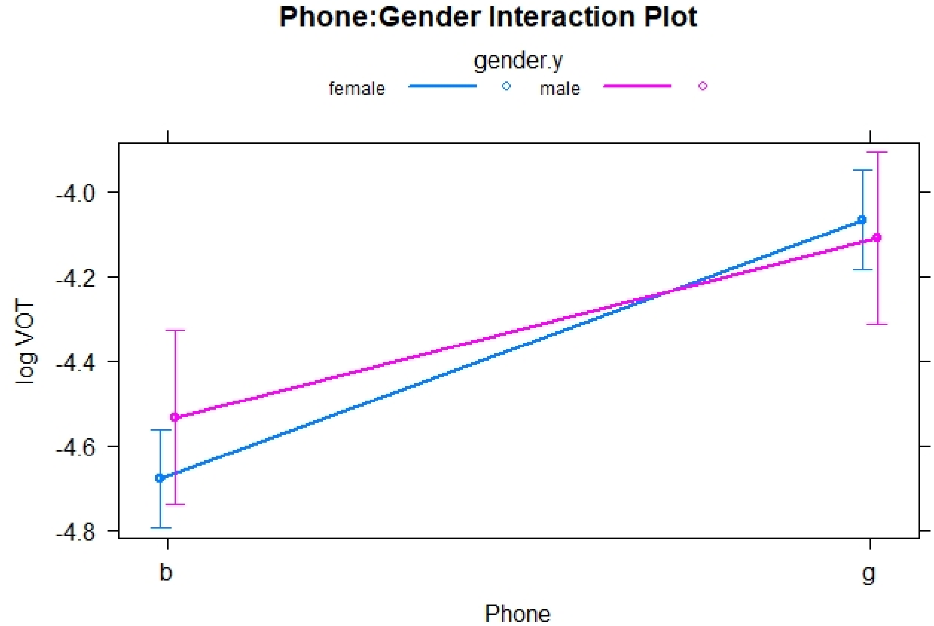


Figure 4.28: Phone and Gender interaction effect on log VOT in Table 4.9

The effect of LoR on /g/ was significantly more negative than /b/. As shown in Figure 4.29, an increase in LoR was related to an increase in VOT in /g/, that is less transfer, but no changes in /b/.

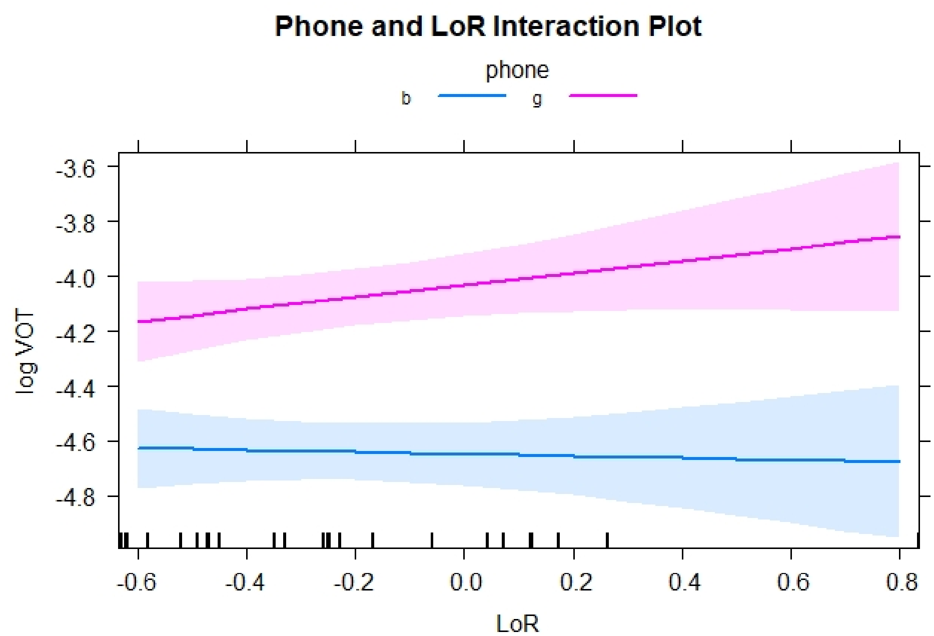


Figure 4.29: Phone and LoR interaction effect on log VOT in Table 4.9

4.4.4.1.2 Model II

The formula for the linear mixed model of the best fit was:

```
logVOT ~ Phone + Inverse Mean Switchcost Hin + Phone:Inhibitory
Skill Score Eng + Phone:Inhibitory Skill Score Hin + LoR:Inverse
Mean Switchcost Hin + Phone:LoR:Inhibitory Skill Score Hin +
Phone:LoR:Inhibitory Skill Score Eng + (1 | Speaker)
```

Table 4.10 presents the summary of this model.

Table 4.10: Model II summary for log VOT in /b/ and /g/

	Dependent variable:
	Log VOT
Intercept	-4.638^{***} (0.049)
Phone g	0.560^{***} (0.039)
Inverse Mean Switchcost Hin	-0.153^{**} (0.049)
Phone b:Inhibitory Skill Score Eng	-0.017 (0.066)
Phone g:Inhibitory Skill Score Eng	-0.339^{***} (0.067)
Phone b:Inhibitory Skill Score Hin	0.108 (0.075)
Phone g:Inhibitory Skill Score Hin	0.325^{***} (0.079)
Inverse Mean Switchcost Hin:LoR	-0.252^{*} (0.099)
Phone b:Inhibitory Skill Score Hin:LoR	0.111 (0.177)
Phone g:Inhibitory Skill Score Hin:LoR	0.625^{***} (0.181)
Phone b:Inhibitory Skill Score Eng:LoR	-0.170 (0.131)
Phone g:Inhibitory Skill Score Eng:LoR	-0.400^{**} (0.132)
Observations	411
Log Likelihood	-172.379
Akaike Inf. Crit.	372.759
Bayesian Inf. Crit.	429.019
Note:	*p<0.05; **p<0.01; ***p<0.001

To begin with, the effect of Phone was similar to that in Model I (Table 4.9) ($\beta = 0.56, t(397) = 14.19, p < .001$).

There was a significantly negative effect of Inverse Mean Switch Cost (Hindi), applicable to Hindi VOT in /b/ ($\beta = -0.15, t(397) = -3.11, p = .002$).This means that higher Inverse Mean Switch Cost in Hindi (better switching ability) was associated with shorter VOT (less transfer) in /b/. This was qualified by a two-way interaction with LoR, applicable only to /b/ ($\beta = -0.25, t(397) = -2.55, p = .011$). So, the effect of Inverse mean Switch Cost Hindi on log VOT for /b/ was modulated by LoR such that an increase in LoR exaggerated the effect of Inverse Mean Switch Cost Hindi. This is depicted in Figure 4.30.

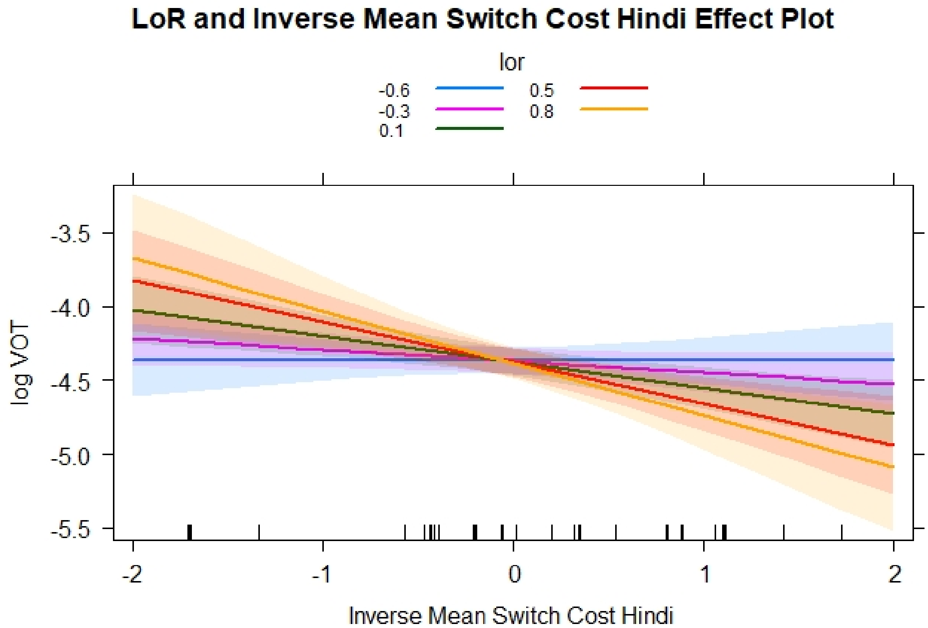


Figure 4.30: LoR and Inverse Mean Switch Cost Hindi interaction effect on log VOT in Table 4.10

A two-way interaction emerged between Inhibitory Skill Score (English) and Phone such that the effect of Inhibitory Skill Score (English) on Phone was more negative for /g/ as compared to /b/ ($\beta = -0.34, t(397) = -5.08, p < .001$). This interaction indicates that increasing Inhibitory Skill Score (English) was associated with decreasing VOT in /g/ (so, more transfer), but no change in /b/. This was qualified by a three-way interaction with LoR ($\beta = -0.40, t(397) = -3.02, p = .003$), as shown in Figure 4.31. This interaction effect indicates that for VOT in /g/, the effect of Inhibitory Skill Score (English) was exaggerated by an increase in LoR.

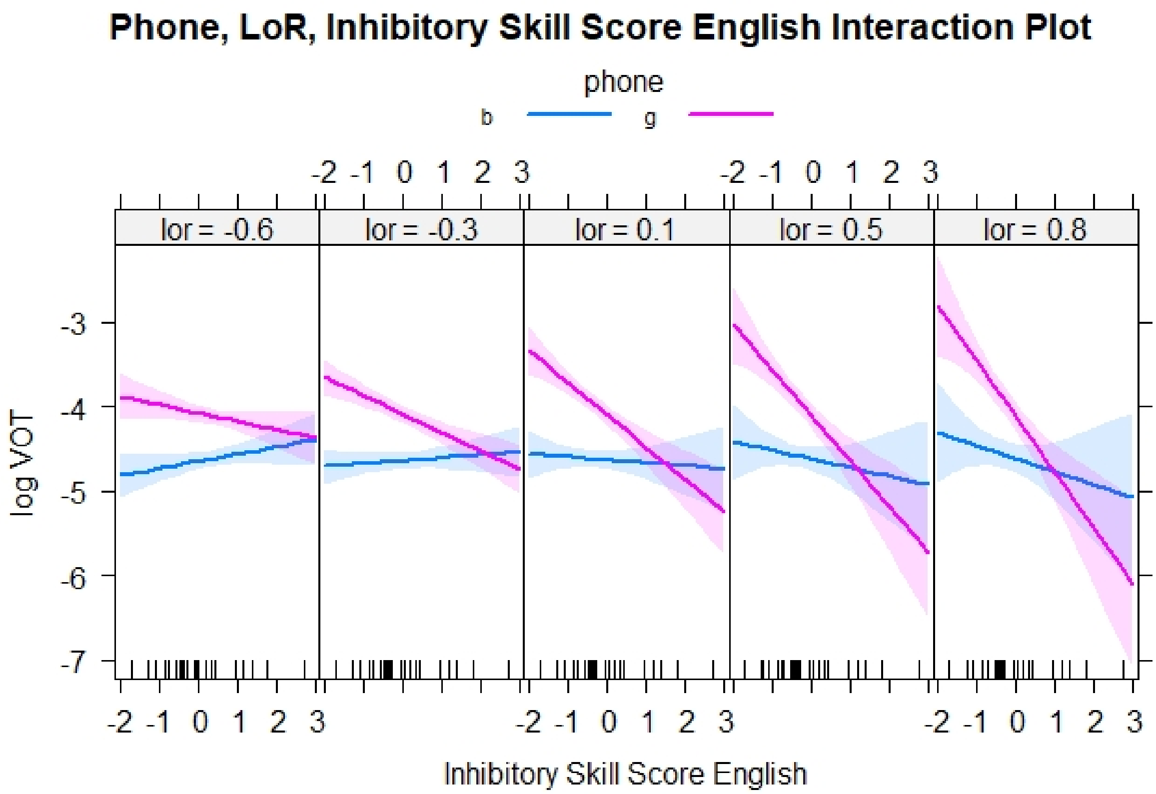


Figure 4.31: Phone, LoR and Inhibitory Skill Score English interaction effect on log VOT in Table 4.10

Another two-way interaction emerged between Inhibitory Skill Score (Hindi) and Phone such that the effect of Inhibitory Skill Score (Hindi) on Phone was significantly more positive for /g/ ($\beta = 0.63, t(397) = 3.46, p < .001$). That is, higher Inhibitory Skill Score (Hindi) was associated with a steeper increase in VOT in /g/ (less transfer), but not for /b/. This was qualified by a three-way interaction with LoR ($\beta = 0.63, t(397) = 3.46, p < .001$). Figure 4.32 shows that higher Inhibitory Skill Score Hindi was associated with an increase in VOT in /g/ (less transfer) and /b/ (more transfer), but this effect was especially exaggerated for /g/ than /b/ with increasing LoR.

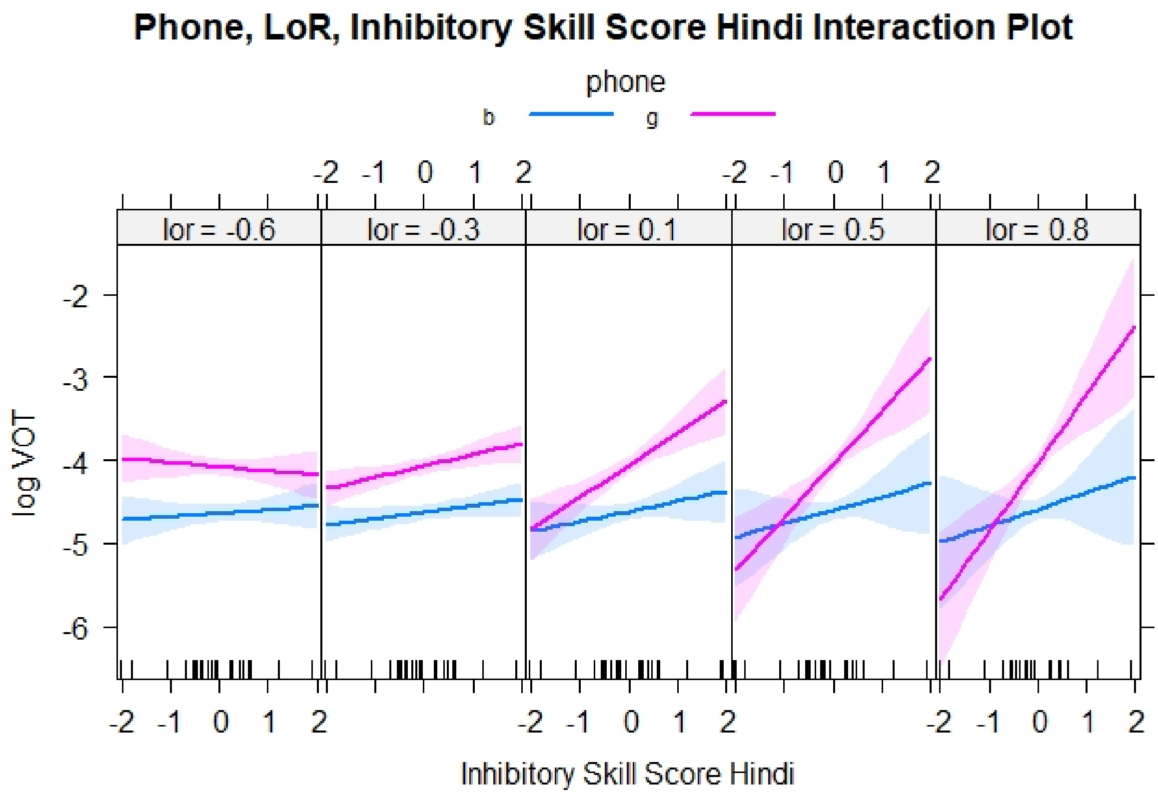


Figure 4.32: Phone, LoR and Inhibitory Skill Score Hindi interaction effect on log VOT in Table 4.10

4.4.4.1.3 Model III

The formula for the linear mixed model of the best fit was:

```
logVOT ~ Phone + Dominance Eng + Indian Identity + AoE +
Phone:Dominance Eng + Phone:Indian Identity + Phone:AoE +
Dominance Eng:AoE + Indian Identity:AoE + Phone:Dominance Eng:AoE
+ Phone:Indian Identity:AoE + (1 | speaker)
```

Table 4.11 presents the summary of this model.

Table 4.11: Model III summary for log VOT in /b/ and /g/

	Dependent variable:
	Log VOT
Intercept	-4.656^{***} (0.054)
Phone g	0.618^{***} (0.040)
Dominance Eng	-0.101 (0.056)
Indian Identity	-0.072 (0.060)
AoE	-0.057 (0.067)
Phone g:Dominance Eng	0.128^{**} (0.043)
Phone g:Indian Identity	-0.015 (0.043)
Phone g:AoE	-0.084 (0.048)
Dominance Eng:AoE	-0.073 (0.068)
Indian Identity:AoE	-0.001 (0.100)
Phone g:Dominance Eng:AoE	0.163^{**} (0.052)
Phone g:Indian Identity:AoE	0.163^{*} (0.073)
Observations	411
Log Likelihood	-183.355
Akaike Inf. Crit.	394.710
Bayesian Inf. Crit.	450.970
Note:	*p<0.05; **p<0.01; ***p<0.001

In the above model, Phone was significant with the same effect as in Model I (Table 4.9) ($\beta = 0.62, t(397) = 15.39, p < .001$). Additionally, some interactions emerged in this model.

There was two-way interaction between Phone and Dominance English ($\beta = 0.13, t(397) = 3.01, p = .003$) which indicated that an increase in Dominance English was associated with an increase in VOT (reduced transfer) in /g/, but not /b/. This was qualified by a three-way interaction with AoE ($\beta = 0.16, t(397) = 3.17, p = .002$). This interaction effect indicates that the above effect of Dominance English on VOT in /g/ reversed (more transfer) with decreasing AoE (Figure 4.33).

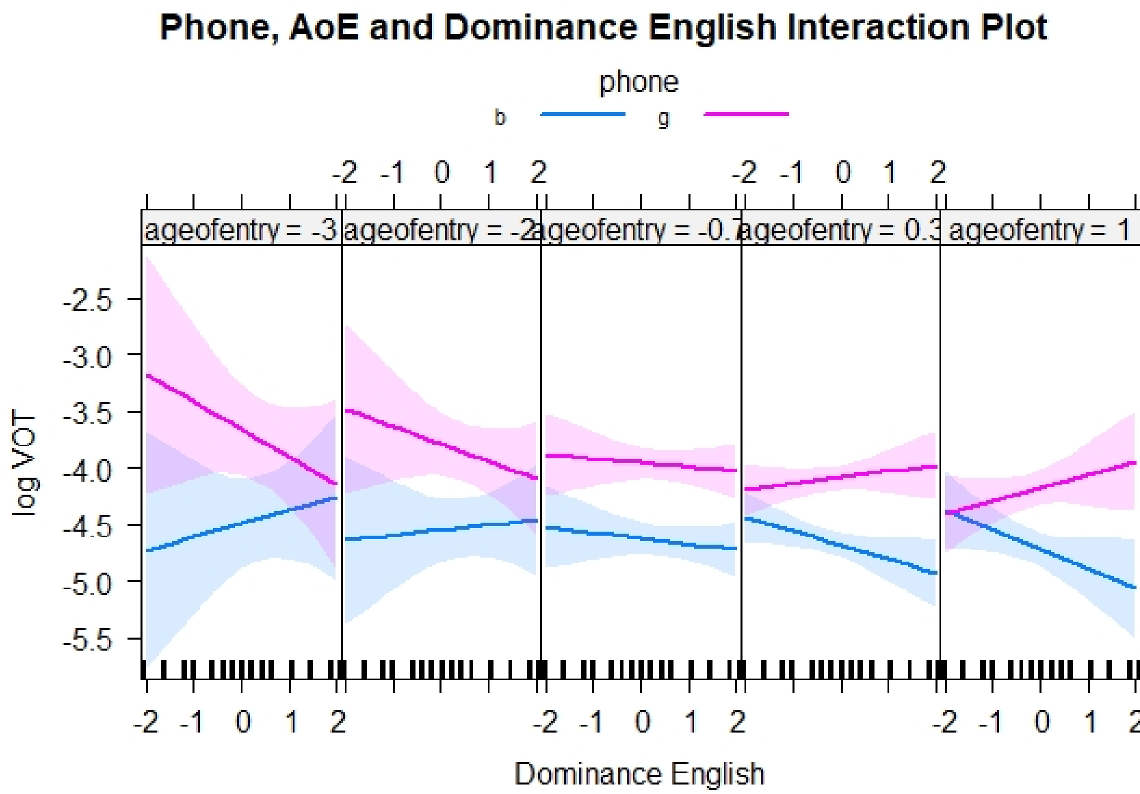


Figure 4.33: Phone, AoE and Dominance English interaction effect on log VOT in Table 4.11

A three-way interaction emerged between AoE, Phone and Indian Identity ($\beta = 0.16, t(397) = 2.24, p = .026$), which is depicted in Figure 4.34. For VOT in /b/, increasing AoE and Indian Identity had no effect on VOT. In /g/, however, VOT decreased with increasing Indian Identity (higher transfer), but this effect flattened out with higher AoE (less transfer).

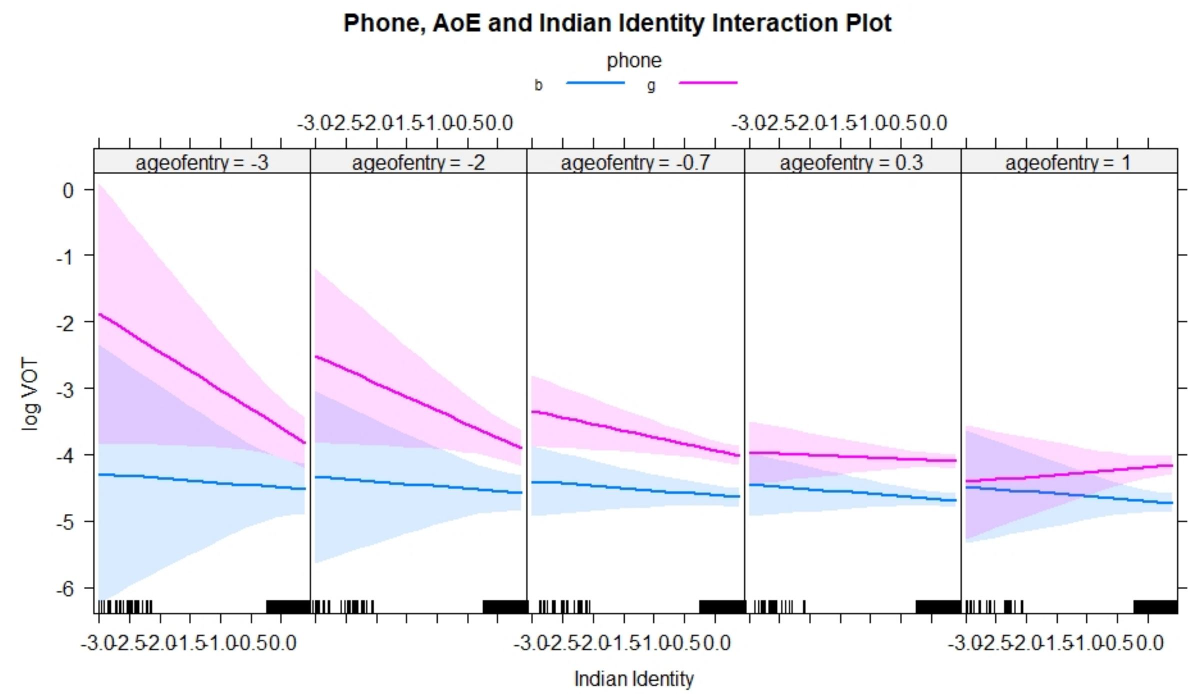


Figure 4.34: Phone, AoE and Dominance English interaction effect on log VOT in Table 4.11

On the one hand, AoE, Glaswegian Identity, Dominance English and Hindi, LoR, Inverse IAL Flanker Effect English, Inverse Simon Effect were associated with higher transfer (increased assimilation; more Glaswegian-like values) in VOT in /t/. On the other hand, Inhibitory Skill Score Hindi, Inverse IAL Flanker Effect Hindi, Indian Contact, AoE were associated with lower transfer (decreased assimilation; more Indian-like values) in VOT in /t/.

Summary

Multiple factors predicted transfer effects in VOT across /b/ and /g/.

