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Focus, Polarity and Framing Effects

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Submitted for the Degree of Ph.D. to the Higher Degree Committee

of the Faculty of Information and Mathematical Sciences, University of Glasgow.

October 2009

Abstract

The experiments reported in this thesis examine a reader's ability to draw inferences about a situation from desires, emotion words and logically equivalent frames. Previous research has provided evidence that listeners (or readers) are able to make inferences about current or presupposed states from the speaker's choice of frame. That is, in experiments involving pronominal reference readers can infer that an expectation has not been reached from the use of a negative natural language quantifier (NLQ) (Moxey, 2006). In experiments on framing effects a listener is able to infer a previous volume of liquid in a glass from the way the glass is now described (Sher & McKenzie, 2006). The experiments reported here aim to take a closer look at how these inferences are made during reading. In the first two experimental chapters character desire and emotion words were used to promote references to the complement set without use of a negative NLQ. Where sentences such as 'The waitress was annoyed by the number of customers who left her a tip' were presented to participants a preference for the complement set was found in sentence continuation and eye-tracking experiments, but not with event related potentials. These results suggest that with such complex inferences to be made participants are able to hold a number of referents in mind during reading. The remainder of the experiments examine reader's interpretation of the logically equivalent frames half full and half empty. In eye-tracking and written experiments it was found that when a character desires a vessel to be full a statement of half full does not fulfil this desire. In contrast when a character desires a vessel to be empty a statement of half empty is satisfactory. It is possible that these results are due to markedness of the terms, where empty is considered marked and full unmarked (Greenberg, 1966). The final two experiments look at two sets of logically equivalent frames in neutral contexts and find that participants find it easier to read about situations which are more familiar or likely to occur. The likelihood of a situation is in turn

related to polarity and frequency which is found to be connected to markedness. The thesis as a whole suggests that reader's inferences are affected by their pragmatic knowledge of situations. This is discussed in more detailed with respect to pronominal reference and logically equivalent frames.

Acknowledgements

With thanks to my Supervisor Dr Linda M Moxey who gave me the opportunity and support needed to think up and complete these exciting experiments.

I would also like to thank Dr Ian McKenzie for lending me his expertise in ERPs as well as plenty of his time and Christopher Hand for his eye-tracking wisdom.

Thank you to Ruth Filik, Heather Ferguson and Jessica Price for their assistance and advice with almost all things academic and to the Language Group at Glasgow University for helping develop my ideas and analyse my results and for listening tome talk about my research.

Thanks to Morna and Ian for all their encouragement over the years and for helping me move house more times than is generally considered sane. To Lucy Petro, fellow WIP, without whom I may never have realised that it is possible to be an academic AND to be fabulous. Finally thanks to my husband for hours of comic relief, for topping up my wine glass when I am in the bath and for not strangling me when I can't stop snoring. All these things have helped me in the timely completion of my research!

Declaration

I declare that this thesis is my own work carried out under the normal terms of supervision.

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Publications

Within this thesis Chapter 2 is under revision for publication.

Ingram, J. & Moxey, L. M. (under revision) Complement set focus without specifying quantity.

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Chapter 1

General Introduction

The series of experiments detailed in the following thesis were designed to examine the effects of subtle contextual manipulations on language processing. The manner in which a reader interprets discourse can be affected by a wide variety of manipulations. In the following thesis the implicit desire of a character was manipulated to make something specific salient to the reader. In the majority of materials the reader is introduced to a situation from which a character's desire may be inferred. For example if provided with a situation where a character is attending a job interview, *Andrew sat nervously waiting to be called into his job interview*, the character's desire about the situation is not explicitly mentioned. However, the reader may infer that the character wants to get the job. From this inferred desire it is possible that the reader may focus on a specific aspect of the situation. It is this aspect of language processing 'reader focus' which underpins the following experiments. In semantic terms focus can be thought of as a contrast of interpretations (Rooth, 1992). That is when speaking (or writing) a protagonist will wish the listener (or reader) to focus on something specific, there are no limits to what the entity in focus may be. This is merely defined by what the context allows. Reader focus has to date not been studied with respect to character's implicit desires. This thesis will make an interesting addition to the literature in this and other (shortly to be introduced) areas of Psychology. In these experiments the manipulation used to allow readers to focus on one entity over another is slight, and this manipulation is reliant almost entirely on the reader's inferences. I will provide evidence that implicit character desire can be used as a focusing tool. In addition I will uncover some interesting issues in language research.

The research described in this thesis links two areas of Psychology, language processing, in particular pronominal reference, and attribute framing, more specifically

the interpretation of logically equivalent frames. These areas have previously been compared (Moxey, 2006) but are not currently considered related. In the following chapter literature relating to the processing of pronominal references and logically equivalent frames will be introduced and discussed. The later experimental chapters seek to demonstrate how readers deal with different types of pronominal reference and different logically equivalent frames when presented in biasing and neutral contexts. These areas although quite different can be connected using reader focus. Investigations of pronominal reference seek to establish the set or group which is in focus or salient to the reader in a given context. Logically equivalent frames such as *5% fat vs. 95% fat free* lead the reader to focus on a specific attribute, in this case fat or fat free. In the course of this thesis further details of how these areas are affected by focus will be described. The experiments which follow will also provide evidence that these seemingly different areas of Psychology are linked by more than reader focus. In the current chapter the areas of complement set reference and logically equivalent frames will be introduced and linked before the more specific aims of the research are laid out.

Natural language quantifiers and the complement set

Evidence from Language Production

Natural language quantifiers (NLQs), words such as *some, many, few, all* or *none,* are often used in place of more specific quantity information. For most of these words (excluding *all* and *none*) it is difficult if not impossible to assign a specific value to the word or phrase, nevertheless their use in formal and casual literature and conversation is frequent. The media may use a statement such as 'Many of the MPs were involved in the recent scandal' or a football fan might mention that 'Some of the players are

overpaid.' It has been established that the numeric value given to these words may vary as a function of context (Moxey & Sanford, 1993a; 1993b) and that although these values may differ between individuals, people have a tendency to positions these words similarly on a scale (Bass, Cascio & O'Connor, 1974; Hartley, Trueman & Rogers, 1984), for example there is generally agreement that *many* represents more than *some* and that *some* represents more than *few*.

In addition to detailing quantity it has been established that NLQs which are negative lead to a distinctly different pattern of pronominal reference than NLQs which are positive. For example:

(1) *A few* of the fans went to the football match.

(2) *Few* of the fans went to the football match.

(3) They cheered loudly when the player scored.

(4) They decided to stay at home and watch it on television.

In language production studies (Moxey & Sanford, 1987; 1993a; 1993b; Sanford, Moxey & Paterson, 1996) when participants are asked to give a continuation sentence (constrained to begin with *They*) for sentence (1) they are likely to write something similar to (3). That is a reference to the fans who <u>did</u> attend the football match. This set has been termed the reference set and a reference to this set describes a property of the group which <u>did</u> fulfil the predicate of the sentence. After reading sentence (2) which uses the negative NLQ *Few* instead of *A few* (3) is a less likely continuation and may seem unnatural. In this case participants are more likely to provide a continuation such as (4) which describes the fans who <u>did not</u> go to the match. This group or set has been termed the complement set and a reference to this set describes a property of the

group which did not fulfil the predicate of the sentence. Moxey and Sanford (1987) found that in sentence completion tasks different negative NLQs led to complement set reference to different degrees. For example *few* leads to complement set continuations around 60% of the time, whereas *not many* leads to complement set continuations around 75% of the time. In addition the number of references to the complement set in a continuation task is generally increased by using the connective *because*.

As noted this type of referencing has been found to be prominent and often preferable for negative NLQs. Some NLQs are explicitly negative as determined using an affix as in *not many,* for others the negativity is implicit such as in *few.* One of the simplest ways to determine a NLQs polarity is to pair it with a tag question as first noted by Klima (1964). Consider the sentences below and the possible tag questions they are paired with:

(5) *Many* people went to the meeting *didn't they/did they?*

(6) *Not many* people went to the meeting *did they/didn't they?*

In (5) it is suitable to end the declarative sentence with *didn't they* and the use of this negative tag question indicates that the preceding quantifier is positive. The opposite is then true for (6), in this case it seems natural to end the sentence with the positive question *did they* and this indicates that the NLQ in use is negative. By substituting any NLQ for those in sentences (5) and (6) it is possible to determine the polarity of the quantifier in question. Those NLQs determined as negative in this way are more likely to lead to a complement set focusing pattern. These NLQs may also lead to different perspectives with respect to positive and negative situations (Sanford, Fay, Stewart & Moxey, 2002) and to a specific memory. Moxey and Sanford (1993a) detail an

experiment in which participants were asked to read a passage containing a quantifier before attempting to recall the details. Results showed that although participants found it difficult to remember the specific NLQ in use they were more likely to recall a different NLQ of the same polarity.

During completion of these experiments on the referential focus of NLQs it was also observed that participant's continuation sentences contained specific, classifiable, content (Moxey & Sanford, 1987; Moxey & Sanford 1993a; Sanford et al., 1996). In early experiments the most common continuation had content which provided details of What-Happened-Next. However when a negative NLQ was used participants had a tendency to provide explanations for the set not fulfilling the predicate of the sentence, Moxey and Sanford termed the content of these continuations Reasons-Why-Not (RWN). Sentence (4) above provides a RWN, in this case an explanation as to why the fans were not at the match. Content which provides a consequence of not fulfilling the predicate of the sentence (attending the match) is also common, for example after (2) a consequence of not fulfilling the predicate would be *They were disappointed to miss the new striker's goal*. After a positive NLQ continuations were more likely to contain what happens next information, Reasons-Why (RW) or consequences of fulfilling the predicate. For example after (1) a RW continuation would be *They wanted to see the new striker score* as this gives a reason why the fans went to the match. Alternatively (3) gives a consequence of attending the match. In the case of RWN continuations it is clear that participants are attempting to explain why the number of people who fulfilled the predicate of the sentence is so low. They are attempting to answer the implicit question *Why did few people attend the match?* The content of continuations may help to determine why participants are led to focus on a specific set. That is where they are answering the implicit question above this will lead to focus on the complement set,

those fans who did not attend the match. It is important to note however that although complement set reference and RWN content are often seen together complement set reference may and does still occur without a RWN.