Only Inverse Mean Switchcost Hindi (for 25 young participants) predicted transfer effects in VOT in /b/, and it was associated with lower transfer (less assimilation; more Indian-like values) in VOT in Hindi /b/.

Far more variables predicted transfer effects in VOT in Hindi /g/. On the one hand, Indian Identity, Dominance English and Inhibitory Skill Score English (for 25 young participants) are associated with higher transfer effects (higher dissimilation) in VOT in Hindi /g/. On the other hand, Inhibitory Skill Score Hindi (for 25 young participants) and LoR (for all 40 participants) were associated with lower transfer effects (lower dissimilation) in VOT in Hindi /g/.

4.4.4.2 VOT: /d/

In this section, the phone /d/ and the dependent variable log VOT were analysed. Acoustic analysis showed that for VOT, Glaswasian /d/ showed longer VOT in both English and Hindi, a pattern consistent with assimilation in this case. However, English underwent more assimilation than Hindi.

Importantly for the present analysis, **longer VOT indicates more transfer, shorter VOT indicates less transfer**.

4.4.4.2.1 Model I

The formula for the linear mixed model of the best fit was:

`logVOT ∼ Vowel Height + Language + Gender + AoE + Language:Gender + Language:AoE + (1 | speaker)`

Table 4.12 presents the summary of this model.

Table 4.12: Model I summary for log VOT in /d/

	Dependent variable:
	log VOT
Intercept	-4.412^{***} (0.066)
Vowel Height Non High	-0.083^{**} (0.028)
Language Hindi	-0.207^{***} (0.033)
Gender Male	-0.040 (0.125)
AoE	-0.130^{*} (0.066)
Language Hindi:Gender Male	0.152^{*} (0.065)
Language Hindi:AoE	0.106^{**} (0.034)
Observations	560
Log Likelihood	-197.473
Akaike Inf. Crit.	412.946
Bayesian Inf. Crit.	451.898
Note:	*p<0.05; **p<0.01; ***p<0.001

To begin with, the effect of Vowel Height was significantly negative for non-high vowels ($\beta = -0.08, t(551) = -2.96, p = .003$). That is, the phone /d/ had shorter VOT when followed by a non-high vowel, than when followed by a high vowel.

Furthermore, the effect of Language was significantly negative for Hindi as compared to English ($\beta = -0.21, t(551) = -6.26, p < .001$), that is, Hindi had shorter VOT than English.

The effect of AoE was only marginally significantly negative ($\beta = -0.13, t(551) = -1.97, p = .05$). That is, VOT got shorter as the AoE increased. This was qualified by a two-way interaction with Language ($\beta = 0.11, t(551) = 3.09, p = .002$). The interaction effect indicated that higher AoE had no effect on Hindi, but it led to a decrease in log VOT (shorter VOT - lesser assimilation) in English (Figure 4.35).

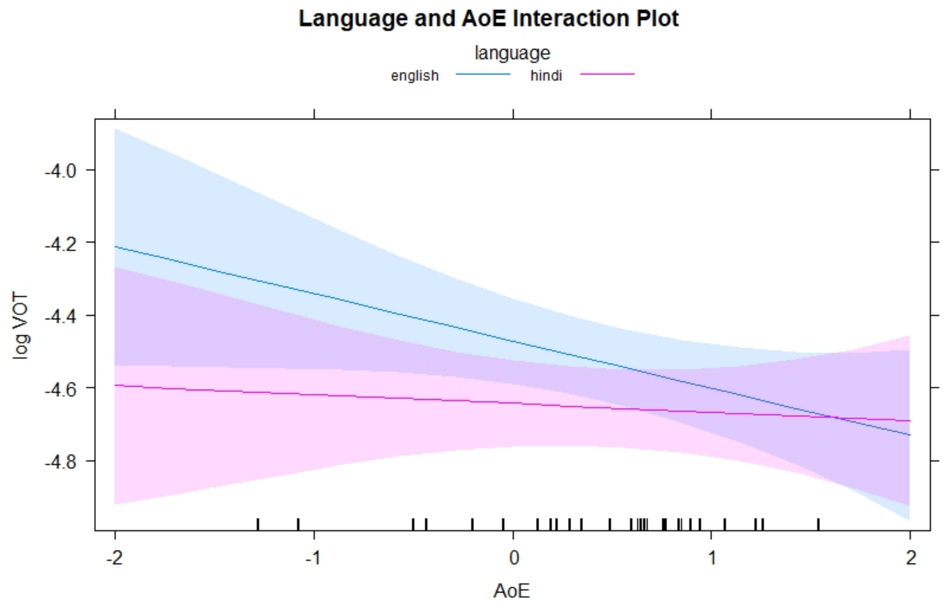


Figure 4.35: Language and AoE interaction effect on log VOT in Table 4.12

Another two-way interaction emerged between Gender and Language ($\beta = .15, t(551) = 2.36, p = .019$), as shown in Figure 4.36. So, while females have shorter VOT in Hindi than in English, this is not the case for males.

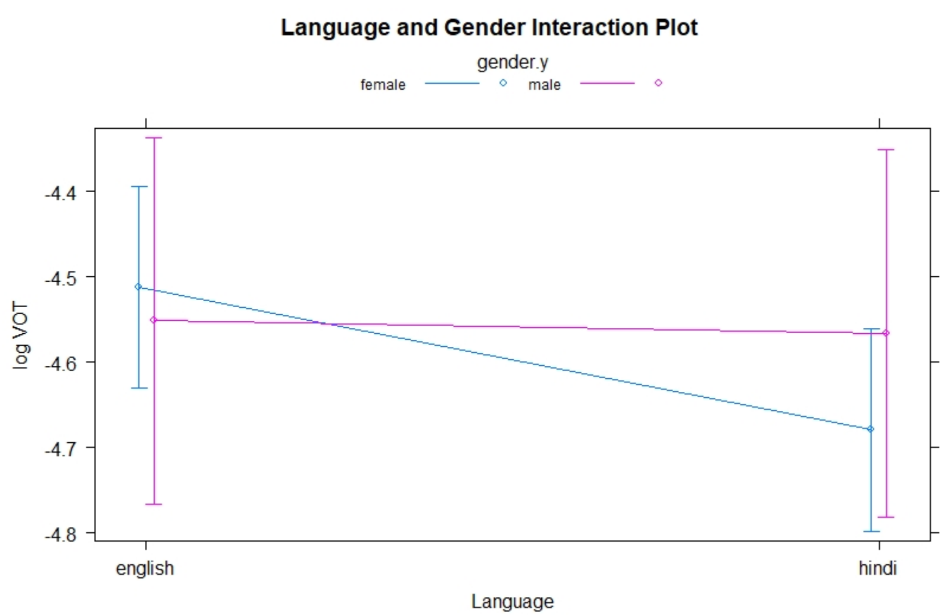


Figure 4.36: Language and Gender interaction effect on log VOT in Table 4.12

4.4.4.2.2 Model II

The formula for the linear mixed model of the best fit was:

```
logVOT ~ Vowel Height + Inverse IAL Flanker Effect Eng + Language
+ Indian Contact + AoE + Language:Indian Contact + Language:AoE +
(1 | speaker)
```

Table 4.13 presents the summary of this model.

Table 4.13: Model II summary for log VOT in /d/

	Dependent variable:
	log VOT
Intercept	-4.493^{***} (0.058)
Vowel Height Non High	-0.065^{*} (0.028)
Inverse IAL Flanker Effect English	0.107^{*} (0.044)
Language Hindi	-0.096^{**} (0.031)
Indian Contact	0.020 (0.051)
AoE	-0.199^{**} (0.067)
Language Hindi:Indian Contact	0.046 (0.028)
Language Hindi:AoE	0.139^{***} (0.038)
Observations	445
Log Likelihood	−112.897
Akaike Inf. Crit.	245.794
Bayesian Inf. Crit.	286.774
Note:	*p<0.05; **p<0.01; ***p<0.001

In the above model, Vowel Height ($\beta = -0.06, t(435) = -2.29, p = .023$), Language ($\beta = -0.10, t(435) = -3.06, p = .002$) and AoE ($\beta = -0.2, t(435) = -2.96, p = .003$) had similar effects on log VOT (applying to English only) as in the previous model (Table 4.12). This was also the case for the interaction effect of AoE on Language ($\beta = 0.14, t(435) = 3.68, p < .001$).

The effect of inverse IAL Flanker Effect English, applying only to English, was statistically significant and positive ($\beta = 0.11, t(435) = 2.42, p = .016$). That is, longer VOT in English (more transfer) was associated with higher Inverse IAL Flanker Effect English (better inhibitory score).

4.4.4.2.3 Model III

The formula for the linear mixed model of the best fit was:

```
logVOT ~ Vowel Height + Language + AoE + Indian Identity +
Language:AoE+ (1 | speaker)
```

Table 4.14 presents the summary of this model.

Table 4.14: Model III summary for log VOT in /d/

	Dependent variable:
	Log VOT
Intercept	-4.490^{***} (0.056)
Vowel Height Non High	-0.065^{*} (0.029)
Language Hindi	-0.104^{***} (0.031)
AoE	-0.165^{**} (0.060)
Indian Identity	-0.151^{**} (0.057)
Language Hindi:AoE	0.167^{***} (0.034)
Observations	445
Log Likelihood	−113.965
Akaike Inf. Crit.	243.930
Bayesian Inf. Crit.	276.715
Note:	*p<0.05; **p<0.01; ***p<0.001

Again, Vowel Height ($\beta = -0.06, t(437) = -2.28, p = .023;$), Language ($\beta = -0.10, t(437) = -3.38, p < .001$) and AoE ($\beta = -0.17, t(437) = -2.77, p = .006$) had similar effects on log VOT (applying to English only) as in Model I (Table 4.12). This was also the case for the significant interaction effect of AoE on Language ($\beta = 0.17, t(437) = 4.94, p < .001$).

There was an effect of Indian Identity, applying only to English, which was significantly negative ($\beta = -0.15, t(437) = -2.65, p = .008$). This is to say that with higher Indian Identity, in English, VOT decreased leading to reduced transfer.

Summary

Multiple factors were found to affect transfer effects in VOT in /d/ differentially across Hindi and English.

On one hand, Inverse IAL Flanker Effect English (in 25 young participants) was associated with higher transfer (increased assimilation; more Glaswegian-like values) in VOT in /d/. On the other hand, Indian Identity (for 25 young participants) and AoE (for all 40 young and elderly participants, and also separately for the 25 young participants) were associated with lower transfer (decreased assimilation; more Indian-like values) in VOT in /d/.

4.4.4.3 RBI: /g/

In this section, the phone /g/ and the dependent variable RBI were analysed. Acoustic analysis showed that for RBI, Glaswasian /g/ showed higher RBI than Indians in English and Hindi in the direction of Glaswegians (that is, assimilation).

In the present analysis, in English and Hindi /g/, **lower RBI indicates reduced transfer (decreased assimilation), whereas higher RBI indicates increased transfer (increased assimilation)**.

4.4.4.3.1 Model I

The formula for the linear mixed model of the best fit was:

```
RBI ~ Vowel Height + LoR + (1 | speaker)
```

Table 4.15 presents the summary of this model.

Table 4.15: Model I summary for RBI in /g/

	Dependent variable:
	RBI
Intercept	0.867^{***} (0.006)
Vowel Height Non High	0.022^{***} (0.003)
LoR	-0.030^{*} (0.013)
Observations	405
Log Likelihood	769.871
Akaike Inf. Crit.	−1,529.742
Bayesian Inf. Crit.	−1,509.722
Note:	*p<0.05; **p<0.01; ***p<0.001

The effect of Vowel Height was significantly positive for non-high vowels than high vowels ($\beta = 0.02, t(400) = 6.49, p < .001$). That is, /g/ had higher RBI when followed by a non-high vowel, than when followed by a high vowel. Another effect emerged for LoR ($\beta = -0.03, t(400) = -2.34, p = .020$) which indicated that in English, RBI decreased (reduced transfer) as LoR increased.

4.4.4.3.2 Model II

The formula for the linear mixed model of the best fit was:

```
RBI ~ Vowel Height + LoR + AoE:Glaswegian Contact + Dominance
Hin:AoE + (1 | speaker) + (1 | word)
```

Table 4.16 presents the summary of this model.

Table 4.16: Model II summary for RBI in /g/

	Dependent variable:
	RBI
Intercept	0.859^{***} (0.004)
Vowel Height Non High	0.022^{***} (0.004)
LoR	-0.035^{***} (0.008)
AoE:Glaswegian Contact	-0.029^{***} (0.005)
AoE:Dominance Hin	0.016^{***} (0.004)
Observations	405
Log Likelihood	782.806
Akaike Inf. Crit.	−1,549.613
Bayesian Inf. Crit.	−1,517.582
Note:	*p<0.05; **p<0.01; ***p<0.001

In this model, the significant effects of Vowel Height and LoR were similar to that in Model I (Table 4.15) (Vowel Height: $(\beta = 0.02, t(387) = 5.76, p < .001)$; LoR: $(\beta = -0.04, t(397) = -4.47, p < .001)$).

There was a two-way interaction between Glaswegian Contact and AoE $(\beta = -0.03, t(397) = -6.09, p < .001)$, as shown in Figure 4.37. This indicates that an increase in Glaswegian Contact is associated with higher RBI (more transfer) in English, but this effect flattens with an increase in AoE.

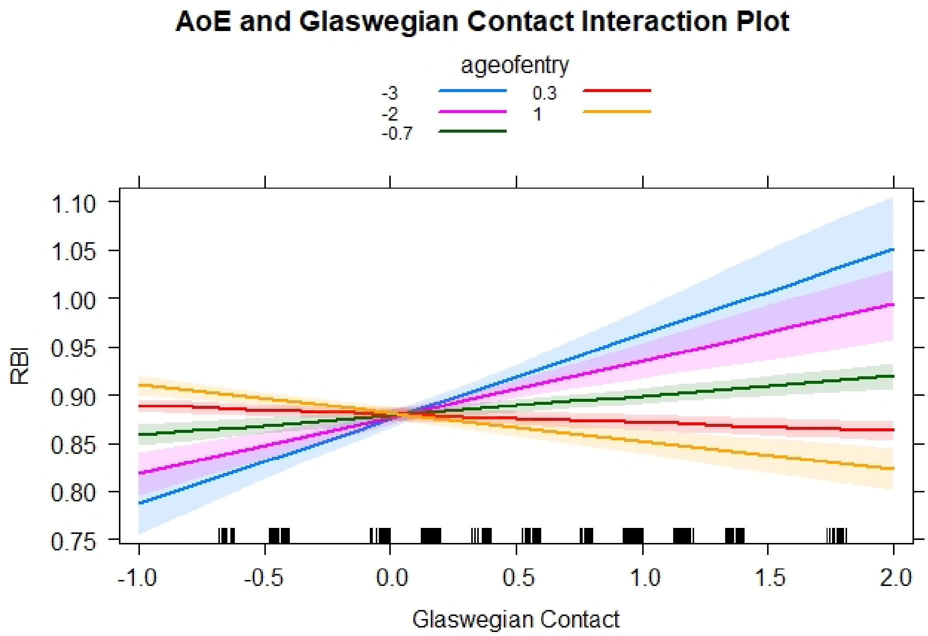


Figure 4.37: AoE and Glaswegian Contact interaction effect on RBI in Table 4.16

Finally, a two-way interaction also emerged between AoE on Dominance Hindi ($\beta = 0.02, t(397) = 3.97, p < .001$). Figure 4.38 shows that an increase in Dominance Hindi is associated with decrease in RBI (reduced transfer), but this effect flattens with increasing AoE.

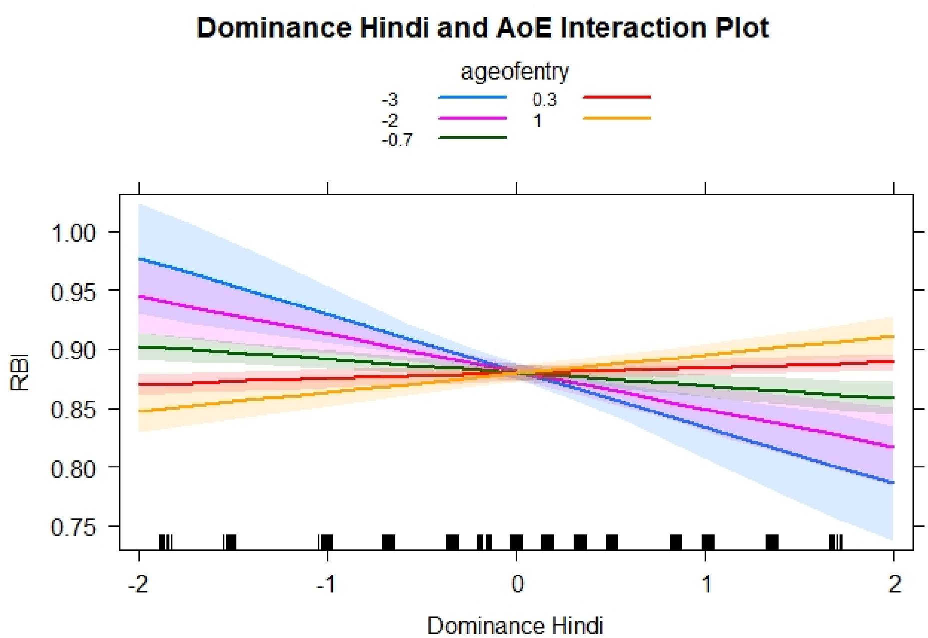


Figure 4.38: AoE and Dominance Hindi interaction effect on RBI in Table 4.16

4.4.4.3.3 Model III

The formula for the linear mixed model of the best fit is:

`RBI ~ Vowel Height + Dominance Eng + Indian Identity + AoE + Dominance Eng:AoE + Indian Identity:AoE + (1 | speaker)`

Table 4.17 presents the summary of this model.

Table 4.17: Model III summary for RBI in /g/

	Dependent variable:
	RBI
Intercept	0.869*** (0.006)
Vowel Height Non High	0.022*** (0.003)
Dominance English	0.0004 (0.005)
Indian Identity	0.012* (0.005)
AoE	0.004 (0.007)
Dominance English:AoE	−0.017** (0.006)
Indian Identity:AoE	−0.032** (0.010)
Observations	405
Log Likelihood	775.317
Akaike Inf. Crit.	−1,532.634
Bayesian Inf. Crit.	−1,496.599
Note:	*p<0.05; **p<0.01; ***p<0.001

The effect of Vowel Height was similar to that in Model I (Table 4.15) ($\beta = 0.02, t(396) = 6.52, p < .001$).

Another significantly positive effect emerged for Indian Identity ($\beta = 0.01, t(396) = 2.16, p = .032$), but with a small effect size. This indicates that in English in /g/, RBI increased with higher Indian Identity (increased transfer). This was qualified by a two-way interaction with AoE such that the effect of AoE on Indian Identity was significantly negative ($\beta = -0.03, t(396) = -3.22, p = .001$). Figure 4.39 shows that there is a positive relationship between RBI and Indian Identity (increased transfer), which flattens out as the AoE increases.

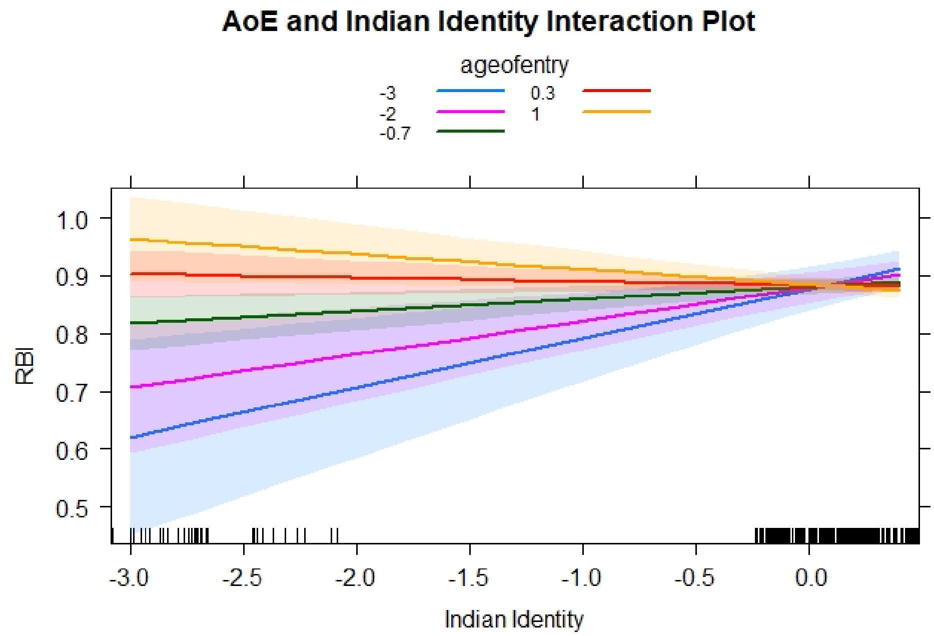


Figure 4.39: AoE and Indian Identity interaction effect on RBI in /g/ in Table 4.17

Finally, a two-way interaction also emerged between between AoE and Dominance English such that the effect of AoE on Dominance English was significantly negative ($\beta = -0.02, t(396) = -2.80, p = .005$). This means that in English /g/ RBI increased with Dominance English (higher transfer), but this pattern reversed as AoE increased (Figure 4.40).

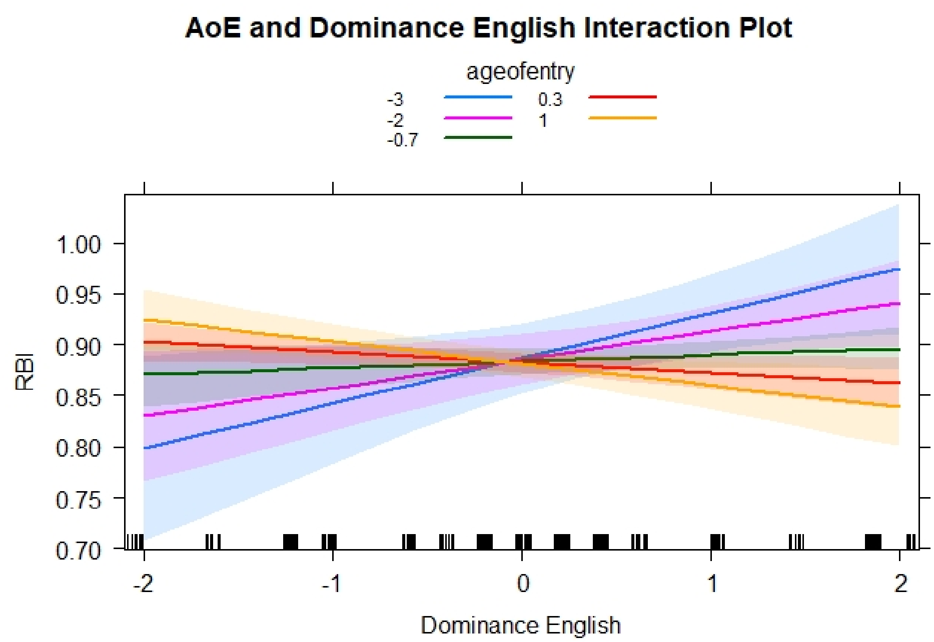


Figure 4.40: AoE and Dominance English interaction effect on RBI in /g/ in Table 4.17

Summary

Multiple factors were found to affect transfer effects in RBI in /g/ differentially across Hindi and English.

On the one hand, Indian Identity, Glaswegian Contact and Dominance English (for the 25 young Glaswasians) were associated with higher transfer (increased assimilation; more Glaswegian-like values) in RBI in /g/. On the other hand, LoR (for all 40 young and elderly Glaswasians as well as separately for 25 young Glaswasians) and Dominance Hindi (for the 25 young Glaswasians) were associated with lower transfer (decreased assimilation; more Indian-like values) in RBI in /g/.

4.4.4.4 VDC: /g/ - Voicing Percentage in /g/)

As Table 4.1 shows, in the acoustic analysis for VDC, only /g/ underwent transfer (dissimilation) and in Hindi only. That is, Glaswasians had a higher probability than Indians of having 100 percent VDC in Hindi for /g/. Therefore, the variable Language has been re-leveled for this particular analysis, so that the reference level for Language is Hindi. Furthermore, in the acoustic analysis, Voicing During Closure (VDC) was analysed as a categorical variable with levels of ‘none’ (0 per cent VDC), ‘some’ (1 - 99 per cent VDC) and ‘all’ (100 per cent VDC). In the present analysis, for the ease of analysis and interpretation, VDC will be analysed as a continuous variable: Voicing Percentage (the amount of voicing from 0 to 100 percentage). For this purpose, raw voicing percentage has been subjected to an empirical logit transformation using `logit()` function in `car` package (J. Fox & Weisberg, 2019; version 3.1.1)’.

Importantly, for the present analysis, **lower voicing percentage is related to reduced transfer (decreased dissimilation), whereas higher voicing percentage is related to increased transfer (increased dissimilation)**.

4.4.4.4.1 Model I

The formula for the linear mixed model of the best fit was:

```
logit(Voicing Percentage) ~ Vowel Height + Language + AoE + LoR
+ Language:AoE + (1 | speaker) + (1 | word)
```

Table 4.18 presents the summary of this model.

Table 4.18: Model I summary for Voicing Percentage in /g/

	Dependent variable:
	logit(Voicing Percentage)
Intercept	2.836^{***} (0.284)
Vowel Height Non High	-0.499^{**} (0.177)
Language English	-0.197 (0.177)
AoE	0.363 (0.260)
LoR	-1.435^{*} (0.564)
Language English:AoE	0.492^{***} (0.142)
Observations	379
Log Likelihood	-658.553
Akaike Inf. Crit.	1,335.106
Bayesian Inf. Crit.	1,370.544
Note:	*p<0.05; **p<0.01; ***p<0.001

In this model, the effect of Vowel Height was significantly negative for non high vowels ($\beta = -0.50, t(370) = -2.82, p = .005$). This is to say that /g/ had higher voicing percentage when followed by a high vowel, than when followed by a non-high vowel.

Another significant effect emerged for LoR on voicing percentage ($\beta = -38.40, t(465) = -2.55, p = .011$). This was to the effect that voicing percentage in Hindi decreased with increasing LoR (less transfer).

The effect of AoE on voicing percentage in /g/ in Hindi was not of significance ($\beta = 0.36, t(370) = 1.40, p = .164$).

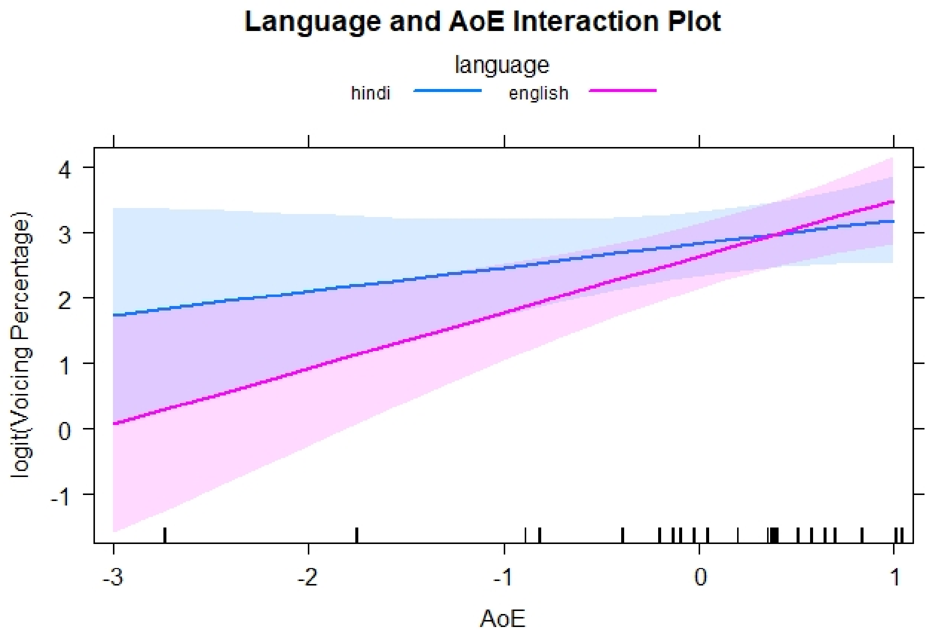


Figure 4.41: Model AoE and Language interaction effect on Voicing Percentage in Table 4.18

4.4.4.4.2 Model II

The formula for the linear mixed model of the best fit was:

`logit(Voicing Percentage) ~ Vowel Height + LoR + AoE + Dominance Hin + AoE:Language + LoR:Dominance Hin + LoR:Inverse Mean Switchcost Hin + AoE:Indian Contact + (1 | speaker)`

Table 4.19 presents the summary of this model.

Table 4.19: Model II summary for Voicing Percentage in /g/

	Dependent variable:
	logit(Voicing Percentage)
Intercept	3.030*** (0.164)
Vowel Height Non High	−0.512*** (0.135)
LoR	−1.005** (0.309)
AoE	0.504*** (0.142)
Dominance Hin	−0.931*** (0.139)
AoE:Language	0.476*** (0.143)
LoR:Dominance Hin	−2.529*** (0.304)
LoR:Inverse Mean Switchcost Hin	0.919*** (0.241)
AoE:Indian Contact	−0.604*** (0.182)
Observations	379
Log Likelihood	−643.491
Akaike Inf. Crit.	1,308.982
Bayesian Inf. Crit.	1,352.295
Note:	*p<0.05; **p<0.01; ***p<0.001

In this model, Vowel Height ($\beta = -0.51, t(368) = -3.79, p < .001$) had the same effect as in Model I (Table 4.18). Additionally here, AoE had a significantly positive effect on voicing percentage in Hindi /g/ ($\beta = 0.50, t(368) = 3.55, p < .001$). This indicated that voicing percentage in Hindi /g/ increased with increasing AoE (increased transfer). The interaction effect between Language and AoE is not of relevance here since voicing percentage in English /g/ was not found to have undergone transfer in the acoustic analysis. However, AoE did interact with Indian Contact to produce a negative effect on voicing percentage in Hindi /g/ ($\beta = -0.60, t(368) = -3.33, p < .001$). This was such that while there was an increase in voicing percentage with increasing AoE (increased transfer), this was subject to the amount of Indian Contact. That is, higher Indian Contact was associated with increased transfer in those with early AoE, but this effect flattened out with increasing AoE so that those with higher AoE were not affected by the amount of Indian Contact.

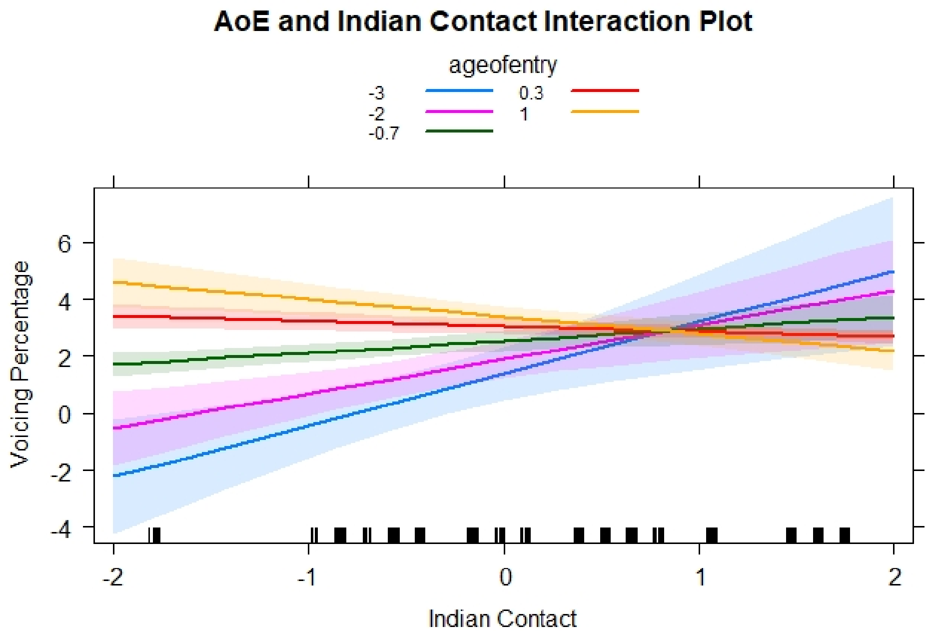


Figure 4.42: AoE and Indian Contact interaction effect on Voicing Percentage in /g/ in Table 4.19

Furthermore, Dominance Hindi had a significantly negative effect on voicing percentage $(\beta = -0.93, t(368) = -6.68, p < .001)$. This means that an increase in Dominance Hindi was associated with a decrease in voicing percentage in Hindi /g/ (less transfer).

LoR had a similarly negative effect on voicing percentage $(\beta = -1.01, t(368) = -3.25, p = 0.001)$ as in Model I (Table 4.18). LoR also engaged in a two-way interaction with Dominance Hindi $(\beta = -2.53, t(368) = -8.33, p < .001)$ to indicate that the effect of Dominance Hindi was greater with increasing LoR (Figure 4.43).

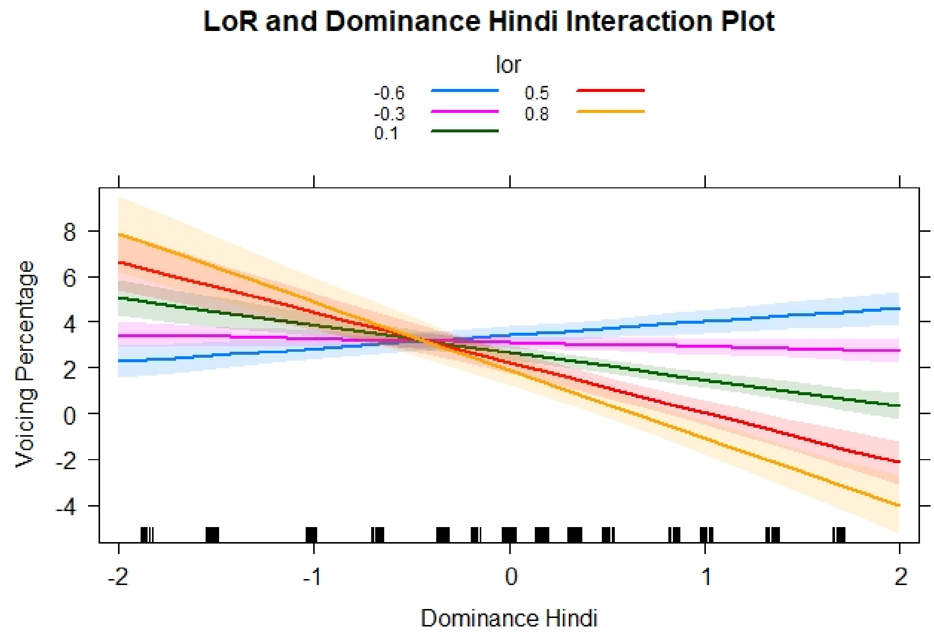


Figure 4.43: LoR and Dominance Hindi interaction effect on Voicing Percentage in /g/ in Table 4.19

Finally, a significant two-way interaction also emerged between LoR and Inverse Mean Switch Cost Hindi ($\beta = 0.92, t(368) = 3.82, p < .001$) such that the negative effect of Inverse Mean Switch Cost Hindi was reversed with an increase in LoR (Figure 4.44).

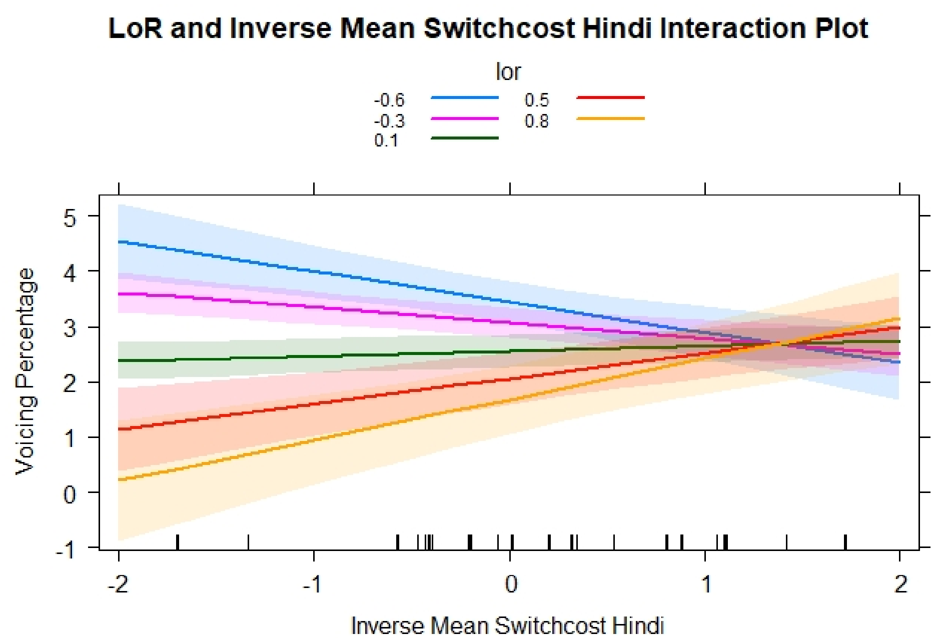


Figure 4.44: LoR and Inverse Mean Switchcost Hindi interaction effect on Voicing Percentage in /g/ in Table 4.19

4.4.4.4.3 Model III

The formula for the linear mixed model of the best fit was:

```
logit(Voicing Percentage) ~ + Vowel Height + Indian Identity +
AoE + AoE:Language + Indian Identity:AoE + (1 | speaker)
```

The summary of this model is shown in Table 4.20.

Table 4.20: Model III summary for Voicing Percentage in /g/

	Dependent variable:
	logit(Voicing Percentage)
Intercept	3.065^{***} (0.129)
Vowel Height Non High	-0.499^{***} (0.135)
Indian Identity	0.464^{***} (0.121)
AoE	0.870^{***} (0.138)
AoE:Language	0.459^{**} (0.143)
Indian Identity:AoE	-1.691^{***} (0.187)
Observations	379
Log Likelihood	−642.413
Akaike Inf. Crit.	1,300.826
Bayesian Inf. Crit.	1,332.326
Note:	*p<0.05; **p<0.01; ***p<0.001

In this model, Vowel Height, AoE and the interaction between Language and AoE had the same significant effects as in Model II (Table 4.19) (Vowel Height: $(\beta = -0.50, t(371) = -3.69, p < .001)$; AoE: $(\beta = 0.87, t(371) = 6.30, p < .001)$; Language and AoE: $(\beta = 0.46, t(371) = 3.20, p = .001)$.

Additionally, a significantly positive effect emerged for Indian Identity $(\beta = 0.46, t(371) = 3.85, p < .001)$. As Indian Identity increased, voicing percentage also increased (increased transfer). This was qualified by a significant interaction with AoE $(\beta = -1.69, t(371) = -9.04, p < .001)$. Figure 4.45 shows that the above effect of Indian Identity was flattened with increasing AoE. So, voicing percentage increased with Indian Identity but this effect is reduced with increasing AoE.

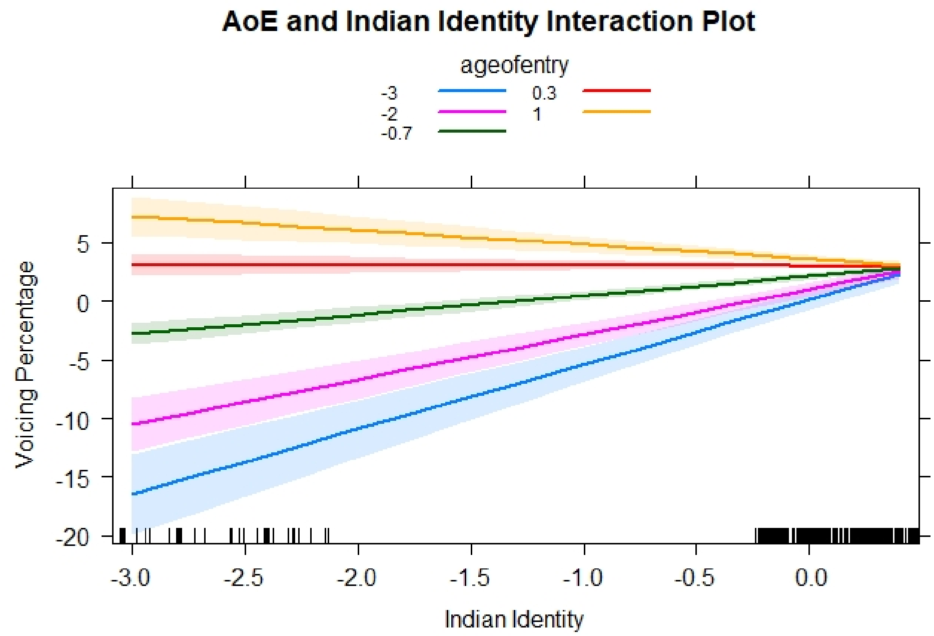


Figure 4.45: AoE and Indian Identity interaction effect on Voicing Percentage in Table 4.19

Summary

Multiple factors were found to affect transfer effects in Voicing Percentage in Hindi /g/ differentially across Hindi and English.

On one hand, Indian Identity, and Indian Contact (for the 25 young Glaswasians) were associated with higher transfer (increased dissimilation; more exaggeratedly Indian-like values) in VDC in Hindi /g/. On the other hand, LoR (for the 40 young and elderly Glaswasians as well as separately for the 25 young Glaswasians) and Dominance Hindi (for the 25 young Glaswasians) were associated with lower transfer (decreased dissimilation; more Indian-like values) in VDC in Hindi /g/.

4.5 Discussion

The present section is reserved for the discussion of the above results in two subsections. First, in §4.5.1, the effect of each predictor has been discussed separately. Then, in §4.5.2, general observations have been drawn on the nature of these predictors as a whole and specific questions about their effect on backward transfer have been addressed.

4.5.1 On the specific effects of predictors

1. **AoE**

   Several aspects of the effect of AoE on backward transfer effects have come to light.

First, an increase in AoE was discovered to be associated with either (1) increasingly Indian-like values (as in VOT in English /d/ and /t/), or (2) increasingly exaggerated Indian-like values (as in /l/ in English, Voicing Percentage in /g/ in Hindi). The former possibility confirms the role of more stable and developed L1 categories in late arrivals (as was predicted), whereas the latter possibility indicates an attempt on the Glaswasians' part to maintain a contrast with the similar Glaswegian categories.

Furthermore, it seems that Glaswasians' English was more vulnerable to the effects of AoE, as compared to their Hindi (in /t/, /d/ for VOT, and /l/ for F2-F1 difference). The absence of an effect of AoE on Hindi indicates that either their IE categories are more unstable than Hindi categories, or it may represent increased input and influence from the host language Glaswegian English, which affected Indian English more than Hindi.

The third finding regarding AoE was its interaction with social factors such as Indian Contact, Indian Identity, Glaswasian Contact, and also Dominance English.

2. **Indian Contact (IC)**

Predictor	Phone	Cue/Feature	Language	Effect	Interaction
Indian Contact (IC)	/l/	F2-F1 Difference	English	no effect	-
			Hindi	$\uparrow$ IC = $\downarrow$ dissimilation	-
	/t/	VOT	English	$\uparrow$ IC = $\uparrow$ assimilation	subsides to no effect as AoE increases
			Hindi	$\uparrow$ IC = $\uparrow$ dissimilation	in early arrivals
				$\uparrow$ IC = $\downarrow$ assimilation	corresponding effect seen as AoE increases
	/g/	VDC	English	NA (no transfer)	NA
			Hindi	$\uparrow$ IC = $\uparrow$ dissimilation	subsides to no effect as AoE increases

Table 4.21: Summary of the effects of Indian Contact (IC) on backward transfer

The findings on the effect of IC on backward transfer in the present analysis are summarised in Table 4.21.

What is interesting here is that the effect of IC on English and Hindi are different. In English, IC effects are either absent (/l/), or they may lead to more assimilation (/t/ in early arrivals). But in Hindi, higher IC was related to either increasingly Indian-like values, that is, no transfer (/l/ and /t/ in later arrivals) or increasingly exaggerated Indian-like values, that is, dissimilation (/t/ and /g/ in early arrivals). Importantly, higher IC was certainly not found to increase Glaswegian-ness or assimilation in Hindi. It appears that higher IC represents higher influence of the heritage language Hindi (as spoken by Indians or long-term Indian Glaswasians), which ensured the maintenance of it in Glaswasians, instead of assimilation.

An unexpected effect of higher IC was the increased assimilation of VOT in English /t/ in early arrivals. It is possible that this assimilation represents a stronger attempt to integrate or assimilate (Berry, 2001) to the host community by adapting their native accent of English to Glaswegian English in face of higher IC. Additionally, the reason why it only showed in /t/ is probably because Glaswasians are more perceptually sensitive to the difference in short-lag and long-lag VOT. This is also supported by results from the XAB similarity judgement task (Chapter 2) which indicated that the participants were better at perceiving the similarity between Glaswegian word-initial (aspirated) stops and Hindi aspirated stops. Furthermore, it is possible that the longer VOT in Glaswegian English word-initial /t/ carries more perceptual salience as compared to other categories and cues. It is probably because of this that assimilation was not found for any other cues. Also, aspiration is phonemic in Hindi, so higher IC would only have helped reinforce this idea in their Hindi, leading to either no transfer to VOT in /t/ in Hindi, or in later arrivals, or increased dissimilation in early arrivals. In any case, these results highlight that Glaswasians are perceptually aware of the distinctiveness in VOT for /t/ and also apply it distinctively in their English and Hindi.

3. **Indian Identity (II)**

Predictor	Phone	Cue/Feature	Language	Effect	Interaction
Indian Identity (II)	/t/	VOT	English	$\uparrow$ II =$\uparrow$ assimilation (to Indians)	in early arrivals
				$\uparrow$ II = $\downarrow$ assimilation	as AoE increases
			Hindi	$\uparrow$ II = $\uparrow$ assimilation (to Indians)	subsides to no effect as AoE increases
	/d/	VOT	English	$\uparrow$ II = $\uparrow$ assimilation (to Indians)	-
			Hindi	no effect	-
	/g/	VOT	English	NA (no transfer)	NA
			Hindi	$\uparrow$ II = $\uparrow$ dissimilation	-
		VDC	English	NA (no transfer)	NA
			Hindi	$\uparrow$ II = $\uparrow$ dissimilation	subsides to no effect as AoE increases
		RBI	English	$\uparrow$ II = $\uparrow$ assimilation	subsides to no effect as AoE increases
			Hindi	no effect	-

Table 4.22: Summary of the effects of Indian Identity (II) on backward transfer

Table 4.22 summarises the findings of the effect of Indian Identity on backward transfer.

An interesting observation here is even when transfer was present across both English and Hindi, Hindi did not show an effect of Indian Identity on /d/ (VOT) and /g/ (RBI), for which it had undergone assimilation. In the case of /g/ RBI, it so happens to be the situation that the amount of assimilation in Hindi and English was equal. Therefore, an absence of effect on Hindi RBI in /g/ seems to indicate that it may be affected by the predictors in the same way as its English counterpart.

Nevertheless, in English, in all cases bar RBI in /g/, higher Indian Identity was associated with assimilation towards Indian-like values. In Hindi, higher Indian Identity was associated with either more Indian-like values (VOT in /t/) or exaggeratedly Indian-like values (voicing percentage and VOT in /g/).

What is tricky to understand is the case of RBI in /g/ in English, which showed increased assimilation to Glaswegian English in early arrivals with higher Indian Identity. One possible argument for this is that an increase in Indian Identity does not imply a decrease in their Glaswegian Identity (GI). So, probably an increase in assimilation for this category is related to their higher GI. But this was not found to be the case. Another possible argument is that such individuals who have given themselves a higher rating for Indian Identity have done so as an act of compensation or out of guilt for assimilating to Glaswegian English. For instance, Venturin, 2019 argues that “losing one’s L1 even partially may lead to the desire to revitalize one’s connection with one’s native country, its population and the original identity" (p. 255).

4. **Glaswegian Contact (GC)**

Predictor	**Phone**	**Cue/Feature**	**Language**	**Effect**	**Interaction**
Glaswegian Contact (GC)	/g/	RBI	English	↑ GC = ↑ assimilation	subsides to no effect as AoE increases
			Hindi	no effect	-

Table 4.23: Summary of the effects of Glaswegian Contact (GC) on backward transfer

As per the prediction, higher GC was found to be associated with higher assimilation in English, but only in one category (Table 4.23). Moreover, GC represented higher contact with and influence from Glaswegian English, which was partly also accounted for by AoE. However, AoE had far more effect and on multiple categories and cues as compared to GC, which seems to confirm that the effects of AoE account for far more than just the quantity of contact with Glaswegian English, that is, for example, primarily, the state of development of L1 categories.