Evidence from language comprehension

Sanford et al. (1996) used self paced reading in order to establish that this preference for the complement set after negative NLQs was evident during language comprehension as well as in language production. Results indicated that sentences containing complement set references took longer to read if they had been preceded by a positive NLQ as opposed to a negative NLQ. In contrast sentences containing a reference set reference were read slower after a negative NLQ than after a positive NLQ. This suggests that negative NLQs led to focus on the complement set during language comprehension to the same extent that positive NLQ led to focus on the reference set. A later study used eye-tracking methods to further investigate this claim (Paterson, Sanford, Moxey & Dawydiak, 1998). Results from eye movements in the Paterson et al. study suggests that reading was disrupted by a reference to the reference set after a negative NLQ and by a reference to the complement set after a positive NLQ. However these disruptions did not occur to the same degree. Positive NLQs led to an increase in processing time for the critical region, which identified the complement set, and for the post-critical region, as well as an increased number of regressions from the post-critical region. Negative NLQs led to increased reading times for reference set references only in the post-critical region and there was no increase in regressions. Reference set references following a negative NLQ lead to later processing difficult than complement set references following a positive NLQ. These differences are likely to be due to the ability of the participant to integrate these references into the prior context as opposed to an issue with the initial reference. The asymmetry in these eye-

tracking results suggests that reference set references following a negative NLQ do not lead to as early and obvious problems as complement set references following a positive NLQ. This is consistent with the production study data, where the preference for complement set after a negative NLQ is dependant on the NLQ in use.

Theories of complement set focus

There is a clear association between negation and complement set reference. However there is more than one aspect of negation which may be the root of complement set focus. Early in their research Moxey and Sanford (1993a) identified that those NLQs which were complement set licensing were able to take negative polarity items. Negative polarity items, such as *anymore*, are said to occur in close proximity to negative expressions. For example sentence (7) uses the negative NLQ *few* whereas (8) contains the positive *a few*.

(7) *Few* children play outside anymore.

(8) *A few* children play outside anymore.

The negative polarity item 'anymore' is acceptable after *few* but not *a few*. Negative polarity items need not involve quantified statements. For example *John didn't like Jane anymore* is acceptable whereas *John did like Jane anymore* is not. However, when pairing negative polarity items with expressions of quantity it is necessary that the NLQ involved is monotone decreasing (Barwise & Cooper, 1981; Zwarts, 1996) and it is this property of many negative NLQs which has been linked to complement set reference (Kibble, 1997).

Monotonicity is a mathematical property which involves the relations of subsets to sets. The majority of NLQs can be classified as either monotone increasing or monotone decreasing (Barwise & Cooper, 1981; Keenan & Stavi, 1986) using simple sentences. Any quantified statement may be determined monotone increasing if it can replace Q in sentence (9) to make a true statement:

(9) If Q people danced at the party then Q people were at the party.

Positive NLQs such as *some, many* and *a few* can replace Q i.e. *If many people danced at the party then many people were at the party,* logically if many people were dancing then many people were at the party. Negative NLQs cannot replace Q *If not many people danced at the party then not many people were at the party.* The fact that not many people danced does not logically imply not many people were at the party. Quantified statements which are monotone decreasing can be identified by their replacement of Q in (10):

(10) If Q people were at the party then Q people danced at the party.

Negative NLQs such as *few* and *not many* can replace Q, for example, *If few people were at the party then few people danced at the party,* logically if few people were at the party it is not possible for more than few people to have danced at the party. Positive NLQs do not fit in this sentence *If a few people were at the party a few people danced at the party,* because a few people being at the party does not entail that any of them danced. A number of NLQs which have been classified as monotone decreasing lead to complement set reference and so it has previously been suggested that this property alone is responsible for this type of reference (Kibble, 1997). Two problems

with this theory have been identified. First complement set reference is a variable property. That is some NLQs lead to these references more often than others (Moxey & Sanford, 1993a; Sanford et al., 1996). In contrast although people's judgements of whether a NLQ is monotone increasing or decreasing may vary, downwards monotonicity is a stable property which a NLQ may either hold or not hold (dependent on the judge) but cannot hold to a specific degree. If this property is the cause of complement set focus then each monotone decreasing NLQ should lead to complement set references to an equal degree. The second problem with this theory is that Kibble along with Nouwen (2003) describes the complement set as the difference between the superset (the entire set) and the reference set. This set exists by default but is not necessarily explicitly mentioned in the text. Were this the case cardinal NLQs such as *at most N,* which do not have a superset, would not lead to complement set references. In fact complement set reference are found with this type of NLQ (Moxey, Sanford and Dawydiak, 2001) as detailed below.

Moxey et al., (2001) compared downwards monotonicity with another aspect of negation to establish a property which correlates with the variances in complement set references, and presented in favour of *denial* (Clark, 1976; Horn, 1989; Wason, 1965). Consider the statement *John didn't go to the cinema.* Alone this is not particularly informative for the reader. But, if the reader expected John to go to the cinema the negation in the sentence has now denied this presupposition. Just as the negation in this example denies the presupposition that John would go to the cinema, use of a negative NLQ as in (2) denies the reader's presupposition of a larger amount. That is, the statement *Few of the fans were at the match*, is a denial that a larger quantity of fans were at the match. Previous results have shown that when speakers use certain negative NLQs listeners believed that speakers might have expected more (Moxey & Sanford,

1993a). Moxey et al.'s Inference Account (2001) hypothesizes that when participants provide a RWN continuation they are actually giving an explanation as to why more is not the case. That is when asked to provide a continuation for *Few of the fans went to the match* participants may attempt to answer the implicit question *Why did so few fans go to the match?* The search for an answer to this question results in a RWN and complement set continuation. The Inference Account suggests that the extent to which a given NLQ is taken as a denial of the predicate of the sentence determines the likelihood of complement set reference. Evidence for the Inference Account comes from a series of sentence continuation experiments which found that complement set reference and RWN continuations were more common for monotone decreasing NLQs which were taken as denials than for monotone decreasing NLQs which were taken as affirmations. These experiments also identified that the complement set was the preferred referent for the cardinal quantifier *at most 10 of the.* Under Kibble's account this would not be possible as the complement set can only exist when NLQs are proportional e.g, *at most 10% of the* as this allows for the unmentioned 90% without specific mention.

Presupposition Denial Account

More recently the Presupposition Denial Account (Sanford, Dawydiak, & Moxey, 2007; Moxey, 2006) has built on the principals of the Inference Account to provide a more detailed explanation of the relationship between denial and complement set reference. The assumption of the Presupposition Denial Account is that the difference between a denied larger amount and a smaller amount which is denoted by the NLQ is what leads to complement set focus. As shown in the equation below, if subtracting the denoted amount (A) from the expected amount (E) leaves an amount which is greater than zero then the processor is left with a shortfall.

(E) – (A) > 0 = Shortfall

Focus on the existence of a shortfall set, on possible explanations for and consequences of it, is essentially focus on a complement set.

Sanford et al. (2007) have shown a strong statistically significant correlation between incidence of complement set reference and judgments of an NLQ as indicating denial in linguistic tests. These tests required participants to select the appropriate construction of three different sentences containing a given NLQ. These sentences were as follows:

(11) **Not many** of the men were happy, and *neither/so* is Mary.

(12) **Not many** of the students like maths, *do/don't* they?

(13) **Not many** of the men liked the food, and **not many** of the women did *either/too*.

A denial index for each NLQ was calculated using the responses to these questions. Responses of *neither*, *do* and *either* were considered as indicating a denial. If a NLQ lead to all three of these responses (across all participants) its denial index would be 1. The denial index of an expression was found to correlate positively with the proportion of occasions on which the same NLQ lead to complement set focus ($r = 0.959$), accounting for 92% of the variance. Furthermore, Moxey (2006) has shown that when the shortfall is made prominent by explicitly providing a large expectation and then denying this expectation there is an increase in both complement set references and RWN content. In three experiments using different pairs of NLQs a character's

expectation was explicitly stated as either *all* or *none* as in (14). This was followed by a quantified statement.

(14) Robert expected *all/none* of the people in the audience to applaud. *Few* of them clapped. They

When the character expected *all* as opposed to *none* there were more complement set references and more RWN content continuations for the negative NLQs *few* and *not quite all*. When a high expectation is denied with a negative NLQ a shortfall is created, participants then provide complement set references which give explanations for the shortfall. More interestingly when the expectation for *all*, as opposed to *none*, was followed by the positive NLQs *a few* and *a small number* there was a greater number of complement set and RWN continuations. These NLQs carry no negation but are nevertheless capable of creating a shortfall because the small amount they denote is inconsistent with the larger expected amount.

These previous experiments (Moxey, 2006; Sanford et al., 2007; Moxey, Filik & Paterson, 2009) have demonstrated that when a larger amount which is expected by a character is denied, in this case with a negative NLQ this leads to a shortfall between expected and denoted amounts. When this shortfall is in focus complement set references are observed and preferred. It is possible that the shortfall rather than the negative NLQ per se is responsible for complement set referencing and this possibility will be addressed within this thesis. If complement set references can be shown to be related to a shortfall rather than a NLQ this will have implications for a number of different disciplines including experimental pragmatics. The relationship of the complement set to the pragmatics literature will now be discussed.

Pragmatic Inference and the Complement Set

Scalar Implicature

As noted at the beginning of this chapter, although widely variable in the number they are considered to denote, NLQs are generally placed in a similar position on a scale by participants for example, *many* > *some* > *a few.* Such scales are useful for communication as when using the term *some* it is possible to infer that there is a greater number than *a few* but not as much as *many*. The ordering of these terms in such a way can be beneficial to communication and has been studied and debated from a psychological and a linguistic point of view. In particular logical terms such as NLQs can form scalar implicatures which are part of the larger concept of conversational (or Gricean) implicatures. These implicatures are used by listeners to determine implicit inferences within utterances. In Grice's lectures in 1967 he introduced the concept that an utterance can be made up of more than its explicit meaning. That is, the listener may be able to draw an inference from the speaker's implicit meaning. With respect to expressions of quantity, Grice (1989) proposed the quantity maxim, made up of two submaxims, to determine how the speaker should decide upon which term is appropriate for an utterance and what inferences the listener may draw from the speaker's choice of term. The two submaxims were:

i) Make your contribution as informative as is required.

ii) Do not make your contribution more informative than is required.