5. **Dominance English (DE)**

Predictor	Phone	Cue/Feature	Language	Effect	Interaction
Dominance English (DE)	/t/	VOT	English	$\uparrow$ DE = $\uparrow$ assimilation	effect reduced as AoE increases
			Hindi	$\uparrow$ DE = $\uparrow$ assimilation	subsides to no effect as AoE increases
	/g/	RBI	English	$\uparrow$ DE = $\uparrow$ assimilation	effect reversed (to some degree) as AoE increases
			Hindi	no effect	-
		VOT	English	NA (no transfer)	NA
			Hindi	$\uparrow$ DE = $\uparrow$ dissimilation	in early arrivals
				$\uparrow$ DE = $\downarrow$ dissimilation	above effect reversed as AoE increases

Table 4.24: Summary of the effects of Dominance English (DE) on backward transfer

What is striking about the effect of DE is that for the same cue (VOT), higher DE is related to assimilation in /t/, but dissimilation in /g/ (Table 4.24). This could be an indication that VOT in /t/ is a more salient feature of Glaswegian English that the Glaswasians are trying to adopt, but VOT in /g/ is a more salient feature of Hindi that the Glaswasians are trying to maintain by contrasting from the similar counterpart in Glaswegian English. However, the salience of VOT in /g/ in Hindi is only a speculation, as not much research has examined positive VOT in the voiced stops in Hindi - pre-voicing is the most studied feature in the Indic languages. In any case, in face of increasing English dominance, Glaswasians seem to be attempting to maintain a contrast with the similar VOT for /g/ in Glaswegian English.

6. **Glaswegian Identity (GI)**

Predictor	Phone	Cue/Feature	Language	Effect	Interaction
Glaswegian Identity (GI)	/t/	VOT	English	$\uparrow$ GI = $\uparrow$ assimilation	-
			Hindi	no effect	-

Table 4.25: Summary of the effects of Glaswegian Identity (GI) on backward transfer

In line with the prediction, GI was found to be associated with increased assimilation, but only in English and for just one category (Table 4.25). So, its effect seems to be limited to the closer linguistic variety, Indian English, which did not spill over to the more distant Hindi. This seems to indicate that Glaswasians associate ‘being Glaswegian’ to sounding more Glaswegian in English, but not necessarily in Hindi. Additionally, as GI was negatively correlated with Perceived Discrimination (PD), I deduce that lower PD will also be associated with higher assimilation.

7. **Inhibitory Skills** The following sub-sections address the various inhibitory skill measures (linguistic and non-linguistic) separately.

(a) **Inhibitory Skill Scores (English and Hindi)**

It should be noted that the ISSs (ISSE and ISSH) do not represent how good the inhibitory ability is, but the degree to which inhibition is applied (Lev-Ari & Peperkamp, 2013). Thus, higher ISS represents higher applied inhibition instead of better inhibitory ability.

Predictor	Phone	Cue/Feature	Language	Effect	Interaction
Inhibitory Skill Score Hindi (ISSH)	/t/	VOT	English	no effect	-
			Hindi	↑ ISSH = ↑ assimilation	-
	/l/	F2-F1 difference	English	no effect	-
			Hindi	↑ ISSH = ↑ dissimilation	effect exaggerated with increase in LoR
	/g/	VOT	English	NA (no transfer)	NA
			Hindi	↑ ISSH = ↓ dissimilation	effect exaggerated with increase in LoR
Inhibitory Skill Score English (ISSE)	/l/	F2-F1 difference	English	no effect	-
			Hindi	↑ ISSE = ↓ dissimilation	-
	/t/	VOT	English	↑ ISSE = ↓ assimilation	-
			Hindi	no effect	-
	/g/	VOT	English	NA (no transfer)	NA
			Hindi	↑ ISSE = ↑ dissimilation	effect exaggerated with increase in LoR

Table 4.26: Summary of the effects of Inhibitory Skill Score English (ISSE) and Hindi (ISSH) on backward transfer

Interestingly, the effects of ISSH and ISSE were found for the same phone categories and same cues. These findings are summarised in Table 4.26. Additionally, LoR had an interaction with both ISSs for both cases of dissimilation (/l/ and /g/) and this interaction was present only for Hindi categories.

The Role of LoR

Predictor	Phone	Cue/Feature	Language	Effect	Interaction
LoR	/l/	F2-F1 difference	English	no effect	-
			Hindi	↑ LoR = ↓ dissimilation	-
	/t/	VOT	English	↑ LoR = ↑ assimilation	-
			Hindi	no effect	-
	/g/	VOT	English	NA (no transfer)	NA
			Hindi	↑ LoR = ↓ dissimilation	-
		VDC	English	NA (no transfer)	NA

Predictor	Phone	Cue/Feature	Language	Effect	Interaction
			Hindi	$\uparrow$ LoR = $\downarrow$ dissimilation	-
		RBI	English	$\uparrow$ LoR = $\downarrow$ assimilation	-
			Hindi	no effect	-

Table 4.27: Summary of the effects of LoR on backward transfer

The findings suggest that LoR was associated not only with a return to native Indian-like values, as was predicted (Beganovic, 2006; Prescher, 2007; Sharma & Sankaran, 2011; Venturin, 2019), but also with an exaggeration of Indian-like values (Table 4.27).

(b) **IAL Flanker Effects (English and Hindi)**

IAL Flanker Effect English (IALE) and IAL Flanker Effect Hindi (IALH) measured inhibitory skill using a linguistic flanker task. The linguistic flanker task was different from the cued recall inhibition task in the kind of inhibitory ability it measured, and in its within- and cross-linguistic approach to inhibitory skill. On the one hand, the cued recall task measured the ability to inhibit within-language (not cross-linguistic) lexical units or exemplars that were relevant at some point during the task, but not at the time of data elicitation. This is said to result directly from language processing (Miyake et al., 2000). On the other hand, the flanker task is aimed at measuring the ability to ignore distraction from noise while simultaneously trying to identify a target. It is this type of conflict resolution which is implicated in comprehension- and production-based language control which ensures processing in the target language (Abutalebi & Green, 2007; Dash & Kar, 2014; Eben & Declerck, 2019; Green & Abutalebi, 2013), that is examined in this task. The linguistic version of this task was adapted from the more general arrow flanker task and measures the ability to suppress similar distractor information from the bilinguals' 'other' language while trying to respond to the first (Declerck, Snell, & Grainger, 2018; Eben & Declerck, 2019).

The linguistic flanker task in this study was deemed to capture inhibitory skill not only on a within-language level (IWL trials; distractors and target were the same language), like in cued recall inhibition task, but also on a cross-linguistic level (IAL trials; distractors and target were different language). Eventually, only IAL scores were included in this analysis, based on the discussion in §4.4.2. So, while the cued recall inhibition task measured the inhibitory skill at activating/inhibiting language-specific exemplars, the linguistic flanker task was deemed to also measure the ability to inhibit competing information from the 'other' language when processing in the first. So while even though this measure potentially gives a cross-linguistic angle to the elicited inhibitory measure, it is still at a visual level – not necessarily at the level of linguistic processing. In this way, this type of inhibitory ability appears to be more domain-general (as also found by Eben & Declerck, 2019) than specially linguistic as the inhibitory skill score elicited by the cued recall inhibition task.

The above highlights a gap and need for a task that elicits the individuals' inhibitory skill (in terms of poor or good inhibitory ability) at a more cross-linguistic level, arisen out of language selection as well as processing when both of their languages are activated to more or less similar extent in a bilingual mode (language mode continuum; Grosjean, 1989; Soares & Grosjean, 1984). This is especially needed with increasing evidence for the effect of inhibitory skills on backward transfer effects (here and also Lev-Ari & Peperkamp, 2013), and with the focus of research directed towards language use in modes such as monolingual, intermediate, bilingual (Schmid, 2007). Previous research has also suggested that dominance of either of the bilinguals' languages has implications for applying and overcoming the applied inhibition on the involved languages (Meuter & Allport, 1999), which would add an interesting aspect to the investigation of the role of language modes and inhibitory skills on backward transfer effects.

Therefore, based on the above discussion, it can be concluded that the kind of inhibitory skill represented by ISSE and ISSH is different from that represented by IALE and IALH. This is supported by differences in findings across ISS and IAL (Tables 4.26 and 4.28).

Predictor	Phone	Cue/Feature	Language	Effect	Interaction
IAL Flanker Effect English (IALE)	/l/	F2-F1 difference	English	↑ IALE = ↑ dissimilation	-
			Hindi	↑ IALE = ↑ dissimilation	steeper increase than in English
	/t/	VOT	English	↑ IALE = ↑ assimilation	-
			Hindi	no effect	-
	/d/	VOT	English	↑ IALE = ↑ assimilation	-
			Hindi	no effect	-
IAL Flanker Effect Hindi (IALH)	/t/	VOT	English	no effect	-
			Hindi	↑ IALH = ↑ assimilation	-

Table 4.28: Summary of the effect of IAL Flanker Effects on backward transfer

(c) **Inverse Simon Effect (SE) and Inverse Flanker Arrow Effect (FAE)**

The findings for the strictly non-linguistic inhibitory skills - Inverse Simon Effect (SE) and Inverse Flanker Arrow Effect - do not indicate a clear pattern to deduce their effects on backward transfer (Table 4.29) .

Predictor	Phone	Cue/Feature	Language	Effect	Interaction
Simon Effect (SE)	/l/	F2-F1 difference	English	↑ SE= ↓ dissimilation	-
			Hindi	↑ SE= ↑ dissimilation	-
	/t/	VOT	English	↑ SE= ↑ assimilation	-
			Hindi	no effect	-
Flanker Arrow Effect	/l/	F2-F1 difference	English	↑ FAE= ↑ dissimilation	-
			Hindi	no effect	-
	/t/	VOT	English	↑ FAE= ↑ assimilation	-
			Hindi	no effect	-

Table 4.29: Summary of the effect of Simon and Flanker Arrow Effect on backward transfer

8. **Dominance Hindi (DH)**

   As seen in Table 4.30, the effect of DH only emerged in interaction with other predictors such as LoR and AoE.

Predictor	Phone	Cue/Feature	Language	Effect	Interaction
Dominance Hindi (DH)	/t/	VOT	English	no effect	-
			Hindi	↑ DH= ↑ assimilation	as LoR increased
				↓ DH= ↑ dissimilation	as LoR increased
	/g/	RBI	English	↑ DH= ↓ assimilation	subsides to no change as the AoE increases
			Hindi	-	-
		VDC	English	NA (no transfer)	NA
			Hindi	↑ DH= ↓ dissimilation	Effect reverses (to an extent) as LoR increases

Table 4.30: Summary of the effect of Dominance Hindi on backward transfer

   The different effects of DH across /t/ (higher assimilation with increasing value of the predictor) and /g/ (higher dissimilation with increasing value of the predictor), which were also found for LoR and DE, seem to highlight the differences between /t/ and /g/ (probably in salience).

9. **Gender**

   The effect of gender does not seem to be clear and consistent based on the very few instances where the effect of Gender was significant. While both groups showed dissimilation for /l/, males showed less dissimilation for /l/ than females. Additionally, females showed less dissimilation for VOT in /d/ than males, but only in Hindi. This absence of a consistent effect may be explained by a lack of clear motivation to sound more Glaswegian-like by either gender.

4.5.2 Observations on the collective effect of predictors

Based on the above discussion, a list can be drawn about the general effects of the examined predictors across English and Hindi. These are summarised in Table 4.31.

Predictor/s	**Categories Affected**	**General Effect**	**Exception to the General Effect**	**(Generally) Language Affected More**
AoE	/t/ VOT (E) /d/ VOT (E) /l/ (E) /g/ Voicing % (H)	Early arrivals showed more transfer effects than late arrivals. Late arrivals either did not show any assimilation or the effects of other predictors such as IC, II, DE, GC subsided in late arrivals	-	English more than Hindi
Indian Contact (IC)	/l/ (H), /t/ VOT (E, H) /g/ Voicing % (H)	Higher IC was associated with more Indian-like or exaggeratedly Indian-like values in Hindi	VOT in /t/ in English showed higher assimilation with higher IC	Both affected somewhat equally
Indian Identity (II)	/t/ VOT (E, H) /d/ VOT (E) /g/ VOT (H) /g/ Voicing % (H) /g/ RBI (E)	Higher II across English and Hindi was associated with increasingly Indian-like or exaggeratedly Indian-like values	RBI in /g/ in English: higher II was associated with higher assimilation	Both affected somewhat equally
Glaswegian Contact (GC)	/g/ RBI (E)	Same across GC and GI. Higher GC and GI were associated with higher assimilation to GE	-	Only English affected
Glaswegian Identity (GI)	/t/ VOT (E)			
Dominance English (DE)	/t/ VOT (E, H) /g/ RBI (H) /g/ VOT (H)	Higher DE was associated with higher assimilation to GE	VOT in /g/ in Hindi: higher DE was associated with higher dissimilation (in early AoE), lower dissimilation (in late AoE)	Both affected equally

Table 4.31 continued from previous page

Predictor/s	Categories Affected	General Effect	Exception to the General Effect	(Generally) Language Affected More
Inhibitory Skill Score English (ISSE)	/l/ (H) /t/ VOT (E) /g/ VOT (H)	ISSE and ISSH had similar effects on transfer: higher inhibition was associated with more Indian-like or exaggeratedly Indian-like values	(To ISSH) VOT in /t/ in Hindi: higher ISSH associated with higher assimilation	Hindi affected more
Inhibitory Skill Score Hindi (ISSH)	/l/ (H) /t/ VOT (H) /g/ VOT (H)			
LoR	/l/ (H) /t/ VOT (E) /g/ VOT (H) /g/ Voicing % (H) /g/ RBI (E)	Higher LoR was associated with a return to Indian-like or exaggeratedly Indian-like values	VOT in /t/ in English: showed higher assimilation with an increase in LoR	Both affected equally
IALE	/l/ (E, H) /t/ VOT (E) /d/ VOT (E)	Inhibiting Hindi interference was associated with higher transfer effects (assimilatory and dissimilatory)	-	English affected more
IALH	/t/ VOT (H)	Inhibiting English interference was associated with higher assimilation	-	Only Hindi affected
SE	/l/ (E, H) /t/ VOT (E)	Effects inconsistent	-	-
FAE	/l/ (E) /t/ VOT (E)			
DH	/t/ VOT (H) /g/ Voicing % (H) /g/ RBI (E)	Of the two categories affected, associated with more Indian-like values in /g/	VOT /t/ Hindi: showed higher assimilation (for early AoE), higher dissimilation (as AoE increased)	Both affected equally

Table 4.31: The general effects of predictors (E = English, H = Hindi)

Based on the above table and with respect to the discussion in Section 4.5.1, discussed below are four points about the nature of the effect of these predictors on backward transfer.

4.5.2.1 Did the predictors perform as expected?

Roughly, all predictors (more specifically AoE, LoR, Indian Contact, Indian Identity, Dominance English, Glaswegian Contact, Glaswegian Identity, Inhibitory Skill Score Hindi and English, IAL Flanker Effect English) had the expected effect on backward transfer (see Table 4.31).

With respect to language dominance, it was not clear if Dominance Hindi (DH) would ensure no transfer effects only in Hindi or Indian English as well. The same was speculated for English, that is, whether dominance in English would lead to assimilation in English only or in Hindi as well. However, the results suggest that both DH and DE affected both languages to the same extent, and were not limited to only affecting the corresponding language.

The predicted effect of LoR was not supported heavily by previous research as the collective findings were not very consistent and suggested different effects of LoR on backward transfer. As discussed in the respective sub-section for LoR in §4.2, some studies suggested that longer LoR was associated with higher backward transfer effects (Lev-Ari & Peperkamp, 2013), others suggested that the effects of LoR on backward transfer were inconsistent or limited (de Bot & Clyne, 1994; E. de Leeuw, 2009; E. de Leeuw et al., 2007, 2010; Flege, 1988, 1992; Hopp & Schmid, 2011; Köpke & Schmid, 2004; Schmid, 2002; Tsukada et al., 2005; Yagmur et al., 1999), and yet another set suggested that increasing LoR is associated with a return to native-like values, and therefore, a decrease in backward transfer effects (Beganovic, 2006; Prescher, 2007; Sharma & Sankaran, 2011). The third finding motivated the predicted effect of the present study, and the findings indeed support this prediction: in general, increasing LoR was, in fact, found to be associated with either more Indian-like (or long-term Glaswasian-like) values or exaggeratedly Indian-like values.

The set of predictors whose effect was not clear or consistent consisted of Simon Effect and Flanker Arrow Effect. Based on the lack of a clear pattern, regarding these predictors, these two domain-general and not specifically linguistic inhibitory skills may not be very predictive of the effects of inhibitory skills on backward transfer, especially when their involvement in linguistic processing is only speculated, and there is no evidence on where exactly these skills might be applied. In any case, the effects of the inhibitory skill involved in linguistic processing (ISSE and ISSH) were found to be generally consistent with the predictions as well as Lev-Ari and Peperkamp's (2013) findings. Furthermore, as Lev-Ari and Peperkamp (2013) only examined the three voiceless stops /p t k/ and in English-French bilinguals, it is impossible to compare their results with the present findings across the same categories.

Another predictor that did not have much effect on backward transfer was language switching ability (Inverse Mean Switch Cost, Inverse Mean Switch Cost Hindi, Inverse Mean Switch Cost English). The effect of this was seen for only one category and respective cue (VOT in /b/ in Hindi), which did not show an effect of any other predictor: higher Inverse Mean Switch Cost Hindi (better switching ability into Hindi) was associated with less assimilation to Glaswegian English, that is, more Indian-like values for VOT in /b/ in Hindi. This result is consistent with the prediction that better switching ability would be associated with little to no backward transfer. Furthermore, this effect of Inverse Mean Switch Cost Hindi was exaggerated by an increase in LoR.

Very interestingly, it is these executive functions like language switching ability and inhibitory skills (ISSH, ISSE) that have consistently interacted with LoR indicating that their role in affecting backward transfer gets bigger as the LoR in the host country increases (Lev-Ari & Peperkamp, 2013), whereas the sociolinguistic factors have been found to usually only interact with AoE. As also found by Lev-Ari and Peperkamp (2013), higher inhibition was associated with decreased backward transfer effects. They argued that "the more exposure bilinguals have had to their L2, and the more opportunity their L2 has had to influence their L1, the more important their level of inhibitory skill becomes in its ability to keep them immune to L2's influence" (324).

4.5.2.2 Are some phones acting 'wildly'?

The reason why the effects of the involved predictors were proposed to be general and not absolute is because there were exceptions to the effects of some of these predictors. What is interesting about these exceptions is that the only categories showing up over and over as exceptions were /t/ and /g/ (/t/ more than /g/).

Of the six exceptions, there were four instances where VOT in /t/ showed the opposite effect of the predictor than what was expected and generally found. As seen in Table 4.31, while the rest of the categories showed that higher Indian Contact, LoR, Dominance Hindi and Inhibitory Skill Score Hindi were associated with increasingly Indian-like or exaggeratedly Indian-like values, VOT in /t/ was associated with increasingly Glaswegian-like values. For Indian Contact and LoR this effect was found for VOT in /t/ in English, whereas for Inhibitory Skill Score Hindi and Dominance Hindi this effect was found for VOT in /t/ in Hindi.

The other two cases of exceptions were related to the category /g/. While the rest of the categories showed that higher Indian Identity was associated with increasingly Indian-like or exaggeratedly Indian-like values, RBI in /g/ in English was associated with increasingly Glaswegian-like values. Additionally, while the rest of the categories showed that higher Dominance English was associated with increasingly Glaswegian-like values, VOT in /g/ in Hindi was associated with increasingly exaggerated Indian-like values. This second case can be reasonably argued to arise directly from dominance in English, in the face of which, Glaswasians are exaggerating the native characteristics of VOT in /g/ in Hindi.

However, the individual opposite effects of the four predictors Indian Contact, LoR, Dominance Hindi and Indian Identity, on VOT in /t/ in English and RBI in /g/ in English are indeed surprising. It is not clear as to why only these categories should show such opposite effects. Furthermore, for instance, with higher LoR, RBI in /g/, which was also affected by this predictor, could have undergone assimilation like VOT in /t/ in English, but it did not. This on top of everything else indicates that it is something about these specific categories and cues which is making them more susceptible to the opposite effects of the corresponding predictors.

In their specific sections, multiple reasons were given for why such exceptions may have emerged, such as harder attempt at assimilation or integration in face of higher Indian Identity and Indian Contact, or giving themselves a higher Indian Contact, Dominance Hindi, Indian Identity rating to compensate for the guilt of assimilating to Glaswegian English (Venturin, 2019). However, first, this does not apply to LoR, and second, even if this were the case, the effect should have been consistent across all categories.

While it is not clear as to why /g/ and /t/ were affected the way they did, it may be related to these categories being salient in some way across the involved linguistic and/or sociolinguistic varieties. Especially in the case of VOT in /t/, as was argued earlier as well, it seems that aspirated VOT in Glaswegian English carries some salience that gives it perceptual distinctiveness, positive speaker attitudes, and makes it easy to acquire as compared to other cues and categories (Boswijk & Coler, 2020). Thus, because of this, the Glaswasians may have wanted to assimilate to it despite the opposite general effect of the predictor. In this light then, /t/ appears as a rebel with the cause of salience. At the same time, it should be noted that the present study didn't examine the other voiceless stops, namely /p k/, so this effect may not be about /t/ per se.

This discussion also highlights that the effect of predictors is not generalised across all categories, and even not across cues within a given category. For example, within the category of voiced stops, the effect of predictors was not consistent, and even within a given phonetic category, for example, /g/, the effect of a given predictor was not consistent across features. This can be seen in Table 4.31. It is not clear as to what determines which predictor will affect which category and cue combination. But one thing is clear, the categories that seem to be most affected by the examined predictors are: /t/, /g/ and /l/. Again, this may have to do with the associated salience, but these varying effects across categories and cues can, in part, also be explained by the SLM and SLM-r (Flege, 1995b; Flege & Bohn, 2021). For instance, the relationship of perceived similarity/dissimilarity between L1-L2 diaphones, which may realistically be different across these categories, can also make them differentially susceptible to the effect of these predictors.

Here we may turn to the findings of the XAB similarity judgement task to determine whether /l/, /t/ and /g/ were judged as perceptually more similar to GE over other categories. In general, the findings from the XAB task suggest that /b/ and /t/ (in Indian English; IE) were seen as perceptually more similar to GE, whereas /g/, /d/ and /l/ were not (in IE or Hindi). In this light, while the behaviour of /t/ may be related to higher perceptual similarity, that of /l/ and /g/ is certainly not. So, collectively, it does not appear that the behaviour of /l t g/ is related to higher perceptual similarity. However, the XAB task compared perceptual similarity across native languages, not across phones, so this reasoning should be considered with caution.

4.5.2.3 Did the predictors affect English and Hindi categories differently?

One of the big research questions of the present study was whether Glaswegian English will affect Glaswasians' Hindi and Indian English differentially on the basis that the native languages are at different distance from Glaswegian English typologically. So now, the present discussion examines this question in relation to the effect of the sociolinguistic and psycholinguistic predictors. Two questions can be asked under this, which are addressed separately in the following subsections.

4.5.2.3.1 Did the results of the XAB task align with the effect of predictors?

In the present context, in relation to the XAB task, an interesting question is whether the predictors affected English and Hindi differentially depending upon which native language was seen as perceptually more similar to GE. To this end, Table 4.32 compares the findings of the XAB task, that is, if Indian English (IE) was found to be more similar to GE perceptually over Hindi and the predictors that were found to effect the phones across languages. The phones /b/ and /g/ are not included in this Table because (1) /b/ did not undergo transfer in both languages for any given features, and (2) same was the case for /g/ for VCD and VOT. Moreover, RBI was affected equally in Hindi and English so predictors are bound to have the same amount of effect on both English and Hindi.

Phone	XAB Result	Feature	Predictors that affected IE	Predictors that affected Hindi	Predictors that affected IE and Hindi
/l/	IE = H	F2-F1 Difference	AoE	ISSE, ISSH, LoR, IC	IALE
/t/	IE >H	VOT	AoE, GI, ISSE, LoR, IALE	IALH, ISSH, DH	IC, II, DE
/d/	IE = H	VOT	AoE, II, IALE	-	-

Table 4.32: Comparison of perceptual similarity results and predictors that affected English and Hindi differentially in /l/ and /t/

As seen in Table 4.32, the findings of the XAB task indicated equal perceptual similarity between Hindi and IE for /l/. However, clearly, more predictors (both psychometric and social) affected Hindi than IE. Similar to /l/, equal perceptual similarity to GE was also found for VOT in /d/ across Hindi and IE, but the predictors (psychometric and social) only affected English. For /t/, the XAB task indicated higher perceptual similarity between IE and GE. Interestingly, in line with this observation, more predictors (both social and psychometric) affected /t/ in English, as seen in Table 4.32. But at the same time, though less in number, Hindi was also affected by predictors (mostly psycholinguistic). Based on this discussion, it appears that higher perceptual similarity does not necessarily dictate if a certain category will exhibit higher influence from a given predictor. This takes us to the more general question of whether some predictors consistently affected one language over the other.

4.5.2.3.2 Did any predictor affect one language more than the other?

For some predictors, such as LoR and AoE, the expectations regarding this question were not quite clear as they simultaneously represented increased contact with Glaswegian English and decreased contact with the native languages. This means that both Hindi and Indian English could be effected by these two predictors. However, as seen in Table 4.31, AoE was found to affect English categories more than Hindi categories, whereas LoR seemed to affected both languages equally. So again, although AoE, in part, also represents higher Glaswegian influence like LoR, these different effects across LoR and AoE seem to indicate that AoE is primarily accounting for the state of Glaswasians' L1 categories. It appears that Glaswasians' Hindi categories are probably more stable than their L1 Indian English categories which is making the latter categories more susceptible to influence from Glaswegian English, and by extension to the effect of AoE. However, one should take these observations with caution as in some cases, the English category had not undergone transfer in the first place, and therefore, were not included in this analysis, for example, for /g/ voicing percentage and VOT.

The expectations for other predictors such as Indian Contact, Indian Identity, Glaswegian Contact and Glaswegian Identity were clearer than for LoR and AoE. Indian Contact represented increased contact with the Indian community and by extension with Indian English as well as Hindi, based on which it appeared that the effect of this predictor should have similar effect across both languages. Similarly, Indian Identity represented affiliation with the Indian group, and by extension Indian English and Hindi. Therefore, like Indian Contact, Indian Identity could be expected to have a similar effect across both languages. In line with these expectations, Table 4.31 suggests that both Indian Contact and Indian Identity had similar effects on Indian English and Hindi, if not more tilted towards Hindi for Indian Contact. By contrast, Glaswegian Contact and Glaswegian Identity represented influence from Glaswegian English only, which was expected to affect Indian English more than Hindi. The results confirm this as only English counterparts were found to be affected by these predictors.

With respect to Dominance, it can be argued that higher DE (dominance in English) would be related to higher assimilation of Indian English to Glaswegian English as compared to Hindi, whereas higher Dominance in Hindi would be related to higher maintenance of Hindi than Indian English. The findings however, seem to suggest that both Hindi and Indian English were somewhat equally affected by DE and DH (dominance in Hindi) (especially if one were to consider that /g/ underwent transfer only in Hindi for voicing percentage and VOT). This indicates that dominance in one language does not keep the other linguistic variety, however typologically far or proximate, from its influence.

Finally, with respect to inhibitory skills (ISSE, ISSH, IALH, IALE), it appears that ISSE and ISSH are affecting Hindi more, that is, higher inhibition of Hindi as well as English exemplars are both related to more Indian-like or exaggeratedly Indian-like values in Hindi more than Indian English. The predictor IALE also had different effects across Hindi and Indian English.

IALE, which represented inhibition of Hindi interference, affected English more.

Taken together, these findings suggest that some predictors affected Hindi and Indian English differentially, but this is not necessarily dictated by the perceptual similarity of those categories with the corresponding L2 host categories. However, these observations are not absolute, as for some categories, the 'other' language counterpart was not included in the analysis. Furthermore, there is no previous research to compare and confirm these findings with, so it will require more evidence to conclude this question with a more substantial answer.

4.5.2.4 Are some predictors more primary in affecting backward transfer than others?

This question aims to answer whether there are certain factors that are more 'potent' predictors of backward transfer, just as Flege et al. (2006) identified AoE to be a potent predictor of degree of foreign accent in the L2. In the present study, the answer to this question was determined on the basis of whether a predictor had a (1) generally consistent effect (2) across multiple categories. With respect to this criteria, predictors can be divided into four tiers. The first three tiers are defined by the predictors having a (generally) consistent effect across categories. The distribution of these predictors across the three tiers is based on the number of categories (and cues within them) that they affected, with tier one representing the most, and tier three representing the least. The final and fourth tier consisted of predictors that were not found to have a consistent effect across the affected categories. The categorisation of predictors across the four tiers is shown in Figure 4.46 and discussed below.

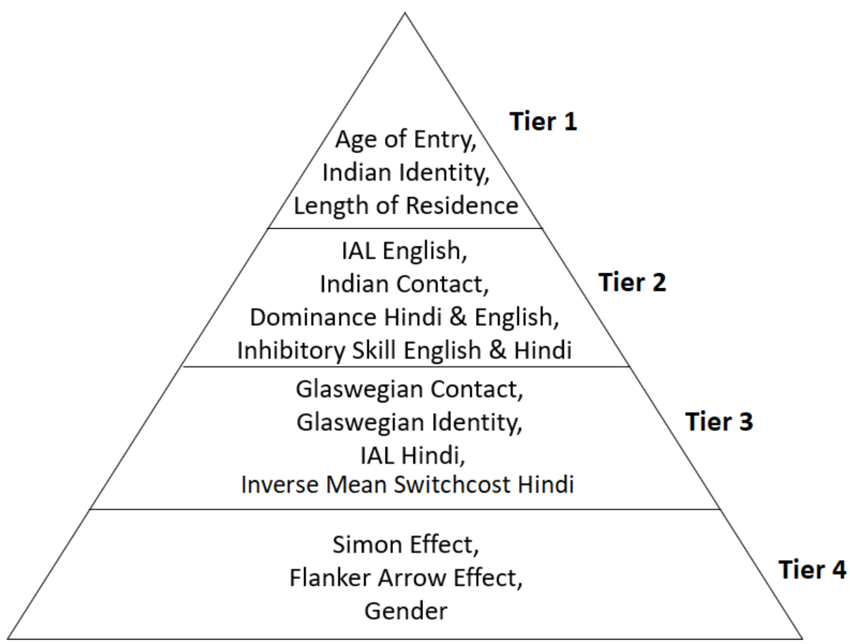


Figure 4.46: Categorisation of predictors across tiers

The first tier consisted of three factors that came across as the most potent predictors of backward transfer: AoE, LoR and II. As seen in Table 4.31, all these three predictors had a generally consistent effect on the various categories, or multiple features of a given category that they affected. While the role of AoE has been examined and confirmed more extensively in relation to L2 acquisition in the past (Flege, 1995b, 1997; Flege & Bohn, 2021; Flege & MacKay, 2010; Flege, MacKay, & Meador, 1999; Piske et al., 2001) (Flege 1995b; Flege et al.2006), the examination of AoE with relation to backward transfer, and especially only in adult speakers, has been rather recent, and therefore, scarce (Ahn et al., 2017; E. de Leeuw, 2009; Karayayla & Schmid, 2019). So, the present study confirms the role of varying AoE in adults in affecting backward transfer as also found by (E. de Leeuw, 2009).

Similar to AoE, while LoR has been extensively studied with relation to SLA, the same has not been the case for backward transfer. With reference to SLA, compared to AoE, LoR is not identified as an important determinant of foreign accent in L2 (Piske et al., 2001:198). Two reasons can be cited for this. First, because of its possible correlation with AoE, and second, its inconsistent effects across previous research (Piske et al., 2001). However, in the present study, LoR was found to have a generally consistent effect which was present in multiple categories, and confirms that an increase in LoR marks a return to more native-like values (Beganovic, 2006; Prescher, 2007; Sharma & Sankaran, 2011), or possibly represents a shift in the direction of assimilation from Glaswegian English to Glaswasian English (the variety of the long-term Glaswasians). Not only that, LoR was also found to interact with cognitive skills like language switching ability and inhibitory skills, in that the role of these cognitive skills grew bigger in affecting backward transfer as the LoR increased. This was also found by Lev-Ari & Peperkamp, 2013, the only other study that examined the role of inhibitory skills in affecting backward transfer. Interestingly, factors like Indian Contact, Indian Identity, Glaswegian Contact, Dominance English were involved in interaction with AoE, whereas Dominance Hindi interacted with both LoR and AoE. So, it appears that both LoR and AoE have a crucial effect on backward transfer and also interact selectively with other variables. In fact, this effect of LoR is fascinating in that it indicates that adult migrant bilinguals can regain the elements of their L1 that may have been 'lost' at some point during their residence in the host country. This is similar to findings that the 'leftover traces' (Bowers, Mattys, and Gage, 2009:1064) of the phonology of a language that individuals learned as children but lost contact with, make it easier for them as adults to reacquire that knowledge (Bowers et al., 2009; Isurin & Seidel, 2015; Keijzer & de Bot, 2018).

Finally, the effect of Identity has not been investigated in either SLA or backward transfer research. However, there is some sociolinguistic research (see §4.2.5.2) which suggests that individuals' affiliation or recognition of the self as belonging to a certain group (Labov, 1963) or groups (Alam, 2015; Alam & Stuart-Smith, 2014; Harris, 2006) can affect their linguistic choices. This is also supported by research on speech accommodation and the present study also confirms this as influencing backward transfer across languages as well as dialects.

The next tier of influential predictors consists of Indian Contact, Dominance Hindi, Dominance English, Inhibitory Skill Score English and Hindi, IAL Flanker Effect English, that is, a combination of executive skills and social variables. As seen in Table 4.31, all these predictors also had different, but, generally consistent effects across multiple categories (and also cues in some cases). Similar to Identity, investigation of the role of Contact in SLA and backward transfer has been limited, but the present results highlight its effect on backward transfer. This has also been highlighted to be the case for language use (here dominance – DE and DH) which has previously also been identified as an influential predictor for L1 attrition and backward transfer (Flege, 1995b; Flege & Bohn, 2021; Schmid, 2002). Finally, this study also highlighted the role of the much less examined inhibitory skills in affecting backward transfer.

The third tier consisted of the predictors Glaswegian Contact, Glaswegian Identity, IAL Flanker Effect Hindi, Inverse Mean Switch Cost Hindi (again, a combination of psychometric and social variables), which were consistent in their effect, but affected only one phone category (and cue within it). With reference to the number of categories affected by Indian Identity and Indian Contact, and Glaswegian Identity and Glasewegian Contact, it appears that an individual's identity and contact with respect to their heritage group is more important in native language maintenance than not identifying or being in contact with the host language. Yes, Glaswegian Contact and Glaswegian Identity did have a consistent effect on backward transfer, but it was far more limited than the effect of Indian Identity and Indian Contact.

Finally, the last tier consisted of Simon Effect, Flanker Arrow Effect and Gender that were found to have inconsistent effects across categories. On one hand, for Simon Effect and Flanker Arrow Effect, this can be contributed to their nature as more domain-general inhibitory skills which are speculated to be involved in linguistic processing somehow and at some stage – but it is not confirmed as to where and in what capacity. On the other hand, the inconsistent effect of Gender has been consistently reported in SLA and backward transfer (Piske et al., 2001) and also across speech accommodation (Babel, 2009, 2010; Namy et al., 2002; Nygaard & Queen, 2000; Pardo, 2016; Pardo et al., 2010). This may be argued to be methodological, but even then, the more methodologically apt accommodation studies have identified the role of Gender to be 'complicated' (Pardo, 2016). This seems to be supported by Eckert, 1989 who argues that "gender does not have a uniform effect on linguistic behavior for the community as a whole, across variables, or for that matter for any individual. Gender, like ethnicity and class and indeed age, is a social construction and may enter into any of a variety of interactions with other social phenomena" (p. 253). Gender roles are argued to vary from culture-to-culture and location-to-location (Eckert, 1998) and therefore can be expected to have inconsistent effects on backward transfer especially across different language pairs and communities.

4.6 Summary

The present chapter examined the role of various sociolinguistic and psycholinguistic factors in predicting transfer from the host dominant variety, Glaswegian English, to Glaswasians' native varieties, Hindi and Indian English. The key findings are: (1) multiple predictors were found to modulate transfer effects of assimilation/dissimilation, (2) compared to others, some features had a more consistent and primary effect on backward transfer, and (3) the effect of these predictors was found to be differential not only across categories and features, but also across Glaswasians' native languages Hindi and Indian English.

Chapter 5

General Discussion and Conclusion

5.1 Overview

The present chapter is intended to piece together the important findings from Chapters 2, 3 and 4, and view their implications in the wider context of cross-linguistic influences in bilingual and bidialectal interactions. §5.2 presents a summary of the findings to the three research questions proposed in Chapter 1. This is followed by §5.3, which presents a discussion on three important findings of the present study, that is, the lack of correspondence between perceptual similarity and backward transfer effects, the mechanism of interaction between Glaswegian English, Indian English and Hindi, and the elasticity of adult bilingual-bidialectal systems. The limitations of this study and implications for future research are discussed in §5.4, followed by a discussion of the significance of this work in §5.5.

5.2 Summarising Answers to the Three Research Questions

5.2.1 Was there a phonetic backward transfer of Glaswegian English on Hindi and Indian English?

The primary aim of the present study was to investigate whether there was a phonetic backward transfer of the host dominant language Glaswegian English to Glaswasians' native languages Hindi and Indian English. To this end, I recruited three groups of speakers, one experimental group (Glaswasians; 38) and two control groups (Glawegians, 34; Indians, 31), to participate in a speech production task. This task examined multiple phone categories for one or more acoustic/phonetic features. These were (1) the lateral /l/ for F2-F1 difference, (2) the GOOSE vowel for F1, F2, F3, (3) the voiceless stop /t/ for VOT, and (4) the voiced stops /b d g/ for VOT, VDC and RBI.

Cumulatively taken, the results of the speech production task (Chapter 3) indicated a phonetic backward transfer of Glaswegian English to both Hindi and Indian English. The findings also support the SLM and SLM-r's (Flege, 1995b; Flege & Bohn, 2021) predictions of assimilation and dissimilation. Assimilation, or the merging of perceptually similar L1-L2 diaphones was found for /t/ and /d/ for VOT in Indian English and Hindi, /g/ for RBI in Indian English and Hindi, and /b/ for VOT in Hindi. Dissimilation, or the exaggeration of L1 characteristics to maintain a contrast between perceptually similar L1-L2 categories, was found for /l/ in Indian English and Hindi, /g/ for VDC and VOT in Hindi. There were also instances of 'partial-assimilation' (Romaine, 1989), where a sound category underwent transfer for some, but not all characteristic features. For example, /d/ underwent assimilation for VOT in both languages but remained unchanged for VDC and RBI in both languages. Finally, there were also instances where a sound category remained unaffected, for example, the GOOSE vowel for F1, F2 and F3. These diverse findings highlight that transfer can manifest as different patterns such as assimilation, dissimilation and partial-assimilation.

5.2.2 Did Glaswegian English influence Indian English more than Hindi?

Highly relevant to this research question are two assumptions:

1. Typological proximity between Glaswegian English and Indian English (as compared to Hindi) will probably make the latter more susceptible to influence from the former (Rothman, 2010, 2013, 2015; Trudgill, 1986)

2. According to the SLM and SLM-r (Bohn, 2018; Flege, 1995b; Flege & Bohn, 2021), the higher the perceived similarity between perceptually linked L1-L2 categories, the higher the susceptibility to transfer effects

In relation to these two arguments, the following secondary research question was proposed under this second research question:

In addition to typological similarity, is there also higher perceptual similarity between Indian English and Glaswegian English as compared to Hindi and Glaswegian English?

If Indian English is indeed judged as perceptually more similar to Glaswegian English than Hindi, then as per the SLM, one may also predict higher transfer effects in it. To assess this question, I recruited the two control groups (Glaswegians, 49; Indians, 48) to participate in an XAB similarity judgement task. This task examined perceptual similarity of Indian English versus Hindi to Glaswegian English for eight phone categories (/l/ /u/ /p/ /t/ /k/ /b/ /d/ /g/) (Chapter 2). The results from this task showed that of all the examined phones, only two Indian English phones (/t/ and /b/) were judged as perceptually more similar to the corresponding Glaswegian English phones in comparison to Hindi. Therefore, to answer this secondary question, based on the judgements of Glaswegians and Indians (Glaswasians not included in this task), in this case of language contact, typological proximity of Indian English to Glaswegian English does not guarantee higher perceptual similarity across all corresponding phones in these two varieties.

In any case, based on the higher perceptual similarity in Indian English and Glaswegian English for /t/ and /b/, higher transfer was predicted in production in these Indian English phones as compared to the Hindi counterparts. However, the comparison of results from the XAB task (Chapter 2) and speech production task (Chapter 3) for those sound categories which showed transfer, as shown in Table 5.1, does not support this prediction. While IE /t/ showed the expected correspondence between higher perceptual similarity to Glaswegian English and higher transfer effects from it, IE /b/ did not. Furthermore, when Indian English and Hindi counterparts were judged as equally perceptually similar to the corresponding Glaswegian English category, and hence were predicted to show equal amount of transfer from GE, Hindi showed higher transfer effects in case of /l/ and Indian English showed higher transfer effect in /d/.

Phone Category	**XAB Task Findings**	**Amount of Transfer: IE versus H**	**Production Results = Perception Results ?**
/l/	IE = H	H >IE	×
/t/	IE >H	IE >H	✓
/b/	IE >H	IE = no change H = assimilation	×
/d/	IE = H	IE >H	×
/g/	IE = H	IE = H	✓

Table 5.1: Comparison of perception and production results (Indian English = IE; Hindi = H)

Altogether, these results indicate that higher perceptual similarity may not necessarily dictate higher transfer effects in production. This finding bears the possible implication that there may not be a very strong connection between perceptual similarity and transfer effects in production, which has been discussed further in §5.3.1.

So, to return to the second research question, did Glaswegian English influence Indian English more than Hindi in production? Despite the inconsistency between results of the XAB and speech production tasks, the results from the speech production task indicated that numerically, Indian English did not show more instances of transfer (assimilation or dissimilation) than Hindi. However, what is more important and interesting is that in the cases where both Indian English and Hindi underwent assimilation, English underwent quantitatively higher transfer (VOT in /t/ and /d/) than Hindi, or equal transfer to Hindi (RBI in /g/) - but never less transfer than Hindi. Moreover, Hindi showed more instances of dissimilation, and also quantitatively higher dissimilation than Indian English for /l/, which is the only instance where both Hindi and Indian English underwent dissimilation. So, it appears that transfer effects are, indeed, modulated (at least to some extent) by the linguistic variety: the more typologically proximate Indian English assimilated more to Glaswegian English quantitatively, and there were more instances of contrast-maintenance (dissimilation) in the more typologically distant (to Glaswegian English) variety Hindi.

All in all, though perceptual similarity predictions did not always support it, Indian English still showed higher assimilation as compared to Hindi and Hindi showed more dissimilation as compared to Indian English. This goes to show that varying typological distance between L1-L2 pairs on a whole may be influential in leading to different backward transfer effects across different L1s. At this point, an interesting question to ask in relation to these results is: what do these transfer patterns of assimilation and dissimilation suggest about the manner of interaction between Glaswegian English and the native varieties with reference to backward transfer. This warrants a detailed discussion which is presented below in §5.3.2.

5.2.3 Do various sociolinguistic and psycholinguistic factors affect phonetic backward transfer?

With respect to this question, the findings are summarised under the following two headings.

5.2.3.1 Transfer, a psycholinguistic *and* sociolinguistic phenomenon

Throughout Chapter 1, the role of multiple factors in affecting transfer and accommodation processes was highlighted. However, previous research undertaken under both these umbrellas has been very selective about the factors that are proposed and examined to be affecting such cross-linguistic interference processes. For example, backward transfer research has mainly approached the examination of L2 influence on L1 from a psycholinguistic perspective. This is evident in the type of factors argued and investigated to modulate these processes. Therefore, there has been a comparative neglect of the involvement of sociolinguistic factors or individuals' psycho-social motives in affecting backward transfer processes.

Chang (2010) argued for this to be reasonable because modifying L1 representations in response to L2 acquisition "changes nothing about the social distance between them and native speakers of the L2, given that L1 is not a shared language" (Chang, 2010:3). However, it certainly changes the social distance between them and the other native speakers of their L1 who are either still residing in the country of origin or are living in the host country with them. It may represent a desire of maintaining distance or breaking away from being identified as members of their original community for whatever reasons (for instance, Schmid, 2002), and is a reflection of changing self-identity in relation to their new social context. Based on this argument and the support from the results of Chapter 4, I argue that psycho-social motivations and needs are equally important in modulating transfer effects as are psycholinguistic factors. In fact, of all the examined predictors, Indian Identity was found to be one of the the most potent predictors of backward transfer (in Chapter 4).

The results from Chapter 4 also underline the effects of a few other predictors that are either not very well-supported by previous research (LoR) or remain understudied (language inhibitory skills and switching ability). With respect to LoR, the findings from previous research are divided and inconsistent. However, in the present study, LoR was found to have a generally consistent effect, which is, an increase in LoR beyond three years was associated with either more native-like values or exaggeratedly native-like values. This finding has important implications about the nature of bilingual-bidialectal system which is further discussed in §5.3.3.

In addition to the results for LoR, the findings were also fascinating with respect to the two linguistic cognitive skills examined here, language inhibitory skills (particularly Inhibitory Skill Score Hindi and English) and language switching ability (Inverse Mean Switch Cost Hindi). This study was only the second to examine language inhibitory skills in relation to backward transfer (after Lev-Ari & Peperkamp, 2013) and this predictor was found to have an effect partially consistent with Lev-Ari and Peperkamp's (2013) finding that higher inhibition was associated with more native-like values. In the present study, higher inhibition was also found to be associated with dissimilation. Moreover, this study was the first to examine the role of language switching ability. However, this predictor was not found to influence transfer effects greatly as its effect was only found for one category and corresponding feature, that is, /b/ for VOT. Interestingly, no other predictor was found to affect this category (/b/) and no other category was affected by this predictor (language switching ability).

5.2.3.2 Tackling the 'Cross-Sectional Methodology Criticism in Determining L1 Attrition Argument'

The 'Cross-Sectional Methodology Criticism in Determining L1 Attrition Argument' holds that the evidence of backward transfer (equating to L1 attrition here) in migrants arises as a misinterpretation of the changing nature of the L1 in the country of origin (E. de Leeuw, Mennen, & Scobbie, 2013). According to this argument, what might look like backward transfer in Glaswasians, would in fact result from changes in the Hindi and Indian English of the Indian control group. That is, it is the L1 of the Indian control group which has shifted since the Glaswasians moved out of the country.

Even if one were to entertain this criticism, the findings from Chapter 4 present enough evidence against it in relation to E. de Leeuw, Mennen, and Scobbie's (2013) counterargument that "if some of the late bilinguals perform similarly to the monolingual control group, whilst others do not (...), this supports the claim that L1 attrition has occurred in the experimental group" (p. 688). The effects of the predictors showed that there were Glaswasians who performed like the Indian control group and others that did not. In fact, the confirmation of the predicted general effects of several predictors supports this. For instance, higher AoE was associated with more native-like (Indian control group-like) values (for /t/ and /d/ for VOT in Indian English, /l/ in Indian English and /g/ for VDC in Hindi), as were Indian Contact (for /t/ for VOT in Indian English and Hindi, /g/ for VDC and /l/ in Hindi), Indian Identity (/t/ for VOT in Indian English and Hindi, /d/ for VOT in Indian English, /g/ for VDC and VOT in Hindi) and inhibitory skills (IISH, ISSE) (/l/ in Hindi, /g/ for VOT in Hindi, /t/ for VOT in Indian English). Additionally, the effects of Glaswegian Contact (on /g/ for RBI in Indian English) and Glaswegian Identity (on /t/ for VOT in Indian English) were such that Glaswasians who had higher Glaswegian Contact and Identity showed more Glaswegian-like values.

This argument is especially highly relevant in relation to /l/. In §3.4.1.1.2 in Chapter 3, it was speculated that the Indian clearer /l/ (in India) may be undergoing a shift towards a darker realisation. The comparison of F2-F1 difference data from Shaktawat (2018a) and the present study, however, does not seem to support this. Moreover, in Chapter 4, higher Indian Contact and higher Inhibitory Skill Score English were associated with less dissimilation (more control group-like values) in Hindi /l/. Both these effects seem to indicate that some Glaswasians are indeed performing like the Indian control group. Taken together, these arguments indicate that it is not the changing nature of L1 in the Indian control group which is being misinterpreted as backward transfer effects in Glaswasians, but is evidence of backward transfer itself in Glaswasians.

5.3 Implications of the Findings in the Bigger Picture

5.3.1 The lack of strong correspondence between perceptual similarity and susceptibility to transfer effects

According to the SLM (Flege, 1995b), the patterns of assimilation and dissimilation emerge from perceived cross-linguistic similarity or dissimilarity between corresponding L1 and L2 phones. That is, L1-L2 categories that are perceptually more similar are also more confusable, and therefore more vulnerable to transfer effects than L1-L2 pairs that are perceptually more distinct. However, as discussed in §5.2.2, this was not found to be the case in the present study – higher perceptual similarity between L1-L2 categories did not necessarily dictate higher transfer effects in production (Table 5.1). This implies a lack of a strong correspondence between perceptual similarity and backward transfer effects in production, which supports SLM-r's (Flege & Bohn, 2021) 'co-evolution hypothesis' that argues that perception and production co-evolve without precedence. Flege and Bohn (2021) also present several instances that indicate that production may not necessarily reflect perception. Among these is the case of near-mergers where speakers report no difference between them in perception but maintain the distinction in production (for example, Labov, 1994). However, this observation is against SLM's 'upper-limit hypothesis' that argues that production follows from perception, which is equally supported by evidence (for example, Evans & Alshangiti, 2018; D. Kim & Clayards, 2019).