Scalar implicature and therefore the listeners need to draw an inference comes into play when one of these submaxims is violated. The following dialogue from Noveck (2001) provides an example:

Pierre: Are all the cakes ready?

Bettie: Some are.

Because Bettie did not confirm that all the cakes are ready her utterance can be seen as underinformative and therefore violates submaxim i). According to Grice this underinformative utterance prompts a search for an implicature. Because Bettie said *some* where she might have said *all* Pierre must infer that *all* is not the case and therefore he will conclude that *Some of the cakes are not ready* or *Not all of the cakes are ready*.

More recently the principles of Grice's theory have been expanded (Horn 1972; Gazdar, 1979; Levinson, 1983, 2000) and two concepts have become increasingly important. First that the speaker makes the choice not to provide a more informative utterance and second that the listener can identify that the speaker has made this choice. When the speaker says *some* it is because he or she knows *all* is not the case. The use of *some* then indicates *not all* which the listener is able to infer. With these inferences in mind it is possible to order some NLQs on a scale based on entailment, that is, if *all* of the cakes are ready this entails that *some* of the cakes are ready. As this cannot be reversed it is clear that *all* is a stronger term than *some*. *Some* does not entail *all* since *some* of the cakes are ready does not mean *all* of the cakes are ready. Rather *some* implies that *not all* is the case, that is, the use of a weaker expression implies that stronger expressions do not apply.

The not all inference

The extent to which scalar implicatures affect language use is widely debated due to the logical nature of terms like *some* and *all*. For example the literature on scalar implicature (Horn, 1972) suggests that use of a weaker expression such as *some* indicates that a stronger expression such as *all* is not the case. Problems arise when considering the truthfulness of statements such as sentence (15) below, taken from Noveck and Posada (2003):

(15) Some elephants have trunks.

Although logically true in that some elephants do have trunks, sentence (1) violates the first submaxim. Given that **all** elephants have trunks, a maximally informative speaker would state 'all elephants have trunks'. Arguments in relation to scalar implicature are beyond the scope of this thesis. There are those who feel (15) should be interpreted as *some and possibly all* unless a biasing context determines otherwise (Carston, 1999; Sperber & Wilson, 1985/1995), and those who feel the statement means *some but not all* (Levinson 2000). This second interpretation is particularly relevant to complement set reference because when *some* is used, as in (16), *not all* may be inferred essentially allowing (17). In (17) focus is on those customers who did not leave a tip, the complement set (Moxey, 2006; Sanford et al., 2007; Moxey, Filik & Paterson, 2009).

(16) Some of the customers left a tip.

(17) Not all of the customers left a tip.

Research by Breheny, Katos and Williams (2006) investigating the automaticity of the *not all* inference (Levinson, 2000) versus the more contextually driven account,

relevance theory (Sperber & Wilson, 1995), has produced results which are particularly relevant to this review of complement set focusing. These authors were investigating circumstances under which the *not all* inference became accessible. They found that when the positive NLQ *some* was presented in an upperbound context, where a possibility for *all* has been introduced, the *not all* inference became relevant and allowed integration of a set which had not been explicitly mentioned in the text as in (18):

(18) Mary wanted to create a very special atmosphere and wondered whether to light all her special candles in the dining hall or not. Eventually she took her decision: she lit some of her candles. The others were left unlit to create a nice atmosphere.

In this passage the possibility that *all* the candles may be lit has been introduced to the reader. When then encountering *some* this is interpreted as representing *not all* which allows those candles which were not lit to be in focus and referred to using *The others*. The difference between *all* and *some* in this case could be described as the shortfall. In experiments on complement set reference (Moxey, 2006; Moxey et al., 2009) the upperbound is implied by the character's expectation for *all*, the fact that the upperbound is not met is then inferred from the negative NLQ. The complement set is then in focus and referred to using the plural pronoun *They*. An important difference between Breheny et al.'s experiments and those on complement set reference is that Moxey and colleagues have found this preference for reference to the complement set using plural pronouns whereas these authors mention the shortfall set explicitly using *The others*. Were *They* to be substituted for *The others* above it is unlikely that this sentence would be processed as easily. But note that *some* although possibly implying

not all is a positive NLQ and so there is no negation in Breheny et al.'s example. In general a negative NLQ was used to make the shortfall set salient and this is likely to have led to a preference for the complement set. A slight increase in references to the complement set has been found with the positive NLQ *A few* when the preceding sentence contains an explicit expectation for *all* (Moxey, 2006). However whereas *a few* refers to a low amount, *some* may indicate any amount up to 80% (Moxey & Sanford, 1987). A complement set reference is more likely to become available when the shortfall is between *all* and a relatively small amount.

In completion of experiments on complement set reference it has become clear that there is a link between this type of reader focus and framing effects. In both cases readers must make inferences from a presented piece of information. With complement set reference this involves the set under discussion where as in framing there is generally a decision to be made. Here I shall lay out the basics of framing effects before explaining in more detail how they are related to complement set focusing and previously supposed states. In later chapters it is hoped that I will show how researching these frames from a language processing perspective will provide further information on how we use these perspectives to communicate.

Framing Effects

The broad term framing effects relates to the manner in which the same information may be presented or 'framed' in different ways in order to influence decision making. There are three main types of framing, risky choice framing, goal framing and attribute framing. Of these attribute framing is possibly the simplest as it relates to the manipulation of a single attribute which is generally framed in either a positive or a negative manner. As well as being useful in the observation of decision making

behaviour this framing effect can be used to determine preferences in information valence.

Attribute Framing

The effect of this type of framing on decision making is most clearly demonstrated in an experiment by Levin and Gaeth (1988) where the same sample of meat was labelled either 75% lean or 25% fat. The two labels were displayed side by side and describe the meat as containing an equal amount of fat, however, participants considered the meat labelled 75% lean as more healthy, and in a taste test described this sample as tastier and less greasy. Although the frames are equivalent, labelling the product in terms of how lean it is allows the participant to focus on the large percentage of a positive aspect. A description of the fat content focuses the participant on this negative aspect which is unlikely to be preferred despite its equivalence. Another example of how positive and negative valence is used in attribute framing involves presenting situations in terms of success or failure. A pattern of preference emerges whereby the option depicting success is usually chosen despite the two being equivalent. This has been demonstrated with a number of different issues some of which can have specific relevance to those making the decision, such as evaluation of medical treatment (Levin, Schnittjer & Thee, 1988) or condom use (Linville, Fischer & Fischhoff, 1993). Levin, Schneider and Gaeth (1998) point out that perceived risk is not a necessary part of attribute framing, in that the outcome of the attribute need not be good or bad for the decision maker as in the above examples. Any attribute which can be influenced by valence can be subject to framing manipulations. For example Levin (1987) presented details of basketball players in terms of percentage of shots made (positive frame) or percentage of shots missed (negative frame). There was no risk involved in the situation yet the valence of the statement still affected participant's ratings of the player. This preference for

participants to select the attribute which has been framed positively was noted early by Levin, Johnson, Deldin, Carstens, Cressey and Davis (1986) and support for a valence consistent shift in responses can be found in a detailed list of attribute framing experiments whereby the positively framed information is always preferred (see Levin et al 1998 for full list and further information). These authors argue that there is no case in which a negatively framed attribute is preferred to a positive one, and hence it is this difference in valence which leads to attribute framing effects.

Attribute framing and the Complement Set

It has already been argued that use of a negative NLQ leads to focus on a particular set, that is a set for whom the predicate of the preceding sentence is false. In related experiments it has also been demonstrated that negative NLQs can lead readers to take a particular perspective in relation to a simple declarative sentence (Sanford, Fay, Stewart & Moxey, 2002). Consider sentences (19) and (20):

(19) In the airplane crash, *a few* people were killed, which is a terrible thing.

(20) In the airplane crash, *few* people were killed, which is a good thing.

In (19) the positive NLQ leads readers to focus on the reference set, those people who were killed in the crash and so (despite *a few* indicating a small number) this is considered a terrible thing. In (20) the negative NLQ *few* allows focus to the complement set, those passengers who might have been killed but were not. This allows the situation to be seen from a different perspective, as a good thing, despite the likelihood that the number of deaths may be equal in both instances. In their paper Sanford et al., (2002) go on to show how these perspective effects carry over to logically equivalent frames. For example:

(21) This yoghurt is 5% fat which is a bad thing.

(22) This yoghurt is 95% fat free which is a good thing.

In (21) the emphasis is placed on the amount of fat in the product and so is considered a bad thing. However in (22) the reader is focused on the amount of the product which does not contain fat, this could also be viewed as a portion of the yoghurt which might have contained fat but does not. Intuitively it feels in (22) as if the advertiser is using 95% fat free to describe a reduction in the amount of fat. This is then seen as a good thing despite the overall fat being the same in both cases. In written experiments products described as 75% fat free were identified as healthy by participants even when this was clearly contrasted with 25% fat. In an eye-tracking experiment it was found that participants read a statement of *healthy* quicker than a statement of *unhealthy* after a product had been described as fat-free (95% or 75%). These experiments demonstrate that both NLQs and logically equivalent statements of quantity can lead to a change in perspective.

As far as attribute framing is concerned it is clear that positively framed information is preferred by readers and leads to a positive perspective. This does not help establish the conditions that lead to a preference for the positive frame in situations where two clearly equal frames are presented to decision makers. For example, when participants are asked if they would rather place money on a team who *score 50% of their shots* or a team who *miss 50% of their shots* it should be evident that the teams are equal. However, participants still tend to back the team framed positively, those who score 50% of their shots (Levin, 1987). This pattern may be attributed to what has been termed the 'positivity bias' (Peeters & Czapinski, 1990). These authors suggest that

evaluation of positive information is more straightforward than evaluation of negative information. This leads to a tendency for attributes to be described in positive terms where other factors are held neutral. That is, all things being equal, people will use positive as opposed to negative descriptions. This premise holds across the original results of studies already described (Sanford et al., 2002; Levin & Gaeth, 1988) and also for more recent experiments (Keren, 2007) which used the original situation in which meat was described as 75% lean or 25% fat along with a qualified version of these: *at least* 75% lean and *at most* 25% fat. Note that when a qualified version was used the positivity bias was reduced although still present in the positive situation. The evaluation of these frames was not the only aim of Keren's (2007) experiments. These experiments also examined the relationship between framing effects and trust. The result showed that participants would choose to purchase meat from a butcher who advertised using the lean frame. Participants would also advise a butcher to use this frame in their advertising. In contrast the same participants claim to be more likely to trust a butcher who used a frame depicting the negative attribute, 25% fat. Keren (2007) calls this problem 'trust-choice incompatibility' and notes that this property is asymmetrical. That is where a participant makes a choice before determining trust they are likely to be trust-choice incompatible. In contrast trust–choice incompatibility is reduced if the participant is asked to determine which butcher they trust most before choosing who to buy from.