A possible argument for this disjoint between perceptual similarity and backward transfer effects in production comes from the SLM's explanation of perceived similarity between L1-L2 categories, which is argued to exist on a continuum from 'identical' to 'similar' to 'new' (Bohn, 2018; Flege, 1995b). It is the L1-L2 categories that are perceived as 'similar' that are argued to be more vulnerable to transfer than 'identical', 'new' or 'dissimilar' ones. So, it is possible that the reason why Indian English /b/ did not undergo any transfer from Glaswegian English despite its higher perceived similarity to the corresponding Glaswegian English category is that Indian English and Glaswegian English /b/ were judged as identical, with no scope for transfer. By contrast, Indian English and Glaswegian English /t/ may have been perceived not as identical, but very similar, with the scope to exhibit transfer for VOT. So, the fact that different L1-L2 diaphones are different in their perceptual similarity in comparison to other L1-L2 diaphone pairs may contribute to different transfer effects across them even though they were both similarly judged as having higher perceptual similarity.

Even if this is the case, it foremostly highlights the need for a better understanding of the concept of perceived cross-linguistic similarity. That is, what exactly is it that makes an L1-L2 diaphone pair and their corresponding cues 'identical' or 'similar' or 'dissimilar' and how is this perceptual similarity contextualised in relation to other L1-L2 diaphone pairs. From an exemplar perspective (Bybee, 2001; Pierrehumbert, 2001, 2016), which is also adopted in the SLM-r (Flege & Bohn, 2021), this may be related to how the different perceptual cues that make up a category may have different contributions to the overall perceptual similarity of that category depending upon their weight and salience relative to the other cues.

Consider the case of the categories /t/ and /b/ in Indian English. As compared to their Hindi counterparts, /t/ and /b/ in Indian English were judged as being perceptually more similar to the corresponding Glaswegian English categories (in Chapter 2) and were expected to show higher transfer effects in production as well. However, while Indian English /t/ showed assimilation for VOT in production (as expected), Indian English /b/ remained unchanged for all features (VOT, VCD and RBI) in production (in Chapter 3) (against expectations). Not only this, but as discussed in §4.5.2.2 in Chapter 4, /t/ was the category that kept on coming up as an exception to the general effect of predictors – Glaswasians were assimilating to Glaswegian English even when the other categories were showing the opposite and expected effect of the predictor. These patterns for Indian English /t/ and /b/, when compared as such, indicate that it is something about these categories or their constituent cues that increase or decrease their susceptibility to backward transfer effects. I argue that it may have to do with higher perceptual salience of the category itself or its constituent cues.

In relation to SLA, most studies describe the salience of a sound category in relation to attention (Boswijk & Coler, 2020). That is, a salient feature is reported to be quite conspicuous, vulnerable to attracting attention (Boswijk & Coler, 2020; Cintrón-Valentín & Ellis, 2016; J. Siegel, 2010) and easy to acquire (Ellis, 2018). In context of phonology, a factor that is proposed to be a contributor to salience is acoustic prominence, that is, the "realisation of a phoneme with a previously unheard variant makes a feature salient due to an unexpected phonological distinction" (Boswijk and Coler, 2020:2). In relation to the present finding of higher transfer effects in /t/ for VOT, it can be argued that the aspirated word-initial /t/ in Glaswegian English may appear as acoustically more prominent to Glaswasians, for whom aspiration functions contrastively in their L1 Hindi. So, this use of aspiration in /t/ in Glaswegian English in a non-contrastive manner (with respect to their own accent of Indian English) may have appeared prominent to them, therefore, making the feature more salient – so much so that Glaswasians assimilated to this feature even in presence of predictors such as Indian Identity which was found to have a general effect of more native-like or exaggeratedly native-like values in the other categories. Furthermore, according to Hauser (2021), high voicing during closure is a salient feature in Hindi voiced stops – this was in a way confirmed by the results of the production task where Glaswasians maintained native-like VCD for /b/ and /d/ in Indian English and Hindi, and if there was transfer, as in /g/ for VCD in Hindi, it was to exaggerate this Indic characteristic. So then, in relation to perceptual salience, it appears that when compared across L1 and L2, the more salient features in L1 will either undergo no transfer, or undergo dissimilation, whereas L1 will undergo assimilation towards the more salient features of the L2.

Such differences in salience across various features of a category may also explain the instances of partial-assimilation found for the voiced stops in the present study where transfer was found for some but not other features. This also highlights that backward transfer effects were not generalized across cues of a given category in either direction (assimilation or dissimilation) or degree (Bergmann et al., 2016; Chang, 2012), which goes against previous findings suggesting that the L1 and L2 sounds are linked at the system-wide level (Schmid & Köpke, 2017). Instead, phonetic backward transfer effects were found to be selective across categories and even for the various characteristic features within a given category.

However, the disjoint in perceptual similarity and backward transfer effects in production found in the present study could also be attributed to the methodological concern that different participant groups participated in the XAB and speech production tasks. That is, perceptual judgements from Glaswegians and Indians may not necessarily be in line with the perceptual judgements from the Glaswasians who took part in the production study. Another possible source of the disjoint between perceptual similarity and production results is that the responses to the categories in the XAB task were necessarily holistic. That is, the participants (Glaswegians and Indians) may have been listening to different phonetic cues when judging the XAB comparisons and this, therefore, does not imply anything about the perceptual similarity of the cues that they did not listen to but were examined in the following chapter for shifts in production. These two points may be related to why /l d g/ showed differences in transfer effects across

Indian English and Hindi in production (in Chapter 3) even when the same was not expected based on the results of the XAB task (Chapter 2).

Regardless, as it stands now, there seems to be a disconnect between perceptual similarity and backward transfer effects in production (Flege & Bohn, 2021). This highlights the need for a better understanding of perceptual similarity between and across L1-L2 phone pairs, the possible role of relative weight and salience across categories and cues, in addition to propositions of quantifying these across various language pairs.

5.3.2 Interaction between Glaswegian English, Indian English and Hindi

In the present section, I address the following question: what do the patterns of backward transfer of Glaswegian English on Hindi and Indian English in Glaswasians inform us about the mental organisation and interaction between the phonologies of these linguistic systems?

The pursuit of understanding the organisation and interaction between the L1 and L2 in a bilingual mind has led to the proposition of various models of bilingual language acquisition, representation, interaction and processing (see Bartolotti & Marian, 2012; Best & Tyler, 2007; Dijkstra & Heuven, 2002; Flege, 1995b; Flege & Bohn, 2021; Goldinger, 1998; Green, 1998; Grosjean & Li, 2013; Kroll & Tokowicz, 2005; Kroll, Van Hell, Tokowicz, & Green, 2010; Levelt, 1989; Linck, Hoshino, & Kroll, 2008b; Pierrehumbert, 2001) At the same time, more recent attempts have been made to understand the representation, interaction and processing of D1 and D2 in the bidialectal mind (Declerck, Özbakar, & Kirk, 2021; Kirk, Declerck, Kemp, & Kempe, 2022; Lundquist & Vangsnes, 2018; Melinger, 2018; Pickering & Garrod, 2004; J. Siegel, 2010), with some studies reporting bidialectal processing to be very similar to bilingual processing (Kirk et al., 2022; Lundquist & Vangsnes, 2018; Melinger, 2018). Additionally, various models of L3 acquisition and processing have also been proposed to understand trilingual language interaction and processing (Bardel & Falk, 2007; Brown-Bousfield & Chang, 2023; Flynn et al., 2004; Hoffmann, 2001; Hut, Helenius, Leminen, Mäkelä, & Lehtonen, 2017; Lemhöfer, Dijkstra, & Michel, 2004; Linck et al., 2012; Rothman, 2013; Slabakova, 2017; Westergaard et al., 2017).

However, between these models of bilingual, bidialectal and trilingual language acquisition, interaction, and processing, is a gap that remains unaddressed and comprises of the situation of simultaneous bilingual and bidialectal interaction, as presented by the interaction between Glaswegian English, Hindi and Indian English in Glaswasians. So, in this section, I now ask and try to answer the question: With respect to backward transfer, how does Glaswegian English interact with the native languages and influence them? More specifically, does Glaswegian English affect both native languages independently, or does Hindi get influenced by Glaswegian English via Indian English? In trying to answer this question, I will refer to the various models of interaction between Glaswegian English, Hindi and Indian English, that I proposed based on models of L3 acquisition, in §1.2.3 in Chapter 1. Furthermore, in trying to answer this question, findings from Shaktawat (2018a) will also be considered for added evidence.

Figure 5.1 presents the different types of proposed interactions and effects under the independent and mediated backward transfer models of interaction between Glaswegian English, Hindi and Indian English, that I proposed in Chapter 1.

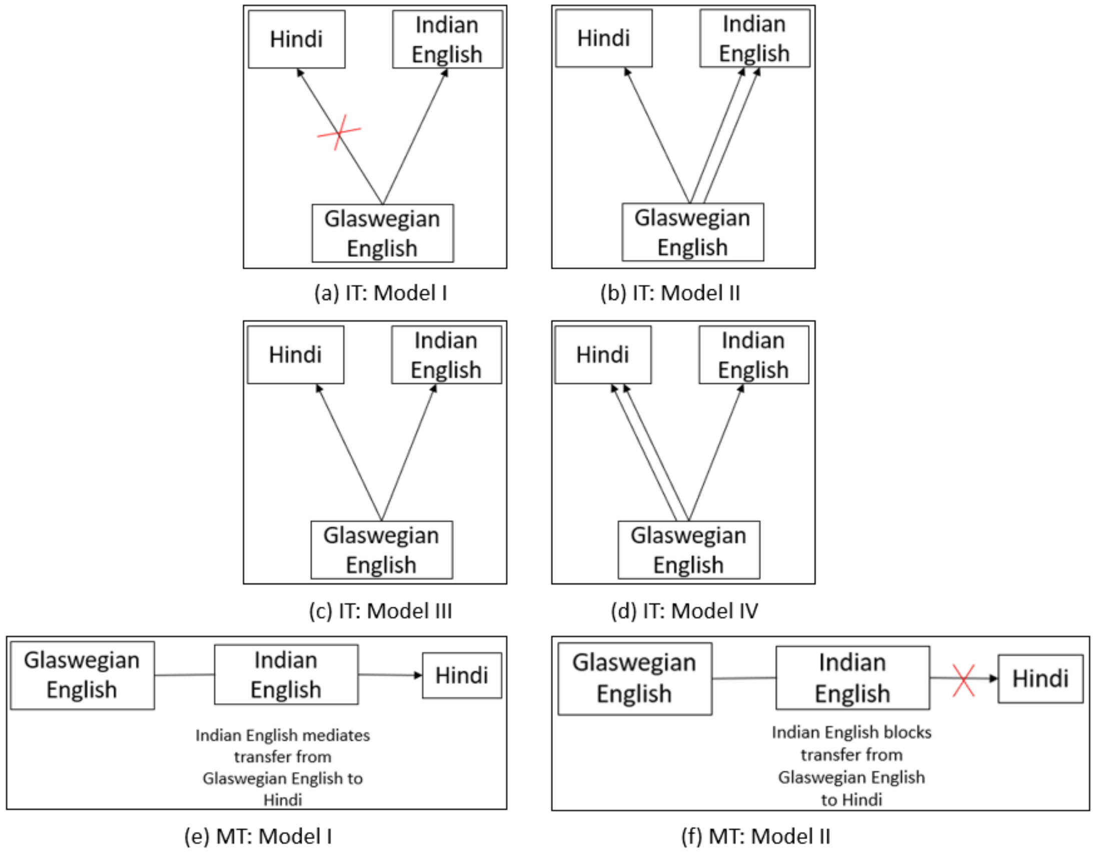


Figure 5.1: The two proposed interaction models of backward transfer of Glaswegian English on Hindi and Indian English. 'IT' stands for Independent Transfer (models) and 'MT' stands for Mediated Transfer (models)

To begin with, the findings from the speech production task (Chapter 3) indicated backward transfer from Glaswegian English to both Hindi and Indian English. Based on this, at the very outset, we can eliminate the Independent Transfer Model I (Figure 5.1(a)) and Mediated Transfer Model II (Figure 5.1(f)), both of which argue for the absence of backward transfer to Hindi.

Moving forward, on the one hand, the basic premise of Independent Transfer models was that Hindi and Indian English are affected by Glaswegian English independently, in that Hindi and Indian English will exhibit transfer in different categories and corresponding features. On the other hand, the basic premise of Mediated Transfer models was that Indian English mediates transfer from Glaswegian English to Hindi because it is the more linguistically proximate L1 to Glaswegian English. The evidence for this model would be seen in both Indian English and Hindi undergoing transfer from Glaswegian English to the same categories and same corresponding features, but Hindi receiving quantitatively less transfer than Indian English.

With reference to Independent Transfer models, there is evidence suggesting that different categories and corresponding features across Hindi and Indian English were differentially affected by Glaswegian English. For example, in the present study, (1) /b/ for VOT in Hindi underwent assimilation, but remained unchanged in English, (2) /g/ for VOT and VDC in Hindi underwent dissimilation but remained unchanged in English. Support for this can also be found in Shaktawat (2018), which showed that (1) /b/ and /g/ for RBI in Hindi underwent assimilation, but remained unchanged in English, (2) GOOSE vowel for F1 underwent dissimilation in Hindi, but remained unchanged in English. Thus, these findings seem to support the Independent Transfer models.

However, what is interesting is that, simultaneously, there is also support for the Mediated Transfer models, as there are also instances in the present study where both Hindi and Indian English underwent transfer for the same category and corresponding features, and Hindi received less transfer quantitatively than Indian English. For instance, both IE and Hindi /t/ and /d/ underwent assimilation for VOT, and Hindi showed quantitatively less transfer than Indian English.

So, the picture of interaction between these linguistic varieties appears to be that of some sort of independent yet mediated transfer. To examine it in more detail, it might help to observe the cases of assimilation and dissimilation separately to see whether independence or mediation of transfer is modulated by the type of transfer process or outcome, that is, assimilation or dissimilation.

5.3.2.1 The Assimilation Situation

To begin with, I make two arguments, which are each followed up right after by presence or absence of evidence for each argument.

Argument 1: If there are cases of assimilation where for a given category, the Hindi counterpart has undergone assimilation without the Indian English counterpart, then it would support independent assimilation to Hindi.

Evidence for Argument 1: This is supported. In the present study, /b/ VOT in Hindi underwent assimilation without the English counterpart. In Shaktawat (2018a), /b/ and /g/ RBI in Hindi underwent assimilation without the English counterpart.

Argument 2: If there are cases of assimilation where for a given category, the Indian English counterpart has undergone assimilation without the Hindi counterpart, then it would support independent assimilation to English, and no mediation of assimilation to Hindi.

Evidence for Argument 2: This is not supported. There are no instances where for a given category, the English counterpart has undergone assimilation, but the Hindi category has remained unchanged. All cases of assimilation in English are accompanied with assimilation in the Hindi counterpart. More importantly in case of VOT in /t/ and /d/, English counterpart showed higher assimilation than the Hindi counterpart, whereas for RBI in /g/, both language counterparts showed equal assimilation.

In conclusion, it seems that if there is assimilation in Indian English for a given category and corresponding feature, it will also be found in the Hindi counterpart (and quantitatively either less or equal assimilation). However, the reverse is not true, that is, assimilation in the Hindi counterpart is not always accompanied by assimilation in the Indian English counterpart.

It is tempting to speculate that when both Indian English and Hindi categories are perceived as perceptually similar enough to Glaswegian English for assimilation (as in the cases of VOT in /t/ and /d/, and RBI in /g/), then transfer to Hindi is mediated via Indian English. When only the Hindi counterpart is seen as perceptually similar enough to Glaswegian English for assimilation, then transfer to it is independent and not via the Indian English counterpart (which may be seen as either too identical or dissimilar for transfer to take place). Unfortunately, as discussed in the previous sections, the results from the XAB and speech production tasks do not align to offer any support to these speculations.

To sum up, assimilation to Hindi emerges as both independent and mediated; assimilation to English is only independent.

5.3.2.2 The Dissimilation Situation

Again, to begin with, I make two arguments, which are each followed up right after by presence or absence of evidence for support for each argument.

Argument 1: If there are cases of dissimilation where for a given category, the Hindi counterpart has undergone dissimilation without the Indian English counterpart, then it would support independent dissimilation to Hindi.

Evidence for Argument 1: This is supported. For VOT and VDC in /g/, the Hindi counterpart underwent dissimilation, whereas the Indian English counterparts remained unchanged. This indicates independent dissimilation to Hindi.

Argument 2: If there are cases of dissimilation where for a given category, the Indian English counterpart has undergone dissimilation without the Hindi counterpart, then it would support independent dissimilation to English, and no mediation of dissimilation to Hindi.

Evidence for Argument 2: This is not supported. There are no instances where the Indian English counterpart has undergone dissimilation without the Hindi counterpart. The only case of dissimilation in the Indian English counterpart was for /l/, where the Hindi counterpart showed higher dissimilation than the English counterpart.

Based on the evidence for argument 2, it seems that if there is dissimilation in a Hindi counterpart, it can possibly (not necessarily) be found in the Indian English counterpart as well. This suggests independent dissimilation to Hindi, which may or may not be mediated via Hindi to

Indian English. It is not clear why dissimilation in VDC and VOT in Hindi /g/ was not mediated via Hindi to the IE counterpart. Two reasons are proposed for this. The first reason is based on the SLM and SLM-r's concept of perceived cross-linguistic similarity between Indian English and Glaswegian English categories, depending upon which, it is possible that the system did not see a need for dissimilation in the Indian English category. The other reason argues for a sequential nature of mediated transfer. It is possible that because of this sequential nature of mediation, the Indian English counterparts may not have *yet* shown transfer at this point of data collection, but will be affected eventually at some point now that the respective Hindi counterpart, which is the mediator of this effect, has undergone dissimilation. However, offering anything less speculative about this would require a longitudinal study which follows the development of these categories across time.

So, it appears that there is, first, independent dissimilation to Hindi, but and second, no independent dissimilation to Indian English, instead a mediation of dissimilation to Indian English through Hindi.

5.3.2.3 Assimilation and Dissimilation taken together

So then, the picture of interaction between Glaswegian English, Hindi and Indian English that has emerged with reference to backward transfer indicates that the effect of Glaswegian English on Hindi and Indian English is both independent and mediated depending upon the type of transfer outcome. The evidence suggests that there is independent assimilation in Hindi and Indian English, mediation of assimilation to Hindi via Indian English, independent dissimilation to Hindi, and mediation of dissimilation to Indian English via Hindi. None of the proposed independent and mediated transfer models in Figure 5.1 capture all these interactions of assimilation and dissimilation entirely. Therefore, I propose the seminal *Proximity Modulated Transfer Hypothesis* of backward transfer, which tries to capture all these independent and mediated interactions and is depicted in Figure 5.2.

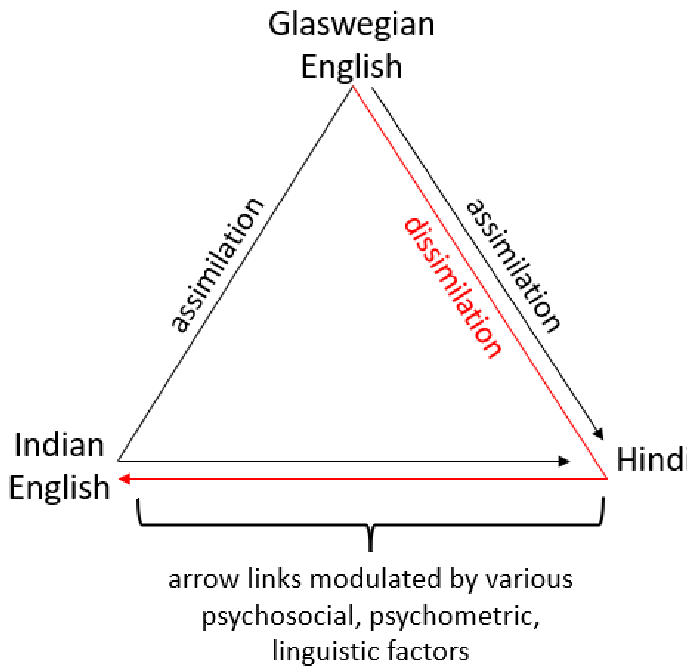


Figure 5.2: The proposed *Proximity Modulated Transfer Hypothesis* of phonetic backward transfer of Glaswegian English on Indian English and Hindi

Furthermore, based on the results of Chapter 4, I argue that these assimilatory and dissimilatory influences from Glaswegian English to the native languages are modulated by many cognitive, psycholinguistic and sociolinguistic factors such as inhibitory skills, language switching ability, language use and dominance, the amount of contact with various speaker communities (such as the Glaswegians, Indians back in India or the long-term Glaswasian community) and indirectly, their respective languages, as well as the perception of self. These findings support the perception of bilinguals not only as individuals with multiple languages in their mind, but also as social beings, who are part of a bigger community with which they are in constant interaction. This interaction shapes their linguistic motivations through the various factors that are themselves in a state of flux, and interacting amongst themselves, thereby leading to dynamic linguistic outcomes.

5.3.3 Implications of the effect of LoR for the nature of adult bilingual-bidialectal system

Most studies of the present kind, especially those that are interested in the effects of age of acquisition of L2, are aimed at examining the differences between children and adult migrants, specifically with reference to investigating maturational constraints and related consequences (Ahn et al., 2017; Barlow, 2014; Flege, 1991, 2003; Flege, MacKay, & Meador, 1999; Gallo et al., 2021; Guion, 2003, 2005; Mackay & Flege, 2004; Mackay et al., 2006; McCarthy et al., 2013). However, the present study focused only on adult bilinguals to arrive at a better understanding of how adult bilingual-bidialectal systems develop over time after complete L1 acquisition in relation to their life in the host community where they are in constant contact with the host language and community. An interesting finding with respect to this focus comes from the reported effect of LoR which was that Indian English and Hindi categories went from being more Glaswegian-like to more (sometimes exaggeratedly) Indian-like (and/or possibly Glaswasian-like; Alam, 2006, 2015; Alam & Stuart-Smith, 2014; Lambert, 2004; Lambert et al., 2007; Stuart-Smith et al., 2011) as the LoR increased. So, higher LoR was associated with a reduction in assimilation to Glaswegian English.

Similar to the effect of LoR in the present study, Chang (2013) reported that in more experienced English-Korean learners, the transfer effects were reduced compared to inexperienced learners. Additionally, Chamorro, Sorace, and Patrick (2016) found that when L1 Spanish speakers living in the UK were exposed exclusively to L1 Spanish for a certain duration, the attrition effects on their L1 diminished, but did not entirely reverse. However, the source of reduced backward transfer in these two studies and the present study are different. Chang's (2013) source was higher experience with L2, that is, the more familiar the L2 learner is with the L2, the reduced the backward transfer effects and vice versa. In Chamorro et al. (2016), however, the source was exclusive contact with the L1. In the present study, the source was longer duration of residence in the host city. However, while LoR represents a period of time spent in the host country, it does not specify what kind of linguistic events or changes occurred during that interval of time. That is, it could reflect changes in L1 or L2 dominance, use or contact, or changes in identity or motivations, or some or all of these. The predictors in the present study that were related to a reduction in assimilation to Glaswegian English were higher Indian Contact, Indian Identity, Dominance Hindi. So, it is possible that higher LoR accounts for some or all of these. Like Chang (2013), it could also be indicative of higher familiarisation with Glaswegian English.

Some previous research argues that these reduced backward transfer effects due to increasing LoR may be related to psychosocial motivations such as seemingly less of a need to accommodate to the host variety, regained confidence in the migrants' L1 or D1 (Sharma & Sankaran, 2011), or increasingly critical approach to the host community, culture and language (Prescher, 2007). As argued by Sharma and Sankaran (2011), longer LoR in Glasgow may represent integration with the the host Scottish society and, more importantly, also with the wider long-term Glaswasian community (Maan, 1992), who are known to exhibit a hybrid Glaswasian accent (Alam, 2006, 2015; Alam & Stuart-Smith, 2014; Lambert, 2004; Lambert et al., 2007; Stuart-Smith et al., 2011) with features which are intermediary between Glaswegian and Indian values. For instance, syllable-initial Glaswasian /l/ was found to be relatively clearer than Glaswegian English /l/, but relatively darker than that of the Asian control group (Stuart-Smith et al., 2011). So, in line with Sharma and Sankaran (2011), the effect of LoR could indicate backward transfer towards Glaswegian English from 9 to 12 years of LoR and backward transfer towards

Glaswasian English of the wider Glaswasian community after 12+ years.

Additionally, in the present study, LoR also mainly interacted with inhibitory skills (ISSH, ISSE). Lev-Ari and Peperkamp (2013) argue that the importance of inhibitory skills in controlling transfer effects increases as the L2 exposure increases by way of longer LoR. At the same time, one must acknowledge that the situation of language contact in the present study and Lev-Ari and Peperkamp (2013) are different in terms of the position of the experimental group and their native languages in Glasgow and contact with multiple linguistic varieties. In any case, the lack of interactions between social predictors and LoR in the present study indicated that the effect of social motivations such as identity or contact did not grow stronger as LoR increased – so inhibitory skills probably have a bigger role in relation to the LoR effects that were observed in this study.

However, in making this argument about the effect of LoR in the present study, I maintain the distinction between performance and competence, such that performance in a language does not reflect the competence in it. So, regardless of whether the experimental group lost and relearnt the L1 characteristics or merely reverted to the L1 settings that were inaccessible due to certain influences or changed the direction of assimilation to the long-term Glaswasian community, this effect of LoR indicates that backward transfer effects in L1 performance remain reversible and dynamic in adult speakers, who have been very much neglected in examination of language development in comparison to younger speakers (de Bot, 2007). In this light, it appears that the adult bilingual-bidialectal system is elastic, capable of springing back to the initial state after the initial introduction of a new set of influences. However, it remains unclear whether whether it can go all the way back, as if the new linguistic experience/knowledge was never acquired.

This finding offers an important implication about the nature of adult bilingual–bidialectal systems – that they are dynamic and constantly changing in face of various influences. This supports a dynamic view of cross-linguistic transfer and the state of L1 as proposed by the Dynamic Model of Multilingualism (Herdina & Ulrike, 2002) and the Dynamic Systems Theory (de Bot, 2007). These models argue that language system constitutes of interconnected subsystems that are in a constant state of flux due to the effect of various internal and external factors acting upon them. These factors are themselves subject to changes because as individuals, we undergo cognitive, perceptual and motor, social, personality developments and changes in our lifespan (de Bot, 2007:54). Not only this, but these factors also interact with each other and changes in any given factor also affect its interaction with another factor, and in turn, the cumulative effect that their interaction has on cross-linguistic transfer processes. An individual may over time develop in their language usage and dominance, or self-identity, political ideologies, changes may also be seen in their social networks and contact with various communities. This dynamic nature of variables which "mutually affect each other's changes over time" (Herdina & Ulrike, 2002:78) lead to complex and dynamic cross-linguistic transfer processes.

5.4 Limitations and Future Directions

The methodology and findings from the present study are not without limitations, which paves way for more careful considerations and directions in related future research.

The first concern is not as much a limitation, as it is an opportunity for proposing and applying more refined research techniques in bilingual populations such as Indians. This is in relation to India being a land of diverse cultures and languages. Every Indian state and culture are represented by their own regional and cultural language/s. Therefore, in addition to speaking Indian English and Hindi, the Indians in this study (Glaswasians and control Indians) mostly also speak one or more regional languages. This was also discussed earlier in §3.2.1.2.2 in Chapter 3. So then, as a result, the Indian speakers in this study are characterised by a diversity in the languages that they speak in addition to English and Hindi depending upon where they reside or migrated from in India.

The need to control for variation from this third regional language was sighted at an earlier stage of this study. Accordingly, the initial plan was to match each Glaswasian participant with an Indian control of the same age, gender and regional language profile, and a Glaswegian control of the same age and gender. However, in sight of the added challenges of data collection during the COVID-19 pandemic, this bit of sophistication to data collection was dropped. Instead, an easier strategy was adopted from Shaktawat (2018). That is, only those Glaswasians and Indian participants were recruited for this study that spoke Indo-Aryan languages, so as to minimise the unwanted effects from the more dissimilar languages such as the Dravidian languages spoken in South India.

Future research can be more careful about this situation of linguistic diversity in Indians and adopt careful means to control for the related undesired effects. The present study achieved this by careful selection of phone categories and features that were least likely to be affected by this Indic multilingualism. It might also be worth examining the variation in backward transfer effects in Glaswasians as a function of the regional languages that they speak. However, even then, accounting for this linguistic situation can get messy because ofttimes Indians may speak multiple regional languages. In such a situation, finding a Glaswasian-Indian pair who have the same age, gender and linguistic profile can get tricky and suffer from, for example, constraints related to time.

This study could also benefit from recruiting more Glaswasians, especially in relation to the number of predictors that were investigated on account of possibly modulating backward transfer effects. As a way around this situation of 'too many predictors, too little data', multiple statistical models were created for each phone category and each corresponding feature. But it would have been ideal to have more participants in general so as to not limit the statistical power of the models.

Another aspect of the present study, which may be seen not as a limitation, but avenue for future research, is the nature of development of Indian English and Hindi sound categories in Indians (in India). This was discussed in §1.2.1.2.3 in Chapter 1 with reference to Laeufer's (1996) typology of bilingual systems. Laeufer argued that depending upon the nature and age of acquisition of languages, bilinguals can develop various types of bilingual systems such as co-existent system, merged systems and super sub-ordinate systems. So then, these Indians (in India), who exhibit much variation in how and when they acquired their Hindi and Indian English, could exhibit different kinds of bilingual systems, with different patterns of interactions between their Hindi and Indian-English categories. This would affect the state that these native categories and corresponding phonetic features are in (dissimilated, or completely or partially merged) when they first come into contact with a new linguistic variety, here, Glaswegian English. Investigating this will be helpful in further understanding how various kinds of bilingual systems develop over time, and also after coming in contact with a new language, and the type of predictors that affect such developments.

Some limitations can be pointed out in relation to the methodological constraints of the speech production and XAB similarity judgement tasks. For this study, all data (except the stimuli for the XAB task) was collected remotely, including the audio recordings from the experimental and control groups for the speech production task. While the audio data was not compressed by LaBB-CAT, it was still vulnerable to variability caused by the variety of recording equipment used across participants and their placement. This is discussed in more detail in §3.2.4 in Chapter 3. Therefore, it is possible that this affected the quality of data, especially formant values in /l/ and GOOSE vowel. Moreover, in XAB similarity judgement task, the stimuli were collected from only one speaker for each language. This is especially problematic for Hindi and Indian English stimuli because in both these varieties, substantial variation exists between speakers. Currently, no research exists on the perception of variation in Indian English and Hindi by native speakers to argue about how using stimuli from only one speaker can skew the results. This highlights not only the need for more research on Indian English and Hindi, but also of careful consideration about the stimuli that is used for these languages in future perceptual experiments.

Now, looking ahead in terms of future research, more evidence is needed to support or negate the mechanisms of interaction identified and proposed in this situation of simultaneous bilingual and bidialectal contact. This evidence can come from different communities that are native speakers of two L1s (where one of them is English) and are in contact with a new variety of English post migration. Furthermore, examination of diverse language pairs would also contribute to understanding the role that various linguistic factors may play in this interaction. Additionally, as has been highlighted multiple times in previous research, the research in this field will benefit strongly from longitudinal studies. In context of the present study, a longitudinal study will aid in understanding the development of categories and corresponding features over time. Previous research argues for a dynamic nature of L1 (de Bot, 2007; E. de Leeuw, 2009; E. de

Leeuw, Mennen, & Scobbie, 2013; E. de Leeuw, Opitz, & Lubińska, 2013; Köpke, 2007; Mayr et al., 2020), to which the present study adds some evidence, especially in light of the effect of LoR. However, it still remains unclear as to how categories and features develop over time. That is, if the categories that did not change on first contact remain in that state continually or undergo transfer at some point due to changes in certain factors over time, or if strongly assimilated categories can still revert to being native-like. This will also allow an insight into selectivity in L1 phonetic transfer.

Examining this phenomenon from the perspective of individual variation will also be very helpful in studying whether individuals employ a specific transfer strategy throughout the system to obtain a certain transfer outcome or if it is strictly a function of linguistic factors such as perceived cross-linguistic similarity which determine the transfer outcomes. So, while transfer and the strategies of assimilation and dissimilation were not generalised across categories and corresponding features, is it the case that individuals apply and generalise a certain type of transfer process throughout their system depending upon the circumstances and nature of their bilingualism?

Finally and importantly, what the present study did not do, given the number of predictors, was to examine separately the interaction of the experimental group with the long-term Glaswasian community who have been settled in Glasgow since 1950s and 1960s (Maan, 1992) and are known to exhibit a hybrid Glaswasian accent with values of features intermediate to the Glaswegian and respective Asian control groups (Alam & Stuart-Smith, 2014; Lambert, 2004; Stuart-Smith et al., 2011). It is possible that some of the results found in Chapter 3 and 4 are due to this interaction with this long-term Glaswasian community instead of interaction only with the Glaswegian community. In the present study, Indian Contact represented contact with Indians in India as well as with the wider long-term Glaswasian community in Glasgow. Future research can apply this distinction in this predictor (Indian Contact) to examine how contact with Indians in India differed from contact with the long-term Glaswasian community in affecting backward transfer effects. This would also bear implications for the proposed Proximity Modulated Transfer Hypothesis of backward transfer (Figure 5.2) in accounting for the effect of Glaswasian English (in addition to Glaswegian English) on backward transfer to Hindi and Indian English of the first generation Indian immigrants in Glasgow. However, this is an important step to understanding backward transfer in an ethnolinguistic minority such as this, which in reality, is in interaction with not just one, but two host varieties (Glaswegian English and Glaswasian English).

5.5 Significance and Conclusion

Much previous research has found evidence of backward transfer in bilingual interactions and of L1 phonetic accommodation in short- as well as long-term bidialectal interactions. However, this thesis presents one of the few examinations of phonetic backward transfer in a situation of language contact that is simultaneously both bilingual and bidialectal in the sense that the host dominant L2 Glaswegian English here is both a new language with respect to the L1 Hindi, and a new dialect with respect to the L1 Indian English.

By way of this investigation, this study provided evidence of the phonetic backward transfer of Glaswegian English on Indian English as well as Hindi - a combination of linguistic varieties that have never been examined before by either transfer or accommodation research. More importantly, it offered a comparison of phonetic backward transfer across languages and dialects, and argues that backward transfer effects may be modulated by the degree of structural similarity between the involved linguistic varieties. It also adds to the evidence of the role of various cognitive, psycholinguistic and sociolinguistic factors in affecting phonetic backward transfer effects.

Based on the findings of assimilation and dissimilation, I have proposed the Proximity Modulated Transfer Hypothesis of backward transfer to account for the interactions in simultaneously bilingual and bidialectal interactions in an adult speaker group. These mechanisms, may, in fact, also be involved in creation of hybrid accents as found in second and third generation heritage speakers (Kirkham, 2011; Wormald, 2015). Additionally, while much research has focused on understanding how transfer processes differ across children and adults (Barlow, 2014; Flege, 1991, 2003; Flege, MacKay, & Meador, 1999; Guion, 2003, 2005; McCarthy et al., 2013), this work gives an insight into backward transfer effects in adults as they continue living in the host country, and documents the dynamic nature of their L1. All in all, this study has found transfer to be a process that is simultaneously complex yet sophisticated, and dynamic, subject to the effects of various internal or external predictors, and the interaction between them.

Apart from phonetic backward transfer in general, all the above findings also have important implications for a specific kind of situation of language contact that has, over the years, become increasingly widespread but remains comparatively understudied. By this, I refer to the role of English as a medium of instruction along with the native language in countries, which still are or historically were not, dominantly English-speaking. In fact, in many countries with colonial history, such as India, English is recognized as one of the official languages. Such countries also offer English as a medium of education, which is increasingly being favored over an education in the respective native/regional Indian languages because of the access English provides to higher international education and better economic prospects (Annamalai, 2003).

As a result, such individuals, for whom English is the medium of education from an earlier age or is the dominantly used language at home, grow up to be simultaneously or sequentially bilingual in English and the native Indian language/s. Thus, when these individuals migrate to a dominantly English-speaking country, their own dialect of English and the native language of the country of origin interact with this host dominant variety of English, leading to a situation of simultaneous bilingual and bidialectal interaction. This is the reality of immigrants from several such countries of origin, which remains rather understudied in the area of cross-linguistic influence. The present study documents one such instance in a first-generation ethnolinguistic minority in the UK, and similar studies across other such first-generation minorities will allow to paint a more comprehensive picture of this kind of linguistic interaction and its consequences on their native languages and identity.

Appendix A

Participant Information Sheet

University of Glasgow

College of Arts
Research Ethics

Participant information sheet

Introduction

My name is Divyanshi Shaktawat and I am a PhD student at the University of Glasgow in the department of English Language and Linguistics. These experiments will be carried out as part of my PhD dissertation.

What is the purpose of this study?

This study aims to explore how languages vary when they come in contact with other languages, societies and cultures.

How will the study be conducted?

You will participate in a few tasks: a perception task, in which you will respond to similar sounds as per instructions; a production task, in which you will be recorded while reading a wordlist; a questionnaire related to your language use; and other tasks to measure your general everyday skills. All these tasks will take place on online platforms and hosted on University servers. Therefore, your participation and data will be secure and remain confidential.

Do I have to take part?

Participation is entirely voluntary. You may drop out of the project at any time and there will be no adverse consequences if you wish to do so.

What if I have a problem?

Any complaint or concern about any aspect of this study; please contact my supervisor, Dr Clara Cohen.

Will my taking part in the study be kept confidential?

All data will be anonymised so that anyone reading the dissertation will not know who has contributed to it. Nobody other than my supervisors and I will have access to your data and all data will be stored securely on University servers.

How can I access information relating to me or complain if I suspect information has been misused/ used for purposes other than I agreed to?

University of Glasgow

College of Arts
Research Ethics

If you have any concerns regarding the ethical conduct of the study or the processing of your data, you can contact the researcher or their supervisor in the first instance if you have any concerns. If you are not comfortable doing this, or if you have tried but don't get a response or if the person in question appears to have left the University, you can contact the College of Arts Ethics Officer (email: arts-ethics@glasgow.ac.uk).

Where there appear to have been problems, you can – and indeed may be advised to – submit an 'access request' or an objection to the use of data. As part of the University's obligations under General Data Protection Regulation (GDPR), participants retain the rights to **access** and **objection** with regard to the use of non-anonymised data for research purposes.

1. Access requests and objections can be submitted via the UofG online proforma accessible at: https://www.gla.ac.uk/myglasgow/dpfoioffice/gdpr/gdprrequests/#.
2. Access requests and objection are formal procedures not because we mean to intimidate participants into not raising issues, but rather because the University is legally required to respond and address concerns. The system provides a clear point of contact, appropriate support and a clear set of responsibilities.

Anyone who submits a request will need to provide proof of their identity. Again, this is not to deter inquiries, but rather reflects the University's duty to guard against fraudulent approaches that might result in data breaches.

Who has reviewed this project?

The study has been reviewed and approved by the University of Glasgow, College of Arts Ethics Committee.

What happens when the research study stops?

The data will be analysed and the results will be written up as part of my PhD dissertation. These results may also be used in conference presentations and published in academic papers in the future.

Any questions? Please contact:

Principal Investigator:
Divyanshi Shaktawat
Department of English Language and Linguistics
University of Glasgow
🖂:

Supervisor:
Dr Clara Cohen
Department of English Language and Linguistics
University of Glasgow
🖂:

Appendix B

Consent Form

University of Glasgow

College of Arts
Research Ethics

CONSENT TO PARTICIPATE/ AGREEMENT TO THE USE OF DATA
Online survey

I understand that Divyanshi Shaktawat is collecting data on online platforms in the form of recordings, perception, questionnaire and other responses for use in an academic research project at the University of Glasgow.

I consent to participate in the project activities on the following terms:

1. I have the choice to omit any question or task.
2. I can decline to submit a response once I have completed the activity.

I agree to the processing of data for this project on the following terms:

1. Use and storage of research data in the University of Glasgow reflects the institution's educational/ research mission and its legal responsibilities in relation to both information security and scrutiny of researcher conduct.
    a. As part of this, under EU legislation (General Data Protection Regulation [GDPR]), I understand and agree that the 'lawful basis' for the processing of personal data is that the project constitutes 'a task in the public interest', and that any processing of special category data is 'necessary for archiving purposes in the public interest, or scientific and historical research'.
    b. I understand that I have the right to **access** data relating to me or that I have provided and to **object** where I have reason to believe it has been misused or used for purposes other than those stated.
    c. The third-party software packages and platforms used for data collection as part of the project are GDPR-compliant.
    d. Project materials in both physical and electronic form will be treated as confidential and kept in secure storage (locked physical storage; appropriately encrypted, password-protected devices and University user accounts) at all times.
2. All names and other material likely to identify individuals will be redacted. This process will be completed by September 2022. After this, the material will be deemed to have been anonymised.
3. My participation in this experiment is voluntary, so I may opt out at any stage before the data has been anonymised. I understand that once the data has been anonymised, in accordance with EU legislation (General Data Protection Regulation [GDPR]), it may be used for the purposes of the project without further reference back to me. However, I understand that I may request access or raise an objection if I have legitimate grounds for concern that I remain directly identifiable from it or that it has been used for purposes other than those stated.

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4. My data will only be listened to, and/or analysed using phonetic analysis, by the researcher and her supervisors.
5. The material may be used in future publications, both print and online.

ALL PARTICIPANTS:

☐ I consent to take part in the project
☐ I agree to the terms for data processing as outlined above.
☐ I confirm I have been given information on how to exercise my rights of access and objection.

In addition:

☐ I give my consent for the use of my recording for future linguistic research and teaching by bona fide academic students and researchers from the English Language and Linguistics at the University of Glasgow.

Name of Participant: ________________________________ Date: _________

Signature: ____

OR

Signed on behalf of the contributor (i.e. parent/guardian in case of a person under 18)

Name of Guardian: ___________________________________ Date: _________

Signature: ____

Researcher's name and email:	Divyanshi Shaktawat
Supervisor's name and email:	Dr Clara Cohen
Department address:	English Language and Linguistics 12 University Gardens University of Glasgow Glasgow G12 8QQ UK

Appendix C

English Stimuli: AXB Similarity Judgement Task

Say pa again
Say ba again
Say ta again
Say da again
Say ka again
Say ga again
Say la again
Say soop again
Say sup again
Say sha again
Say fa again
Say ra again
Say va again
Say sa again
Say wa again
Say za again

Say beap again
Say bip again
Say bawp again
Say bope again
Say vep again
Say vap again
Say vaap again

Appendix D

Hindi Stimuli: AXB Similarity Judgement Task

कहा पा आपने	/kəha: pa: a:pne/	कहा सूप आपने	/kəha: sup a:pne/
कहा फा आपने	/kəha: p^{h}a: a:pne/	कहा सुप आपने	/kəha: sʊp a:pne/
कहा बा आपने	/kəha: ba: a:pne/	कहा बीप आपने	/kəha: bi:p a:pne/
कहा भा आपने	/kəha: b^{h}a: a:pne/	कहा बिप आपने	/kəha: bip a:pne/
कहा टा आपने	/kəha: ʈa: a:pne/	कहा बोप आपने	/kəha: bop a:pne/
कहा ठा आपने	/kəha: ʈ^{h}a: a:pne/	कहा बौप आपने	/kəha: bɔp a:pne/
कहा ता आपने	/kəha: t̪a: a:pne/	कहा वेप आपने	/kəha: ʋep a:pne/
कहा था आपने	/kəha: t̪^{h}a: a:pne/	कहा वैप आपने	/kəha: ʋɛp a:pne/
कहा डा आपने	/kəha: ɖa: a:pne/	कहा वाप आपने	/kəha: ʋa:p a:pne/
कहा ढा आपने	/kəha: ɖ^{h}a: a:pne/	कहा फ़ा आपने	/kəha: fa: a:pne/
कहा दा आपने	/kəha: d̪a: a:pne/	कहा जा आपने	/kəha: dʒa: a:pne/
कहा धा आपने	/kəha: d̪^{h}a: a:pne/	कहा ज़ा आपने	/kəha: za: a:pne/
कहा का आपने	/kəha: ka: a:pne/	कहा सा आपने	/kəha: sa: a:pne/
कहा खा आपने	/kəha: k^{h}a: a:pne/	कहा शा आपने	/kəha: ʃa: a:pne/
कहा गा आपने	/kəha: ga: a:pne/	कहा वा आपने	/kəha: ʋa: a:pne/
कहा घा आपने	/kəha: g^{h}a: a:pne/	कहा रा आपने	/kəha: ra: a:pne/
कहा ला आपने	/kəha: la: a:pne/		

Appendix E

English Wordlist Stimuli: Speech Production Task

Say late again	Say date again	Say gate again
Say lame again	Say dame again	Say game again
Say lace again	Say days again	Say gape again
Say lake again	Say dane again	Say gaze again
Say lazy again	Say duck again	Say gum again
Say luck again	Say dumb again	Say gun again
Say love again	Say dug again	Say gut again
Say lust again	Say dub again	Say gulf again
Say lucky again	Say dull again	Say gust again
Say luggage again	Say does again	Say gull again

Say tail again	Say bait again	Say boot again
Say tame again	Say bail again	Say goose again
Say taste again	Say bake again	Say moon again
Say tape again	Say bane again	Say doom again
Say tug again	Say buck again	Say choose again
Say tuck again	Say bun again	Say suit again
Say tummy again	Say bug again	Say loop again
Say tub again	Say bud again	Say tool again
Say tough again	Say bus again	Say cool again
Say ton again	Say buzz again	Say food again

Appendix F

Hindi Wordlist Stimuli (With IPA Transcription): Speech Production Task

/kəha: lekʰən a:pne/	कहा लेखन आपने
/kəha: lep a:pne/	कहा लेप आपने
/kəha: leʈna: a:pne/	कहा लेटना आपने
/kəha: lekʰ a:pne/	कहा लेख आपने
/kəha: lepna: a:pne/	कहा लेपना आपने
/kəha: ləj a:pne/	कहा लय आपने
/kəha: ləgʰʊ a:pne/	कहा लघु आपने
/kəha: lət̪a: a:pne/	कहा लता आपने
/kəha: ləhər a:pne/	कहा लहर आपने
/kəha: ləga: a:pne/	कहा लगा आपने

/kəha: ʈeɖʰa: a:pne/	कहा टेढ़ा आपने
/kəha: ʈeka: a:pne/	कहा टेका आपने
/kəha: ʈekna: a:pne/	कहा टेकना आपने
/kəha: ʈesu: a:pne/	कहा टेसू आपने
/kəha: ʈər a:pne/	कहा टर आपने
/kəha: ʈəsər a:pne/	कहा टसर आपने
/kəha: ʈəpka: a:pne/	कहा टपका आपने
/kəha: ʈəka: a:pne/	कहा टका आपने
/kəha: ʈəhəl a:pne/	कहा टहल आपने
/kəha: ʈəkna: a:pne/	कहा टकना आपने

/kəha: ɖera: a:pne/	कहा डेरा आपने
/kəha: ɖeɖʰ: a:pne/	कहा डेढ़ आपने
/kəha: ɖeʧki a:pne/	कहा डेचकी आपने
/kəha: ɖel a:pne/	कहा डेल आपने
/kəha: ɖəs a:pne/	कहा डस आपने
/kəha: ɖəfli: a:pne/	कहा डफली आपने
/kəha: ɖəʈna: a:pne/	कहा डटा आपने
/kəha: ɖəmru: a:pne/	कहा डमरू आपने
/kəha: ɖər a:pne/	कहा डर आपने
/kəha: ɖəgər a:pne/	कहा डगर आपने

/kəha: bel a:pne/	कहा बेल अपने
/kəha: beʧ a:pne/	कहा बेच आपने
/kəha: beʈa: a:pne/	कहा बेटा आपने
/kəha: ber a:pne/	कहा बेर आपने
/kəha: bəl a:pne/	कहा बल आपने
/kəha: bət̪a: a:pne/	कहा बता आपने
/kəha: bəd̪ʰa: a:pne/	कहा बढ़ा आपने
/kəha: bəh a:pne/	कहा बह आपने
/kəha: bəʤa: a:pne/	कहा बजा आपने
/kəha: bəna: a:pne/	कहा बना आपने

/kəha: geru: a:pne/ कहा गेरू आपने
/kəha: geṯi: a:pne/ कहा गेती आपने
/kəha: gela: a:pne/ कहा गेला आपने
/kəha: gerʊa: a:pne/ कहा गेरुआ आपने
/kəha: gəʤ a:pne/ कहा गज आपने
/kəha: gəi: a:pne/ कहा गई आपने
/kəha: gərəm a:pne/ कहा गरम आपने
/kəha: gəṯ a:pne/ कहा गत आपने
/kəha: gəṯi a:pne/ कहा गति आपने
/kəha: gəja: a:pne/ कहा गया आपने

/kəha: bu:ṯa: a:pne/ कहा बूता आपने
/kəha: gʰu:s a:pne/ कहा घूस आपने
/kəha: mu:k a:pne/ कहा मूक आपने
/kəha: ɖu:ba: a:pne/ कहा डूबा आपने
/kəha: ʧu:ha: a:pne/ कहा चूहा आपने
/kəha: su:kʰa a:pne/ कहा सूखा आपने
/kəha: lu:ʈ a:pne/ कहा लूट आपने
/kəha: ʈu:ʈ a:pne/ कहा टूट आपने
/kəha: ku:ḏa: a:pne/ कहा कूदा आपने
/kəha: pʰu:l a:pne/ कहा फूल आपने

Appendix G

Questionnaire: For Indian Control Group

Questionnaire

Reminder: All data will remain strictly confidential.