The framing experiments in the current thesis do not relate directly to trust, however these results do highlight the possibility that the frames previously mentioned are not actually equivalent. In particular Levin et al., (1998) argue that positive frames are always preferred, these authors do not consider the inferences which may be made from this information when the frames are presented individually in conversation or text.

That is they do not consider the ability of the listener to draw inferences not only from statement A as presented by the speaker but also from the knowledge that the speaker has chosen to deliver statement A over its logical equivalent B (Sher & McKenzie, 2006). When these statements are used in language it is unlikely that a speaker would provide a listener with both frames. A speaker would choose either the positive or the negative frame to convey the information and a listener is aware of this. In this case, positive and negative statements which may be normatively and logically equivalent may not convey the same information. That is a speakers choice of frame may be as important to the listener as the frame itself.

To date attribute frames have not been looked at from a conversational perspective. There has been little or no investigation of how listeners or readers interpret these frames online or in isolation. There has however been some offline investigation into the interpretation of risky choice frames when presented to participants in isolation. Risky choice frames involve a reader being given a choice between a certain outcome and a more risky outcome. For example participants are presented with a situation where a disease has broken out which will kill 600 people. Participants, acting as advisors, are asked if they would rather select (a) an assistance program where 200 people will certainly survive or (b) an assistance program where there is a 1/3 chance that 600 the people will survive but a 2/3 chance that no one will survive. These risky choice frames may also be affected by valence, the previous example given shows the positively valenced options. The alternative negative options would be (a) a program where 400 would certainly die or (b) a program where there is a 1/3 chance that no one will die and a 2/3 chance that 600 will die. Results from early experiments on risky choice framing (Kahneman & Tversky, 1979) show that participants are risk averse when provided with the positively framed options but risk seeking when given the

negatively framed options. Recently in an experiment which attempted to examine a speaker's choice of frame and listener's interpretations of that frame van Buiten and Keren (2009) used materials adapted from Kahneman & Tversky (1979). These authors found that when participants were asked to act as an advisor and promote a specific program (riskless or risky as identified by the experimenter) to a city council, speakers in both situations chose to promote this program using the positive frame. That is they preferred a description in terms of survival rather than deaths regardless of whether they were promoting the program with a certain survival rate or with a more risky approach. Participants in this case fail to identify that the negative frame is more persuasive in situations involving risk (Tversky & Kahneman, 1981). These researchers go on to examine the persuasiveness of these frames when they are presented to participants in isolation. When participants were asked to evaluate the persuasiveness of a single frame, on a scale from 1 to 6, they rate the negative frame as more persuasive than the positive frame when the situation involves risk. In a third experiment participants were asked to act as listeners and imagine they were on the city council asked to make the decision. In this case the risky and riskless programs were chosen an almost equal amount of times (49 and 51% respectively), however regardless of the program chosen 85% of participants felt they had been most influenced by the positive frame. These results demonstrate that when jointly assessed more weight is given to the positive than the negative frame. When assessed in isolation the persuasiveness of the negative frame becomes apparent. These authors then posit that in order for speakers and listeners to come to the same conclusions about frames they must either both evaluate both (all) frames or both be given only a single frame.

These experiments although based on the more complex effects of risky choice framing identify the problems which can occur in the communication of frames when speakers

and listeners do not have the same information. That being said, there is evidence that speakers and listeners are excellent at drawing inferences from frames. In attribute framing this is best demonstrated in the Information Leakage Account as detailed below.

The Information Leakage Account

It is clear that when presented with a positive and a negative frame listeners are able to make inferences based on more than polarity. As mentioned previously a listener (or reader) is sensitive to the speaker's choice of frame along with the information held in the frame itself. So the listeners' interpretation of an expression can be influenced by their perception of why a speaker chose a specific frame. After hearing a speaker use a certain frame the listener may think *Why did the speaker say that the product was 95% fat free? They must have been indicating that this is a good thing*. With such inferences in mind McKenzie and Nelson (2003) used a series of experiments to investigate participant's choice making strategies with respect to framing of information. They hypothesized that a speaker's choice of frame would vary relative to some explicit or implicit reference point and, due to a tendency in the English Language to emphasise the variable which has increased, a listener would be able to infer a speaker's reference point from their choice of frame. In the first two experiments they found that speakers (participants) amended their choice of frame dependant on the previous situation. Participants would chose to describe a 4 ounce measuring cup which was filled to the 2 ounce mark as *half full* when it had previously been empty. They would describe the same cup as *half empty* when it had previously been full. In these experiments the previous volume determined the reference point such that a reference point of empty lead to a description of *half full* and a reference point of full lead to a description of *half empty*. In a further experiment an established treatment for a disease

was described as causing 100% of suffers to die. In this case when asked to describe the effectiveness of a new treatment participants were likely to mention the percentage of people who people survive. That is to say of 50% of people will survive was considered a better description than 50% of people will die. When an alternative reference point was used, such that the old treatment led to 100% survival, participants preferred to describe the new treatment in terms of mortality, that is 50% of people will die as opposed to 50% will survive. These experiments have shown that a change in reference point can affect a speaker's choice of frame. In the third experiment McKenzie and Nelson (2003) provided evidence that listeners were able to identify the speaker's choice of frame. Participants were given a passage to read such as (23):

(23) "Imagine that Mary was sitting at her kitchen table with a glass in front of her. She left the room briefly and came back to find that the contents of the glass had changed. When asked to describe the glass now, Mary said "The glass is half full." Given how Mary chose to describe the glass after its contents had changed, please choose the statement below in terms of what you think was most likely true about the glass before its contents changed." (pp 600)

Participants were then asked to select the volume of the glass before the contents had changed, either full or empty. It was found that when Mary stated the glass was *half full* listeners would infer that the glass had previously been empty. When she stated that the glass was *half empty* participants thought the glass had previously been full. Correlation of the data from the first and third experiments in this paper then demonstrated that listeners use a frame to infer a particular reference point to the same degree that speakers use a reference point to choose a frame. These authors argue that it

is possible that the ability to infer reference points may at least in part be responsible for the results of previous framing studies.

Sher and McKenzie (2006) use more naturalistic techniques to expand on the conclusions drawn by McKenzie and Nelson (2003) and reword their hypothesis in terms of information leakage. The earlier study relied on participant's interpretation of descriptions of cups from their own and a character's point of view. The more recent experiments used actual cups of water. Participants were asked to pour water from one cup to another and then place the cup which was *half full/empty* on the edge of the desk. This more natural way of determining a participant's beliefs with respect to which cup is *half full/empty* was meant to tackle the problem, highlighted by McKenzie and Nelson, that participants in the initial study were attempting to define a relationship between the initial and latter states of the cups. That is they were specifically asked to make a choice about a prior state. Sher and McKenzie found that participant's choice of cup was dependent on an increase in comparison to a reference point. That is when asked for the *half empty* cup the cup most often chosen was the one which had originally been full (because its emptiness had increased). When asked for a *half full* cup the cup most often furnished was the one which was originally empty (its fullness had increased). This experiment was followed by two further experiments which investigated a speaker's selection of frames. In this case the authors attempted to allow participants to select a frame in a way more akin to normal conversation as opposed to making a choice between a pair of frames. In an experiment where participants had to describe the number of times a dice landed on a particular coloured side (where 1 side was white and 5 sides were black or vice versa) it was found that the frame selected was always the one which had increased relative to the reference point. That is where 1 side of the dice is white one would expect the dice to land with this side up 1 in 6 times.

When the dice landed with the white side up more than 1 in 6 times participants were likely to describe this event in the following way: 'The die came up white n out of 6 times'. In a similar experiment participants were asked to describe the number of times a penny came up head or tails after 7 flips. It was found that participants were more likely to mention the side which had come up a greater number of times than the reference point. That is where there are only 2 sides to a coin the reference point is 0.5. As the coin was flipped 7 times it was impossible for both sides to occur an equal number of times. Participants tended to describe the coin in terms of the side which came up more often.

This research has been extended to include valence, in particular referencing McKenzie and Nelson's evidence that the choice of a positively valenced frame indicates that the positive property is more prominent in comparison to the reference point. Furthermore the valence of an object is more likely to be referred to if that property is above a reference level. To demonstrate that the valence of a statement is relevant to the interpretation of the reference frame used by the listener, Sher and McKenzie asked participants to describe very good or very bad research and development teams in terms of either their success or their failure. It was evident that bad teams were more likely to be described in terms of their failure. Statements which involve a team's failure or are negatively valenced are more likely to be interpreted by the listener as indicating that the team or event is bad. Sher and McKenzie go on to speculate that the preference for valence consistent shifts in attribute framing is due to their finding that good things are described in good terms and therefore listeners can easily infer that something which has been described using good terms is good. This would explain Levin et al.'s finding that positively framed attributes are always preferred. It is not that the positive frame is preferable but rather that the positive attribute is likely to have been depicted using the

positive frame. Further evidence in support of the information leakage account and valence is provided in a study by Teigen and Karevold (2005). In their experiments participants, classed as speakers, were advised that they are part of a team who are either behind or ahead of schedule. They are then asked to make a choice between two logically equivalent frames when passing this information onto a colleague. An example of two frames would be as follows, 'As far as the task is concerned (a) we have done 20% of the work OR (b) we have 80% of the work left'. When the participants were told the team were ahead of schedule they were more likely to chose the positive frame, in this case *work completed*, whilst if behind schedule the negative, *work left*, was preferred. Other participants were classed as listeners. When given details of *work completed* these participants inferred that the team was ahead of schedule. Alternatively they inferred that the team were behind schedule when given details of *work left*. Clearly in these experiments participants have taken the positive frame to determine a positive situation and a negative frame to determine a negative one. These results may also be interpreted with respect to McKenzie and Nelson's (2003) experiments in that the participants have a tendency to describe things which have increased relative to a reference point. When the term 'work done' is used, the team is assumed to be ahead of schedule because the amount of work completed has increased relative to some implicit reference point. When the alternative 'work left' is used the team is assumed to be behind schedule as the amount of work still to be completed has not changed or has not decreased at the rate it should have. As both speakers and listeners in Teigen and Karevold (2005) have made judgements in this way the statements are not information equivalent and so it can be said that information has been leaked from the frames.

This group of experiments involving information leakage and reference points is of interest to psycholinguists. In the majority of this work a choice is being made, however van Buiten and Keren (2009) have highlighted the importance of these issues in communication. A listener or readers ability to infer reference points online would clearly aid communication. If it can be shown that these inferences are made online this will have implications for attribute framing and for wider applications of frames.

Structure of Thesis

The experiments in this thesis were designed to examine some of the questions which have arisen from the previous research. Loosely, these questions can be divided into two areas which will be addressed within the following chapters. The first issue relates to the principles of the Presupposition Denial Account (Moxey, 2006; Sanford et al., 2007). This account posits that it is not the NLQ itself which leads to a pattern of complement set reference but the denial of a large presupposed amount. The current experiments are designed to extend the circumstances under which complement set reference is found and preferred. If the context of a sentence can be manipulated to establish a shortfall between a larger presupposed amount and a smaller denoted amount without a NLQ this may lead to complement set reference. The intention of these experiments was to provide support for the Presupposition Denial Account as well as extending the literature on this type of referencing. The second issue addressed makes use of a similar type of contextual manipulation which is then applied in an online manner to logically equivalent frames (McKenzie & Nelson, 2003; Sher & McKenzie, 2006). The latter chapters used biased and neutral passages to introduce presupposed volumes to readers. These presuppositions are then followed by a logically equivalent volume statement. These experiments were designed to examine whether a supporting

context allows a reader to expect one frame over another because of the reference point it implies.

Although these two areas of investigation differ these experiments are all based on a reader's inferences about a situation. In both cases a reader makes inferences from a reference point to determine what is suitable in upcoming text. These experiments, which are detailed more comprehensively below, will determine the effects of context on processing of such inferences.

The possibility that complement set references may be preferable without explicit use of a NLQ will be addressed using a number of different methodologies in Chapters 2 and 3. The first experiment of Chapter 2 will use sentence continuations to establish conditions under which complement set reference may be found without the use of a NLQ. The data collected from these continuations will be examined for complement set references and RWN content in order to determine if this type of reference is driven by the denial of a presupposition. The second experiment in this chapter will use eye-tracking to establish whether this type of reference is preferred after such a denial is created. Together these experiments will map out the conditions under which complement set reference is both found and preferred without the use of a NLQ. Chapter 3 will address a theory which has arisen from both the current and previous experiments on complement set reference (Moxey, et al., 2009). It is possible that during processing readers may hold a number of different referents in mind and a specific referent is only chosen when the context forces this. That is, where the preceding context does not exclude a particular set, the reader may hold the reference set, the complement set and other sets in mind. If this is the case a reference to any of these sets should be integrated easily during reading. Using event related potentials

this experiment will map the millisecond by millisecond integration of a word which signifies either the reference set or the complement set into the previous discourse. A number of different time windows which have been related to semantic processing will be analysed and discussed. Ultimately the results of Chapters 2 and 3 will give an overall view of how complement set references may be used in communication without specifying quantity.

The online processing of logically equivalent frames will be examined in Chapters 4 and 5. The four experiments in Chapter 4 will investigate whether the contextual manipulations used in Chapters 2 and 3 can affect processing of the logically equivalent frames *half full* and *half empty*. The preceding literature review has already identified the reference points which people may infer when dealing with these frames (McKenzie & Nelson, 2003; Sher & McKenzie, 2006). Two eye-tracking experiments and two off-line experiments will investigate if these frames lead to the same reference points online when a preference for a specific volume is introduced. In the final experimental chapter materials from previous experiments (Sher & McKenzie, 2006 Teigen & Karevold, 2005) will be adapted in order to establish if the inferences made in previous decision making tasks are made online.

Chapter 2

Complement set focus without an explicit natural language quantifier

Introduction

As is described in the introduction, Sanford et al., (2007) presented an account which attributed complement set reference to the denial of a presupposition. That is when a presupposed amount is denied by a negative or small NLQ this leads the processor to focus on the shortfall which in turn leads to a complement set reference. Moxey (2006) provided evidence for the Presupposition Denial Account by showing that when a high expectation is provided and then denied with a NLQ a shortfall is created which then leads to an increase in complement set references and RWNs. More recent experiments (Ingram, 2006; Moxey, Filik & Ingram, 2009) suggest that the reader's *implicit* expectation of a high amount also influences focus patterns after certain NLQs. However this is not the case for all NLQs, and this pattern has not been seen after any of the positive NLQs tested to date. The aim of this chapter is to more specifically identify the shortfall as a concept which can drive reference to the complement set. It is clear that by negating an expectation a shortfall can be made salient. Crucially, focus on this shortfall (which has not been explicitly mentioned) makes the complement set prominent and often preferable as a referent for a plural pronoun. If establishing a shortfall is the force behind this type of reference then the complement set should be accessible through the denial of something previously denoted, expected or inferred. And notably this denial should not be reliant on a negative NLQ.

There is some evidence (Moxey & Filik, submitted) that a character's explicit *desire* influences focus patterns in the same way as explicit expectation, for example where Robert wants *all* or *none* of the audience to applaud in sentence (1).

(1) Robert wanted all/none of the people in the audience to applaud. Few of them clapped. They

The purpose of Experiment 1 is to investigate implicit desire, using materials in which either a high or a low amount is highly desirable. In addition I test the idea that provided there is a shortfall it is not necessary to use any NLQ to describe the quantity. Rather, I manipulate the emotional reaction of a character to an undisclosed quantity, to imply either a surplus or a shortfall. If a character feels negatively about an amount which he or she is likely to want to be large, this implies that the amount is in fact smaller than desired and hence there is a shortfall. If a character feels negatively about an amount which he or she is likely to want to be small, this implies the amount is too large, and there is a surplus; positive emotions indicate that the desire has been met and there is neither a surplus nor a shortfall. These experiments therefore provide a very direct test of the theory that complement set reference depends on a shortfall, even in the absence of an NLQ.

Experiment 1

In Experiment 1, the hypothesis that a character's high desire together with a negative emotion word will lead to focus on the complement set and to explanations for the shortfall is tested. Specifically, when a reader can infer that the amount desired by a character has not been met this will make the shortfall salient producing a preference for pronominal reference to the complement set. Using a constrained sentence continuation task to establish the set most salient for the reader, implicit desire was manipulated by providing situations in which the character is likely to want either a high amount or a low amount of the set to fulfil the predicate of the sentence. Confirmation or denial of this amount was manipulated using either positive or negative emotion words.

Method

Participants

The participants were 288 native English speakers all of whom were naïve to the purpose of the task. They were recruited from undergraduate Psychology lectures and tutorials at the University of Glasgow. Participation was voluntary and no payment was given.

Materials

These were 288 sentences which were followed by the plural pronoun *They*. Each sentence introduced a character, by describing the character's emotion in reaction to the number of a group who fulfilled the predicate of the sentence. Half of the sentences involved a situation where the character would want the number of the group fulfilling the predicate to be high. The other half involved a situation where the character would want the number of the group fulfilling the predicate to be low. These sentences were chosen from two pilot experiments which included 40 sentences of varying desire in Pilot A and a further 31 sentence in Pilot B. The sentences used in these pilots can be seen in Appendices 1.1 and 1.2. The 24 used in Experiment 1 were identified as best indicating high and low desires. The polarity of the emotion words was also varied with half of the sentences containing positive emotion words and the other half of the sentences containing negative emotion words. An example material in each of the four conditions can be seen in Table 1.1.

Condition	Material
High Desire/Positive Emotion	The waitress was *happy* about the number of the customers who left her a tip.
High Desire/Negative Emotion	The waitress was *upset* about the number of the customers who left her a tip.
Low Desire/Positive Emotion	The stationmaster was *happy* about the number of trains which were delayed.
Low Desire/Negative Emotion	The stationmaster was *upset* about the number of trains which were delayed.

Table 1.1. Examples on an experimental material in each condition for Experiment 1.

Design

Each participant provided a continuation for a single sentence making the experiment entirely between participants. The 288 sentences were derived from 24 basic sentences matched for desirability (12 depicting situations where the character would want the number to be high and 12 depicting situations where the character would want the number to be low). Each of these sentences was then matched with 12 emotion words (6 positive and 6 negative), to make 288 sentences in total (see Appendix 1.3 for sentences and emotion words used). The two independent variables were desire (high versus low), and polarity of emotion word (positive versus negative).

Procedure

Participants were given a slip of paper which gave instructions along with a test sentence followed by *They* as shown in Table 1.2. The instructions advised them to carefully read the sentence provided before writing a sensible continuation to the sentence beginning with the pronoun *They*. Once completed the slips were collected by the experimenter.

Instructions

Please read the sentence below carefully and then provide a suitable next sentence which continues the theme of the passage.

Please note the sentence you provide must begin with They.

The waitress was happy about the number of the customers who left her a tip.

They_____

Table 1.2 Example of instructions and material given to participants in Experiment 1.

Results and Discussion

Six independent judges studied each continuation sentence and categorised them with respect to the referent of the plural pronoun *They* and the content of the information in the sentence.

Referent Analysis

The referent of the plural pronoun *They* was placed, by each judge, into one of the following four categories as defined in Moxey (2006). Examples based on the above sentences (a) and (b) are provided:

Reference set: the pronoun appears to refer to the set for whom the predicate is true in the sentence.

(Those customers who did leave the waitress a tip)

Complement set: the pronoun appears to refer to the set for whom the predicate is false in the sentence.