Please give yourself a 4 digit identifying code ___________ (numbers only). You will be asked this code in the next task, so please remember it.

1. Age: _________________
2. Gender: _______________
3. Occupation: ____
4. Which part of India do you live in? _____________________________________
5. Have you ever been abroad, if so, for how long? ____________________________
6. Where are your parents from (roots)? ____________________________________
7. Which Indian Ethnic group do you belong to? (For example Bengali/Marathi/Punjabi/Gujarati, etc.) ____________________________________
8. What language/s do you speak? ____
9. Which is your native language? ____
10. At what age did you acquire Hindi? ______________________________________
11. At what age did you acquire English? ____________________________________
12. What is your level of formal instruction in Hindi? ____________________________

13. What is your level of formal instruction in English? ______________________________

14. Please list the number of years and months you spent in each language environment:

    Hindi: _____________

    English: ____________

15. Please check your highest education level:

    Less than High School ☐
    High School ☐
    Bachelors' ☐
    Masters' ☐
    Ph.D./M.D./J.D. ☐
    Professional Training ☐

Appendix H

Questionnaire: For Glaswegian Control Group

Questionnaire

Reminder: All data will remain strictly confidential.

Please give yourself a 4 digit identifying code ___________ (numbers only). You will be asked this code in the next task, so please remember it.

1. Age: _________________
2. Gender: ______________________
3. Occupation: ____
4. Have you always lived in Glasgow? _______________________________________
5. For how long have you lived in Glasgow? __________________________________
6. Have you lived abroad, if so, for how long? _________________________________
7. How many languages do you speak? _______________________________________
8. What is your level of formal instruction in English? __________________________
9. Please check your highest education level:

   Less than High School ☐
   High School ☐
   Bachelors' ☐
   Masters' ☐
   Ph.D./M.D./J.D. ☐
   Professional Training ☐
10. Where are your parents from? ____
11. What is the native language of your caregivers? (parents, guardians, etc)

    ____

Appendix I

Questionnaire: For Glaswasians

Questionnaire

**Kindly read the following and give your consent for participation in this experiment*

I give my consent to the use of data for this purpose on the understanding that:

- I have the choice to omit any question or task
- I can decline to submit a response once the activity is completed
- I have the right to access data relating to/provided by me and to object where I have reason to believe it has been misused
- All names and other material likely to identify individuals will be anonymised.
- My participation in this experiment is voluntary, I may opt out at any stage.
- The softwares used for data collection are GDPR compliant and will be hosted securely using University servers.
- The material will be treated as confidential and kept in secure storage at all times.
- My data will only be listened to, and/or analysed using phonetic analysis, by Divyanshi Shaktawat and her supervisors.
- The material may be used in future publications, both print and online.

☐ I give my consent to participate in this experiment

☐ I confirm I have been given information on how to exercise my rights of access and objection

☐ I agree to the terms for data processing as outlined above

☐ I give my consent for the use of my recording for future linguistic research and teaching by bona fide academic students and researchers from the English Language and Linguistics at the University of Glasgow

If you wish, you can also read the detailed consent form and participant information sheet at Participant Information Sheet and Consent Form

Please insert today's date:

May | 2023

Reminder: All data will remain strictly confidential.

Please give yourself a 4 digit identifying code (numbers and letters, please do not write 0000). You will be asked this code in the production task which you will access using the second link, so please remember it.

For the results of this study to be accurate, your data will be compared with someone of the same age, gender and place of origin in India as you. Therefore, it would be great if you could provide the email address of a relative/friend/acquaintance in India whom you have spent a lot of time with, lives in the same area in India as you used to, is of the same gender, matches your linguistic configuration, and would love to participate in this study! They will have to spend less than half an hour at this and their compensation will be £5. You can also provide them my email address (d.shaktawat.1@research.gla.ac.uk) or provide me with their contact information (like email address, etc.) below (all information will be confidential). It would be great if you could please tell them in advance that I will be contacting them for this study.

Contact Information:

Please provide your contact information (email address or phone number) which I can use to contact you in future in relation to this study (if needed).

A. Questions about yourself and your background.

1. Date of Birth

2. Gender

3. Occupation

4. For how long have you been living in Glasgow now? **(to be answered in years and months)**

5. Which part of India did you live in?

6. Have you lived abroad (apart from Glasgow & India), if so, for how long?

7. Which Indian Ethnic group do you belong to? (For example Bengali/Marathi/Punjabi/Gujarati, etc.)

8. Please check your highest education level:

Please Select...

9. Which statement is most true about the neighbourhood where you live?

- ◯ Almost all people are from a different ethnic group than mine.
- ◯ A majority of the people is from a different ethnic group than mine.
- ◯ There is about an equal mix of people from my ethnic group and other groups.
- ◯ A majority of the people is from my ethnic group.
- ◯ Almost all people are from my ethnic group.
- ◯ Other (please specify)

B. Questions about your linguistic knowledge and use.

1. Please list all the languages that you know in order of acquisition (native language first):

2. Please list all the languages that you know in order of dominance (that is, which language is currently used the most by you):

3. Please list all the languages that you know in order of proficiency (that is, which language are you the most proficient in):

4. Did you acquire Hindi before coming to Glasgow?

- Yes
- No

5. At what age did you acquire Hindi?

6. Did you acquire English before coming to Glasgow?

- Yes
- No

7. At what age did you acquire English?

8. What is your level of formal instruction in Hindi?

9. What is your level of formal instruction in English?

10. How often do you speak to your adult family members in

a. Hindi

Not at all	A little	Half of the time	A lot	All the time

b. English

Not at all	A little	Half of the time	A lot	All the time

11. How often do you speak with your children/ grandchildren/ other Indian children in

a. Hindi

Not at all	A little	Half of the time	A lot	All the time

b. English

12. How often do you speak with your close friends in

a. Hindi

Not at all	A little	Half of the time	A lot	All the time

b. English

Not at all	A little	Half of the time	A lot	All the time

13. How often in everyday communication do you speak in

a. Hindi

Not at all	A little	Half of the time	A lot	All the time

b. English

Not at all	A little	Half of the time	A lot	All the time

14. How often do you watch T.V. programmes, movies, shows in

a. Hindi

Not at all	A little	Half of the time	A lot	All the time

b. English

Not at all	A little	Half of the time	A lot	All the time

15. How often do you listen the radio in

a. Hindi

Not at all	A little	Half of the time	A lot	All the time

b. English?

Not at all	A little	Half of the time	A lot	All the time

16. How often do you use social media applications (Facebook, Instagram, etc.) in

a. Hindi

Not at all	A little	Half of the time	A lot	All the time

b. English

Not at all	A little	Half of the time	A lot	All the time

17. On a scale of 1-10, please rate your **level of proficiency in Hindi** at reading, speaking, writing and understanding (**0**-None, **1**-- low, **2**- very low, **3**-fair, **4**- slightly less than adequate, **5**- adequate, **6**- slightly less than adequate, **7**- good, **8**- very good, **9**- perfect, **10**-excellent)–

a. Reading

b. Speaking

c. Writing

d. Understanding

18. On a scale of 1-10, please rate your **level of proficiency in English** at reading, speaking, writing and understanding (**0**-None, **1**-- low, **2**- very low, **3**-fair, **4**- slightly less than adequate, **5**- adequate, **6**- slightly less than adequate, **7**- good, **8**- very good, **9**- perfect, **10**-excellent)–

a. Reading

b. Speaking

c. Writing

d. Understanding

C. Some questions about your family and friends.

1. How many of your family members (e.g. spouses, parents, brothers, sisters, sons, daughters) and relatives (aunts, uncles, cousins, etc.) live in Glasgow?

a. family members (e.g. spouses, parents, brothers, sisters, sons, daughters)

None	Only one	Some	Many	All of them

b. relatives (aunts, uncles, cousins, etc.)

None	Only one	Some	Many	All of them

2. How often do you meet your family members and relatives who live in Glasgow?

a. family members

Never	Every 6 months	Every 3 months	Once a month	Several times a month	We live together

b. relatives

Never	Every 6 months	Every 3 months	Once a month	Several times a month	We live together

3. How many close Indian, Glaswegian, non-Indian & non-Glaswegian friends do you have?

NOTE: In this study,

Indian= A person of Indian heritage (1st generation or later);

Glaswegian= A native of Glasgow/Scotland (native speaker of Glaswegian English); NOT of Indian heritage

Non Indian & Non Glaswegian= A person who is not from Glasgow/Scotland or India. May also include native/heritage Punjabi/Urdu/Sindhi speakers from Pakistan, Bengali speaker for Bangladesh, or heritage Punjabi speaker from Australia or other countries. **But please specify if they are from South Asian countries-- which country and what their native/heritage language is.**

a. Close Indian friends

None	Only one	A few	Some	Many

b. Close Glaswegian friends

None	Only one	A few	Some	Many

c. Close non-Indian & non-Glaswegian friends

None	Only one	Some	Many	All of them

If any of your close non Indian & non Glaswegian friends are from South Asian countries (native or heritage), please specify the country and their native/heritage language.

4. How often do you spend free time with your

a. close Indian friends

Never	Rarely	Sometimes	Often	Almost always

b. close Glaswegian friends

Never	Rarely	Sometimes	Often	Almost always

c. close non-Indian & non-Glaswegian friends

Never	Rarely	Sometimes	Often	Almost always

5. How many of your Indian, Glaswegian, non-Indian & non-Glaswegian friends have the same place of work/study as you?

a. Close Indian friends

None	Only one	A few	Some	Many

b. Close Glaswegian friends

None	Only one	A few	Some	Many

c. Close non-Indian & non-Glaswegian friends

None	Only one	A few	Some	Many

6. How many of your friends live in the same neighbourhood as you?

a. Close Indian friends

None	Only one	A few	Some	Many	All

b. Close Glaswegian friends

None	Only one	A few	Some	Many	All

c. Close non-Indian & non-Glaswegian friends

None	Only one	A few	Some	Many	All

7. How many of your friends attend or participate in the same cultural/ religious activities or customs?

a. Close Indian friends

None	Only one	A few	Some	Many	All

b. Close Glaswegian friends

None	Only one	A few	Some	Many	All

c. Close non-Indian & non-Glaswegian friends

None	Only one	A few	Some	Many	All

8. How often do you have contact with people in India?

Almost never	Rarely	Sometimes	Often	Almost always

9. How often do you visit India?

Never	Once every 8- 10 years	Once every 6- 8 years	Once every 2- 4 years	Every year

D. Some questions about your life and experiences in Glasgow and how you identify yourself:

1. About your experiences in Glasgow

1. I think that others behave in an unfair or negative way towards my ethn ic group.

Strongly disagree	Somewhat disagree	Not sure/ neutral	Somewhat agree	Strongly agree

2. I do not feel accepted in Glasgow.

Strongly disagree	Somewhat disagree	Not sure/ neutral	Somewhat agree	Strongly agree

3. I have never been unfairly treated in Glasgow.

Strongly disagree	Somewhat disagree	Not sure/ neutral	Somewhat agree	Strongly agree

4. I have always been made felt welcome in Glasgow.

Strongly disagree	Somewhat disagree	Not sure/ neutral	Somewhat agree	Strongly agree

2. How do you identify yourself?

a. I think of myself as an Indian.

Not at all	A little	Somewhat	Fairly well	Very well

b. I think of myself as Glaswegian/Scottish.

Not at all	A little	Somewhat	Fairly well	Very well

c. I think of myself as both Indian and Glaswegian/Scottish.

Not at all	A little	Somewhat	Fairly well	Very well

d. I think of myself as part of another ethnic group. If yes, please speci fy which ethnic group.

Not at all	A little	Somewhat	Fairly well	Very well

You can type any other comments that you may have in the space below:

Appendix J

Cued Recall Inhibition Task (English): 6 Counterbalanced Stimuli Lists

List 1

RP+		RP-		NRP
Occupation (5)	**Fruit (5)**	**Occupation (5)**	**Fruit (5)**	**Games (All 10)**
Nurse	Plum	Astronaut	Orange	Hockey, Karate, Baseball, Archery, Judo, Gymnastics, Sailing, Cycling, Rugby, Tennis
Soldier	Mango	Farmer	Blackberry	
Journalist	Apricot	Electrician	Coconut	
Pilot	Guava	Broker	Lime	
Waiter	Strawberry	Tailor	Tomato	

List 2

RP+		RP-		NRP
Occupation (5)	**Fruit (5)**	**Occupation (5)**	**Fruit (5)**	**Games (All 10)**
Astronaut	Orange	Nurse	Plum	Hockey, Karate, Baseball, Archery, Judo, Gymnastics, Sailing, Cycling, Rugby, Tennis
Farmer	Blackberry	Soldier	Mango	
Electrician	Coconut	Journalist	Apricot	
Broker	Lime	Pilot	Guava	
Tailor	Tomato	Waiter	Strawberry	

List 3

RP+		RP-		NRP
Games (5)	**Occupation (5)**	**Games (5)**	**Occupation (5)**	**Fruit (All 10)**
Hockey	Nurse	Gymnastics	Astronaut	Plum, Mango, Apricot, Guava, Strawberry, Orange, Blackberry, Lime, Coconut, Tomato
Karate	Soldier	Sailing	Farmer	
Baseball	Journalist	Cycling	Electrician	
Archery	Pilot	Rugby	Broker	
Judo	Waiter	Tennis	Tailor	

List 4

RP+		RP-		NRP
Games (5)	**Occupation (5)**	**Games (5)**	**Occupation (5)**	**Fruit (All 10)**
Gymnastics	Astronaut	Hockey	Nurse	Plum, Mango, Apricot, Guava, Strawberry, Orange, Blackberry, Lime, Coconut, Tomato
Sailing	Farmer	Karate	Soldier	
Cycling	Electrician	Baseball	Journalist	
Rugby	Broker	Archery	Pilot	
Tennis	Tailor	Judo	Waiter	

List 5

RP+		RP-		NRP
Games (5)	**Fruits (5)**	**Games (5)**	**Fruits (5)**	**Occupation (All 10)**
Hockey	Orange	Gymnastics	Plum	Nurse, Soldier, Journalist, Pilot, Waiter, Farmer, Astronaut, Electrician, Broker, Tailor
Karate	Blackberry	Sailing	Mango	
Baseball	Coconut	Cycling	Apricot	
Archery	Lime	Rugby	Guava	
Judo	Tomato	Tennis	Strawberry	

List 6

RP+		RP-		NRP
Games (5)	**Fruits (5)**	**Games (5)**	**Fruits (5)**	**Occupation (All 10)**
Gymnastics	Plum	Hockey	Orange	Nurse, Soldier, Journalist, Pilot, Waiter, Farmer, Astronaut, Electrician, Broker, Tailor
Sailing	Mango	Karate	Blackberry	
Cycling	Apricot	Baseball	Coconut	
Rugby	Guava	Archery	Lime	
Tennis	Strawberry	Judo	Tomato	

Appendix K

Cued Recall Inhibition Task (Hindi): 6 Counterbalanced Stimuli Lists

List 1

<table>
<tr><th colspan="2">RP+</th><th colspan="2">RP-</th><th>NRP</th></tr>
<tr><th>सब्जी
(Vegetable = 5)</th><th>जानवर
(Animal = 5)</th><th>सब्जी
(Vegetable = 5)</th><th>जानवर
(Animal = 5)</th><th>अंग (Body Parts)
(All 10)</th></tr>
<tr><td>गाजर
(Carrot)</td><td>भालू
(Bear)</td><td>अदरक
(Ginger)</td><td>हिरण
(Deer)</td><td rowspan="5">कान (ear), जीभ (tongue) बाल (hair), दांत (teeth) उंगली (finger), गाल (cheek) पेट (stomach), हाथ (hand) कमर (waist), गर्दन (neck)</td></tr>
<tr><td>मटर
(Peas)</td><td>मगरमच्छ
(Crocodile)</td><td>बैंगन
(Brinjal)</td><td>बकरी
(Goat)</td></tr>
<tr><td>ककड़ी
(Cucumber)</td><td>चींटी
(Ant)</td><td>मिर्ची
(Chilli)</td><td>शेर
(Tiger)</td></tr>
<tr><td>गोभी
(Cauliflower)</td><td>सूअर
(Pig)</td><td>लहसुन
(Garlic)</td><td>घोड़ा
(Horse)</td></tr>
<tr><td>पालक
(Spinach)</td><td>बंदर
(Monkey)</td><td>धनिया
(Coriander)</td><td>खरगोश
(Rabbit)</td></tr>
</table>

List 2

<table>
<tr><th colspan="2">RP+</th><th colspan="2">RP-</th><th>NRP</th></tr>
<tr><th>सब्जी
(Vegetable = 5)</th><th>जानवर
(Animal = 5)</th><th>सब्जी
(Vegetable = 5)</th><th>जानवर
(Animal = 5)</th><th>अंग (Body Parts)
(All 10)</th></tr>
<tr><td>अदरक
(Ginger)</td><td>हिरण
(Deer)</td><td>गाजर
(Carrot)</td><td>भालू
(Bear)</td><td rowspan="5">कान (ear), जीभ (tongue) बाल (hair), दांत (teeth) उंगली (finger), गाल (cheek) पेट (stomach), हाथ (hand) कमर (waist), गर्दन (neck)</td></tr>
<tr><td>बैंगन
(Brinjal)</td><td>बकरी
(Goat)</td><td>मटर
(Peas)</td><td>मगरमच्छ
(Crocodile)</td></tr>
<tr><td>मिर्ची
(Chilli)</td><td>शेर
(Tiger)</td><td>ककड़ी
(Cucumber)</td><td>चींटी
(Ant)</td></tr>
<tr><td>लहसुन
(Garlic)</td><td>घोड़ा
(Horse)</td><td>गोभी
(Cauliflower)</td><td>सूअर
(Pig)</td></tr>
<tr><td>धनिया
(Coriander)</td><td>खरगोश
(Rabbit)</td><td>पालक
(Spinach)</td><td>बंदर
(Monkey)</td></tr>
</table>

List 3

RP+		RP-		NRP
जानवर (Animal = 5)	**अंग (Body Parts = 5)**	**जानवर (Animal = 5)**	**अंग (Body Parts = 5)**	**सब्जी (Vegetable) (All 10)**
भालू (Bear)	कान (ear)	हिरण (Deer)	जीभ (tongue)	ककड़ी(Cucumber), अदरक (Ginger), बैंगन (Brinjal), मिर्ची (Chilli), लहसुन (Garlic), धनिया (Coriander), गाजर (Carrot), पालक (Spinach), गोभी (Cauliflower), मटर (Peas)
मगरमच्छ (Crocodile)	बाल (hair)	बकरी (Goat)	दांत (teeth)	
चींटी (Ant)	उंगली (finger)	शेर (Tiger)	गाल (cheek)	
सूअर (Pig)	पेट (stomach)	घोड़ा (Horse)	हाथ (hand)	
बंदर (Monkey)	कमर (waist)	खरगोश (Rabbit)	गर्दन (neck)	

List 4

RP+		RP-		NRP
जानवर (Animal = 5)	**अंग (Body Parts = 5)**	**जानवर (Animal = 5)**	**अंग (Body Parts = 5)**	**सब्जी (Vegetable) (All 10)**
हिरण (Deer)	जीभ (tongue)	भालू (Bear)	कान (ear)	ककड़ी(Cucumber), अदरक (Ginger), बैंगन (Brinjal), मिर्ची (Chilli), लहसुन (Garlic), धनिया (Coriander), गाजर (Carrot), पालक (Spinach), गोभी (Cauliflower), मटर (Peas)
बकरी (Goat)	दांत (teeth)	मगरमच्छ (Crocodile)	बाल (hair)	
शेर (Tiger)	गाल (cheek)	चींटी (Ant)	उंगली (finger)	
घोड़ा (Horse)	हाथ (hand)	सूअर (Pig)	पेट (stomach)	
खरगोश (Rabbit)	गर्दन (neck)	बंदर (Monkey)	कमर (waist)	

List 5

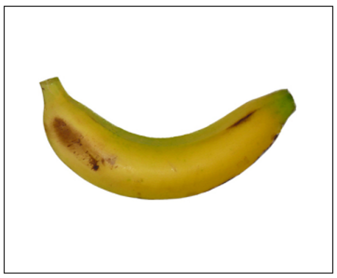
<table>
<tr><th colspan="2">RP+</th><th colspan="2">RP-</th><th>NRP</th></tr>
<tr><th>अंग
(Body Parts = 5)</th><th>सब्जी
(Vegetable = 5)</th><th>अंग
(Body Parts = 5)</th><th>सब्जी
(Vegetable = 5)</th><th>जानवर
(Animal)
(All 10)</th></tr>
<tr><td>कान
(ear)</td><td>गाजर
(Carrot)</td><td>जीभ
(tongue)</td><td>अदरक
(Ginger)</td><td rowspan="5">हिरण (Deer),
बकरी (Goat)
शेर (Tiger)
घोड़ा (Horse)
भालू (Bear)
खरगोश (Rabbit)
मगरमच्छ (Crocodile)
चींटी (Ant)
सूअर (Pig)
बंदर (Monkey)</td></tr>
<tr><td>बाल
(hair)</td><td>मटर
(Peas)</td><td>दांत
(teeth)</td><td>बैंगन
(Brinjal)</td></tr>
<tr><td>उंगली
(finger)</td><td>ककड़ी
(Cucumber)</td><td>गाल
(cheek)</td><td>मिर्ची
(Chilli)</td></tr>
<tr><td>पेट
(stomach)</td><td>गोभी
(Cauliflower)</td><td>हाथ
(hand)</td><td>लहसुन
(Garlic)</td></tr>
<tr><td>कमर
(waist)</td><td>पालक
(Spinach)</td><td>गर्दन
(neck)</td><td>धनिया
(Coriander)</td></tr>
</table>

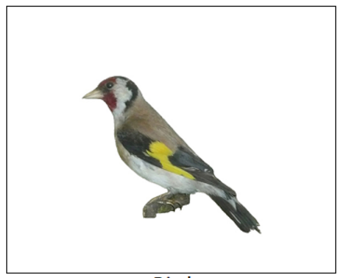
List 6

<table>
<tr><th colspan="2">RP+</th><th colspan="2">RP-</th><th>NRP</th></tr>
<tr><th>अंग
(Body Parts = 5)</th><th>सब्जी
(Vegetable = 5)</th><th>अंग
(Body Parts = 5)</th><th>सब्जी
(Vegetable = 5)</th><th>जानवर
(Animal)
(All 10)</th></tr>
<tr><td>जीभ
(tongue)</td><td>अदरक
(Ginger)</td><td>कान
(ear)</td><td>गाजर
(Carrot)</td><td rowspan="5">हिरण (Deer),
बकरी (Goat)
शेर (Tiger)
घोड़ा (Horse)
भालू (Bear)
खरगोश (Rabbit)
मगरमच्छ (Crocodile)
चींटी (Ant)
सूअर (Pig)
बंदर (Monkey)</td></tr>
<tr><td>दांत
(teeth)</td><td>बैंगन
(Brinjal)</td><td>बाल
(hair)</td><td>मटर
(Peas)</td></tr>
<tr><td>गाल
(cheek)</td><td>मिर्ची
(Chilli)</td><td>उंगली
(finger)</td><td>ककड़ी
(Cucumber)</td></tr>
<tr><td>हाथ
(hand)</td><td>लहसुन
(Garlic)</td><td>पेट
(stomach)</td><td>गोभी
(Cauliflower)</td></tr>
<tr><td>गर्दन
(neck)</td><td>धनिया
(Coriander)</td><td>कमर
(waist)</td><td>पालक
(Spinach)</td></tr>
</table>

Appendix L

Stimuli: Language Switching Task

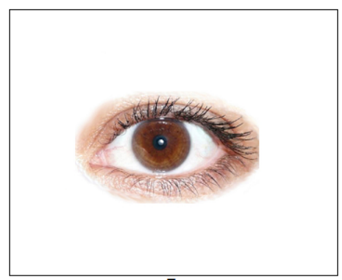

Banana


Bird


Cat

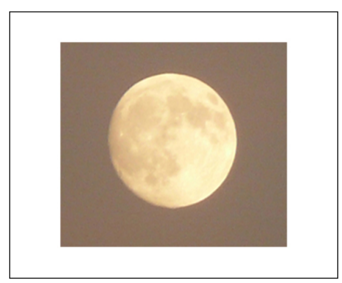

Chair


Cloud


Eye


Flower


Grapes


Moon


Ring


Spider


Tree

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