(Those customers who did not leave the waitress a tip)

General: the pronoun appears to refer to the whole set or the set generally.

(All customers dining in the restaurant)

Other: the pronoun appears to refer to something other than the above sets.

(A reference to a group of individuals who were not customers)

Each sentence completion received a score out of 6 distributed across these categories depending on decisions made by the judges. The distribution of the judgements across the four conditions can be seen in Figure 1.1. As there were 72 sentences in each condition, each rated by 6 judges; the highest possible score for any condition is 432.

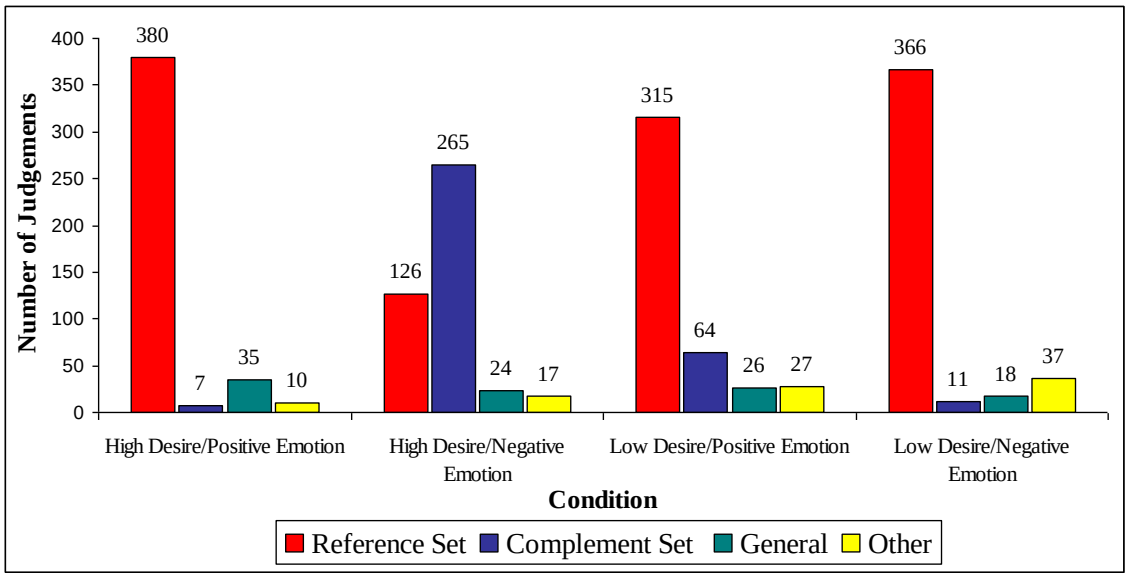

Figure 1.1. The total number of judgements in each 'referent of they' category for Experiment 1.

A 2 (desire) x 2 (polarity of emotion) by-participants ANOVA (F1) which treated both factors as between participant variables and a 2 x 2 by-materials ANOVA (F2) which treated desire as a between materials variable and polarity as a within materials variable were performed on the means for the reference set judgements. The interaction between desire and polarity was significant in both analyses (F1 *(1, 284) = 159.58, p<0.0001; F2 (1,46) = 85.93, p<0.0001*). All simple main effects by-participants and by-materials were significant (all *ps<0.05*). These results suggest that for reference set continuations desire and the polarity of the character's emotion influence participant's continuations to different extents. Specifically, polarity of emotion affects these continuations more when desire is *high*. The highest number of reference set references are produced when desire is *high* and polarity is *positive*, and the smallest number of reference set references are produced when desire is *high* and polarity is *negative*. This result indicates that when the shortfall is made salient there is a reduction in references to the reference set. Polarity of emotion also affects the number of reference set references when desire is low, but this difference is in the opposite direction. In this case there are more reference set references when the emotion word is *negative* and fewer reference set references when the emotion word is *positive*. This is consistent with a surplus being salient when a character feels negatively about an amount they wished to be small.

As with most experiments in this area reference set continuations are more common than complement set continuations in some categories. However, as illustrated in Figure 1.1, there is a higher number of complement set references than reference set references when desire is *high* and polarity is *negative*. ANOVAs, identical to those used for the reference set judgements, were performed on the means for the complement set judgements. The interaction between desire and polarity of emotion was again

significant in both analyses (*F1 (1, 284) = 214.26, p<0.0001; F2 (1,46) = 82.99, p<0.0001*) and simple main effects completed post hoc were all significant (all *ps<0.01*). The complement set results mirror those for the reference set with the largest frequency of complement set continuations being found when desire is *high* and polarity is *negative*. Figure 1.1 shows that the effect of emotion is stronger when desire is *high*, the difference between the number of complement set judgements in the two *high* desire conditions is greater than the difference between the number of complement set judgements in the two *low* desire conditions. This result is as predicted, the denial of a *high* desire with a *negative* emotion has made the shortfall salient resulting in a marked increase in references to the complement set. When desire is *low* there is a significant increase in complement set references in the *positive* emotion compared to the *negative* condition, this corresponds with the decrease in references to the reference set in this condition.

Content Analysis

In previous experiments with NLQs complement set references have generally been accompanied by sentence content which provides a Reason-why-not (Moxey, 2006; Moxey and Sanford 1987, 1993a) and a strong correlation between these has been identified (Sanford et al., 2007). When a shortfall has been made salient by denying an explicitly expected amount with a NLQ continuation sentences were found to contain a RWN, an explanation for the difference between expected and denoted amounts. In the current experiment implicit desire is denied with a small amount, inferred by a negative emotion word. It is important to establish if a shortfall made salient in this way also results in an increase in RWN content along with the observed increase in complement set reference. Analysis of the sentence content for this experiment is more complex than in previous experiments due to the structure of the materials. Each material is

made up of two parts. An initial part containing the character together with a verb phrase describing their emotion, in sentences (a) and (b) *The waitress was happy/upset*, and a second part explaining the character's emotion by indicating the number of a group who share some property or perform some action. In sentences (a) and (b), the second part is *about the number of customers who gave her a tip*. In order to identify the possible types of continuations I first analysed all the continuation sentences and determined 4 different types of continuation relating to the first part (the waitress being happy or upset) and a further 10 types relating to the second part (the number of customers giving a tip). To complete the analysis the six independent judges studied each continuation sentence and categorised them with respect to the content of the continuation. In contrast to the referent results above, the judges were informed that they may place the sentence in as many or as few content categories as they wished. This was particularly important as a continuation can have content referring to both the first and the second parts, i.e. the waitress may be upset for the same reason that the customers did not leave a tip. The content types which the judges used are detailed in Table 1.3. Table 1.4 provides details of abbreviations.

Categories which refer to the first part of the sentence NP1 and/or VP1.	
Name	**Description**
RW-VP1 (Reason Why for VP1)	A reason why the character mentioned in NP1 has experienced the emotion detailed in VP1.
IG1 (Ignores Character/Emotion)	Completely ignores the first part of the sentence and does not give details of why the character has experienced the given emotion.
EOE (Emphasis of Emotion)	Emphasises the emotion that the character in NP1 has displayed.
CVP1 (Consequence of VP1)	Provides details of something which happens because the character in NP1 has felt the emotion in VP1.
Categories which refer to the second part of the sentence NP2 and/or VP2.	
Name	**Description**
RW-VP2 (Reason Why for VP2)	Provides a reason why the group of people or objects mentioned in NP2, for whom VP2 is true, completed the action detailed in VP2.
RWN-VP2 (Reason Why Not for VP2)	Provides a reason why the group of people or objects mentioned in NP2, for whom VP2 is not true, did not completed the action detailed in VP2.
IG2 (Ignores group of people/objects and what they did)	Completely ignores the second part of the sentence and does not give details of what or why the people/objects did or did not do.
CR (Consequence of the Reference set for VP2)	A consequence which occurs because VP2 is true.
CC (Consequence of the Complement set for VP2)	A consequence which occurs because VP2 is not true.
ALT (Alternative to VP2)	Something that the group of people or objects who make up NP2 did instead of VP2.
EX-VP2 (Example of VP2)	An example of VP2.
EA-VP2 (Evidence against VP2)	Provides evidence against VP2 being true.
SM (Indication of a small number)	May assert or infer that VP2 is true for only a small number of NP2.
LG (Indication of a large number)	May assert or infer that VP2 is true for a large number of NP2

Table 1.3 Details of content categories provided to the judges.

Abbreviation	**Sentence part represented by this term**
NP1	The first noun phrase in the sentence, the character. (The waitress)
VP1	The first verb phrase of the sentence, the character's emotion. (was upset)
NP2	The second noun phrase in the sentence, the set. (the customers)
VP2	The second verb phrase in the sentence, the predicate which may or may not be fulfilled. (leave a tip)

Table 1.4 Details of abbreviations used in content categories.

In total 3264 judgements were provided and their distribution across the 14 categories in relation to the four conditions can be seen in Table 1.5. The majority of continuations are distributed over only a few of the original categories, and so, categories with less than 25 judgements in each condition (EOE, CVP1, IG2, EA-VP2, SM and LG) were collapsed into a single category labelled Other for completion of further analysis.

The most prominent categories are the RW-VP1 and RW-VP2 which together account for 55.9% of the continuations (33.3% and 22.6% respectively). In addition to this the IG1, RWN-VP2 and CR categories account for a further 27.9%. Between conditions the number of judgements in the RW-VP1 category is relatively stable with a slight decrease in the low desire and positive emotion condition which is matched by a slight increase in the IG1 judgements for this condition. Judgements in the other categories are disbursed in varying patterns across the conditions.

Category	High/ Positive	High/ Negative	Low/ Positive	Low/ Negative	Total
RW-VP1	278	280	236	284	1078
IG1	81	72	124	69	346
EOE	10	15	7	12	44
CVP1	17	9	9	14	49
RW-VP2	239	91	186	232	748
RWN-VP2	13	223	59	15	310
IG2	11	11	25	25	72
CR	88	13	71	83	255
CC	7	34	10	6	57
ALT	21	28	35	27	110
EX-VP2	32	17	29	30	108
EA-VP2	4	5	4	6	19
SM	0	10	18	0	28
LG	14	3	13	9	39
TOTAL	**815**	**811**	**826**	**812**	**3263**
Other	56	53	76	66	859

Table 1.5 The total number of judgements in each 'content of sentence' category.

Due to the nature of the data collected inferential statistics were completed using hierarchical log linear models. These models draw upon the features of the chi-square and ANOVA in order to determine the significance of the differences on the data without relying on parametric assumptions or linear independence of factor levels. In this type of analysis the response is treated as a factor. As each item was seen by one participant only there is no separate analysis of participants and materials. Effects are reported as LRCS (Likelihood Ratio Chi-Square).

In an overall analysis of the continuations there was a significant three-way interaction between desire, polarity of emotion word and judgement (*LRCS = 285.34, df = 8, p<0.0001*). Further two-way interactions, calculated as partial associations, between desire and judgement, and between polarity of emotion word and judgement were also

significant (LRCS *=140.01, df = 8, p<0.0001;* and *LRCS 154.79, df = 8, p<0.0001* respectively). This shows that the judges' categorization was influenced by both the level of desire and the polarity of the emotion word, and that these factors interact. The number of categories makes it difficult to test the hypotheses using the full data set however and so it was decided to constrain subsequent analyses. Since I am interested in how the salience of a shortfall affects continuations, specifically if the continuation contains an explanation for or a consequence of the shortfall, further analysis has been limited to RW-VP2, RWN-VP2, CR, and CC. These categories represent explanations for and consequences of the second part of the sentence (giving a tip in our example). These four categories have also been used in previous studies to demonstrate patterns of sentence content (Moxey, 2006). This data is shown in Figure 1.2.

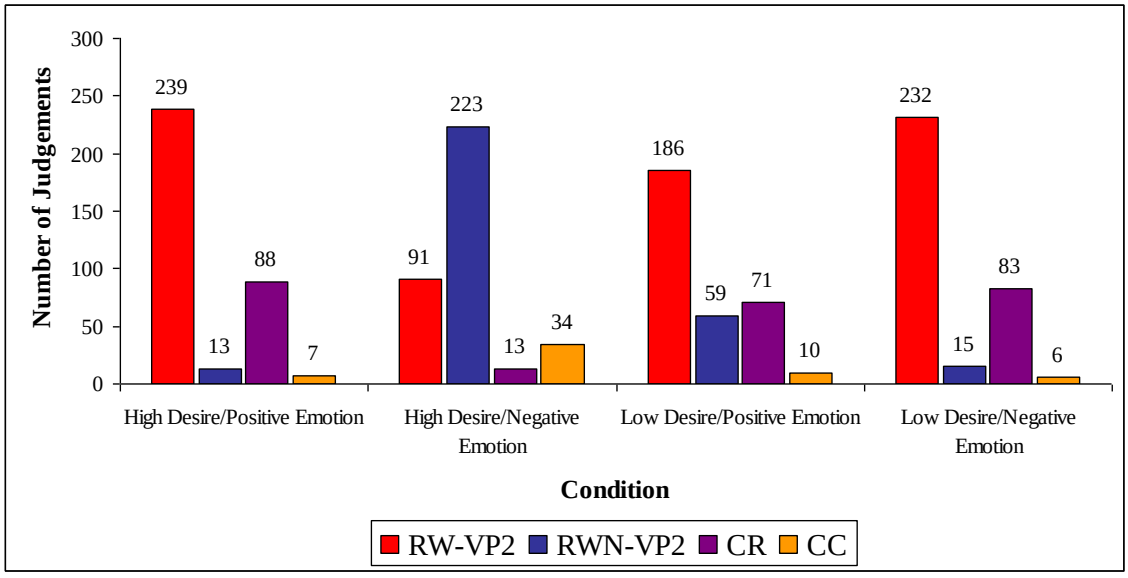

Figure 1.2. The total number of judgements in relevant 'content of sentence' categories for Experiment 1.

The RW-VP2 continuations displayed in Figure 1.2 follow a similar patterns to the reference set judgements seen in Figure 1.1. Further analysis of these continuations using log linear models revealed an interaction between desire, polarity of emotion and judgement (*LRCS = 75.95, df = 1, p<0.0001*), indicating that all effects within the interaction are significant. The effect of polarity is stronger when desire is *high* leading to a reduction of RW-VP2 continuations in the *high* desire and *negative* emotion

condition. In the *low* desire condition there is also a difference between RW-VP2 continuations for *positive* and *negative* emotions. In this case there are fewer when a *positive* emotion is used as opposed to a *negative* emotion, presumably because participants are focusing on the surplus and trying to explain it.

Continuations in the RWN-VP2 category follow the same pattern as complement set judgements and form an opposite pattern to the RW-VP2 judgements. Further analysis of RWN-VP2 judgements revealed all comparisons within the pattern to be significant in an interaction between desire, polarity and judgement (*LRCS = 180.63, df = 1, p<0.0001*). In this case there is a notable increase in this type of judgement in the *high* desire and *negative* emotion condition. The increase in RWN-VP2 continuations in this condition indicates that participants are providing an explanation for a shortfall made salient by the denial of an implied *high* desire with a *negative* emotion word. There is also a notable increase in these continuations in the *low* desire *positive* emotion condition compared to the *low* desire negative condition and the *high* desire positive condition.

The interaction between the two independent variables and judgements was again significant in the CR category (*LRCS = 50.69, df = 1, p<0.0001*) where there is a clear decrease in this type of continuation in the *high* desire and *negative* emotion category. Frequencies of judgements in the CC category were too low to allow further analysis, however from Figure 1.2 there is an increase in these judgements when a shortfall is salient.

The results of Experiment 1 show that when a character's desire is likely to be for a *high* amount and this desire is denied with a *negative* emotion word participants are likely to continue the sentence with a reference to the complement set. After this type of sentence participants were also more likely to provide an explanation for the shortfall, a Reason-why-not. Correspondingly in this condition there was a marked decrease in references to the reference set and content which gave a Reason-why. These results suggest that readers are sensitive to the implicit manipulation of desire, and to the confirmation or denial of that desire. In the *high* desire and *negative* emotion word condition participants infer that there is a shortfall between desired and actual amounts and focus is placed on this shortfall set. The participant's continuations referred to members of the shortfall set and gave explanations why these members did not fulfil the predicate, *i.e. why the customers did not tip the waitress*. These results support the hypothesis, when the shortfall is made salient sentence continuations are more likely to refer to the complement set.

In the *low* desire condition there is also a clear difference in type of reference and type of content after the two emotion words. When a *low* desire sentence contains a *negative* emotion word there are more reference set references and more Reason-why content. It is likely that this is due to the participant identifying a surplus in this condition. When the stationmaster is *upset about the number of trains which were delayed* there are a greater number of delayed trains than was desired. Participants then refer easily to that group which are in this case the reference set. The surplus also prompts readers to provide a Reason-why, an explanation for the number of late trains being more than desired.

Experiment 2

The production task used in Experiment 1 provides evidence of which sets are most available for reference given what has just been read. In the *high* desire and *negative* emotion condition, the reader must infer first that the desire in the sentence is *high* and second that a *negative* emotion means the desire has not been met, before generating a shortfall set. The results of this experiment indicate that these inferences have been made by the reader, and that the complement set is available for reference when desire is *high* and the desire is not met. However, this does not mean that the reference set is unavailable for reference in these circumstances. While reading a piece of text the reader may have several readily available referents for a plural pronoun. If during reading a *high* desire and *negative* emotion word sentence were followed by a reference to the complement set, would this reference be easily integrated into the preceding context? Alternatively if such a sentence preceded a reference to the reference set would the reader have difficulty processing this reference? In Experiment 2 eye-tracking was used to examine these questions. If the inferences in the initial sentences are made online then a complement set reference would be expected to be processed easily after a *high* desire and *negative* emotion word sentence, as a shortfall has been made salient. In contrast when the shortfall has been made salient a continuation to the reference set may be inappropriate and cause the reader some difficulty. When no shortfall is apparent, in all conditions except *high* desire and *negative* emotion, a complement set reference would be expected to cause difficulty during reading whereas a reference set reference would be processed with ease.

In order to test these hypotheses in an eye-tracking experiment it is necessary to add a third factor to the design, as the target sentences must either contain a reference to the reference set or the complement set. Therefore, to simplify the design somewhat, and

include only two factors it was decided to use only *high* desire materials. In Experiment 1 the biggest differences in continuations were found when desire was *high*, so that concentrating on *high* desire will allow us to investigate whether a complement set reference is easily integrated into the context when preceded by a shortfall made salient by the denial of a *high* desire. If this *high* desire is met (via a positive emotion word), then there is no shortfall and only reference set continuations should be easily integrated by readers.

Method

Participants

Participants were 36 native speakers of English all of whom had normal or corrected to normal vision. All participants were either undergraduate or postgraduate students at the University of Glasgow and were paid £6 to take part. Participants were unaware of the purpose of the study.

Materials and Design

There were 36 experimental items (see Appendix 2.1) one of which is shown in Table 2.1. Each item consisted of an initial neutral sentence followed by a second sentence which introduced a character and gave details of a positive or negative emotion which they had felt in relation to a specifically detailed numerical situation. The third and final sentence began with the anaphor *Their* and continued with a noun which described either the reference set or the complement set of the set mentioned by the previous sentence.

Condition	Material
Positive/Reference	The restaurant served good quality meals at reasonable prices. |[1]The waitress was|[2] **overjoyed** by |[3]the number of the customers who left her a tip.|[4] Their **kindness** |[5]influenced how she felt about her job.|
Positive/Complement	The restaurant served good quality meals at reasonable prices. |[1]The waitress was|[2] **overjoyed** by |[3]the number of the customers who left her a tip.|[4] Their **meanness** |[5]influenced how she felt about her job.|
Negative/Reference	The restaurant served good quality meals at reasonable prices. |[1]The waitress was|[2] **annoyed** by |[3]the number of the customers who left her a tip.|[4] Their **kindness** |[5]influenced how she felt about her job.|
Negative/Complement	The restaurant served good quality meals at reasonable prices. |[1]The waitress was|[2] **annoyed** by |[3]the number of the customers who left her a tip.|[4] Their **meanness** |[5]influenced how she felt about her job.|

Table 2.1 Examples of an experimental material in each condition,| denotes regions of analysis.

Two experimental variables were manipulated in a 2 (*positive* or *negative* emotion words) x 2 (*reference set* or *complement set* reference) design. Two of the four conditions were considered consistent **positive/reference set** and **negative/complement set**, and two were considered inconsistent **positive/complement set** and **negative/reference set**. Table 2.1 shows an example material in each of the four conditions. 4 files of 36 items were constructed with 9 items in each condition in a latin square design. Participants were randomly assigned to a file. The 36 items were interspersed at regular intervals between 56 filler materials, which were materials in an unrelated experiment. A further 7 unrelated materials appeared at the end of the experiment after a short break. All sentences were displayed to participants in Courier New font size 10 with two line spaces between each line of text.

Eye Tracking

The participants gaze location and eye movements were recorded from the right eye using a Forward Technology Dual Purkinje Image (DPI) generation 5.5 eye-tracker. A

bite-bar and forehead rest were used to keep the participants head position constant in order to minimise the effects of head movement on the eye-movement record. A VDU screen situated 60cm from the participant's eyes was used to display all the materials and gaze location was recorded every millisecond.

Procedure

Before starting the experiment participants were asked to read a set of instructions along with a description of the eye-tracking procedure. Participants were instructed to read each passage silently at a normal reading pace in order to comprehend the sentences as well as possible. Participants were then seated at the eye-tracker and a calibration procedure in which the participant was asked to fixate on a series of nine fixed targets was completed.

Before each experimental passage was presented participants were asked to complete a set pattern of eye movements. This task served two purposes, first it allowed the experimenter to check the calibration between each trial and second the sequence ended with the participant focusing on a fixation point at the top left of the screen which was also the point where the first character of the passage would be displayed. Once the participant was fixated on the top left point and an accurate calibration was confirmed the experimenter pressed a button which triggered the presentation of the experimental item. Each item was displayed on the screen separately. The passages consisted of 3 lines of text with 2 blank lines between them. Participants read the passage and then pressed either of two buttons. They were then returned to the automatic calibration screen or were asked to answer a comprehension question. Comprehension questions followed 50% of the passages and participants were told that they should comprehend the passages in order to answer the questions. Participants were not given details

regarding their performance on these questions. All participants answered 80% or more of the questions correctly.

Results and Discussion

For analysis the passages were divided into 6 regions in order to determine types of eye-movements and to collate reading times. These regions are indicated by vertical slashes in Table 2.2. Region 1 held a neutral introduction sentence and so is excluded from further analysis. Region 2 introduced the character and Region 3 contained the emotion word. Region 4 gave details of the set which may or may not fulfil the predicate of the sentence. Region 5 was the critical region containing a property of either the complement set or the reference set. The post-critical Region 6 contained the remainder of the critical sentence.

|The restaurant served good quality meals at reasonable prices. [1]|
|The waitress was[2]| **overjoyed** by [3]|the number of the customers who left her a tip. [4]| Their **kindness** [5]|influenced how she felt about her job. [6]|

Table 2.2 Regions of analysis for Experiment 2.

Five different measures of participant eye movements were used for the analysis: first pass reading time, total reading time and regression path time along with % first pass regressions out and % regressions in. First pass reading times give an indication of any difficulties which arise when the reader first encounters a region and these are defined as the sum of the duration of fixations made from the eye-movement first entering a region from the left to exiting that region to either the left or the right. Total reading times provide information about the total amount of time spent focusing on a region, giving an indication of overall difficulty and these are defined as the sum of all fixations made in the region. Regression path times are defined as the sum of all fixations from

when the processor first enters a region from the left until leaving it to the right. This measure therefore includes any regressions the processor has made to reread text and gives an indication of when a problem has been encountered in the text. % Regressions In and % first pass regressions out of a region provide the percentage of trials in which participants have returned to a region from the right or exited a region to the left respectively. Regressions In provide an indication of which regions the participant has chosen to re-read when they have encountered a problem in later text and regressions out give an idea of the regions in which the processor encounters significant difficulty and is then forced to return to previous text.

Before the analysis short contiguous fixations of less than 80ms were pooled using an automatic procedure and were then combined with larger fixations which were within one character. Significantly shorter fixations of under 40ms which were not within 3 characters of another fixation were excluded. Fixations which lasted more than 1200ms were reduced to this time. Trials where there had been significant tracker loss or where the participant had failed to properly read the passage were removed. This was completed by removing any trial where 2 or more adjacent regions had not been fixated on first pass. This accounted for 9.2% of the original data.

Tables 2.3.1 and 2.3.2 show the mean values for each of the eye-movement measures for each region and each condition. Each measure for each region was analysed with a 2 (polarity) x 2 (set) ANOVA which treated participants as a random variable (F1) and another 2 x 2 ANOVA which treated the sentence items as a random variable (F2).

Measure Condition	**Region 2**	**Region 3**	**Region 4**
First Pass Reading Time (ms)			
Positive/Reference Set	523.01 (25.8)	403.93 (17.1)	1435.56 (68.2)
Positive/Complement Set	517.51 (23.5)	393.06 (18.1)	1498.43 (71.1)
Negative/Reference Set	495.57 (25.4)	391.08 (16.6)	1472.57 (68.8)
Negative/Complement Set	515.87 (21.8)	400.42 (16.5)	1480.05 (66.3)
% Regressions Out			
Positive/Reference Set	2.85 (1.1)	13.18 (2.7)	11.93 (2.3)
Positive/Complement Set	3.22 (1.1)	11.08 (2.4)	8.45 (2.1)
Negative/Reference Set	3.86 (1.5)	14.16 (2.4)	12.88 (2.7)
Negative/Complement Set	2.24 (0.9)	9.71 (1.8)	9.96 (1.9)
Regression Path Time (ms)			
Positive/Reference Set	553.87 (28.9)	502.09 (21.5)	1655.53 (93.8)
Positive/Complement Set	554.36 (29.8)	503.79 (40.3)	1676.20 (81.0)
Negative/Reference Set	562.55 (46.0)	496.27 (23.6)	1724.98 (81.4)
Negative/Complement Set	546.93 (24.5)	477.37 (24.2)	1680.08 (84.7)
Total Reading Time (ms)			
Positive/Reference Set	598.04 (43.3)	526.41 (31.0)	1728.17 (110.8)
Positive/Complement Set	601.08 (40.5)	520.25 (36.2)	1823.19 (109.9)
Negative/Reference Set	609.12 (51.9)	560.78 (39.7)	1920.93 (151.6)
Negative/Complement Set	587.04 (43.1)	542.04 (45.9)	1869.66 (112.5)
% Regressions In			
Positive/Reference Set	19.14 (3.6)	12.61 (2.2)	12.65 (2.4)
Positive/Complement Set	16.52 (3.0)	12.07 (2.6)	16.41 (2.6)
Negative/Reference Set	21.87 (3.1)	21.27 (3.7)	15.36 (2.2)
Negative/Complement Set	16.27 (2.8)	15.46 (3.1)	21.54 (3.2)

Table 2.3.1 Means and Standard Errors for all measures for regions 2 to 4.

Measure Condition	**Region 5**	**Region 6**
First Pass Reading Time (ms)		
Positive/Reference Set	434.49 (23.5)	1038.71 (49.4)
Positive/Complement Set	457.25 (25.8)	1085.68 (50.2)
Negative/Reference Set	440.16 (23.7)	1116.10 (59.1)
Negative/Complement Set	437.78 (28.1)	1132.67 (67.6)
% Regressions Out		
Positive/Reference Set	9.33 (1.7)	19.55 (3.4)
Positive/Complement Set	9.69 (1.9)	31.43 (4.2)
Negative/Reference Set	12.63 (2.2)	24.10 (3.2)
Negative/Complement Set	14.53 (2.3)	22.59 (3.4)
Regression Path Time (ms)		
Positive/Reference Set	549.73 (30.7)	1488.52 (173.3)
Positive/Complement Set	551.08 (27.5)	1914.26 (245.7)
Negative/Reference Set	628.42 (48.4)	1813.49 (293.1)
Negative/Complement Set	652.10 (49.2)	1839.43 (304.7)
Total Reading Time (ms)		
Positive/Reference Set	536.26 (33.8)	1232.90 (79.4)
Positive/Complement Set	677.94 (54.9)	1417.32 (99.1)
Negative/Reference Set	601.18 (46.1)	1332.53 (99.2)
Negative/Complement Set	618.39 (46.5)	1398.30 (126.8)
% Regressions In		
Positive/Reference Set	10.03 (1.7)	
Positive/Complement Set	24.70 (3.1)	
Negative/Reference Set	13.14 (2.4)	
Negative/Complement Set	13.32 (2.2)	

Table 2.3.2 Means and Standard Errors for all measures for regions 5 and 6.

First pass reading times.

For each of the regions analysed there were no significant effects found using this measure, although the means for the inconsistent conditions *positive/complement set* and *negative/reference set* do show a slight increase in reading times in the critical region (Region 5).

First pass regressions out.

There were no significant differences in regressions out by-participants or by-materials in Regions 2, 3 and 4. In the critical region (5) there was a main effect of polarity (*F1 (1, 35) = 5.28, p<0.05; F2 (1, 35) = 5.74, p<0.05*) with more regressions out of this region occurring when the emotion word is *negative* regardless of whether the pronoun referred to the *reference set* or the *complement set*. In the post-critical region (6) there was a significant polarity x set interaction (*F1 (1, 35) = 14.37, p= 0.001; F2 (1, 35) = 6.21, p<0.05*). Analysis of simple main effects identified differences between the effects of the emotion word when followed by the *complement set* (*F1 (1, 35) = 10.43, p<0.01; F2 (1, 35) = 2.62, p=<0.05*) with more regressions out when polarity was *positive*. There were no differences in the effect of the emotion word when followed by the *reference set*. In addition there were more regressions out for the *complement set* as opposed to the *reference set* when these had been preceded by the *positive* emotion word (*F1 (1, 35) = 12.37, p< 0.01 ; F2 (1, 35) = 14.69, p< 0.01*), but there were no differences between the types of reference after a *negative* emotion word. These results suggest that on encountering the critical region participants have some difficulty parsing the referent of *Their* when the emotion word has been *negative*, this is reflected by the increase in regressions out of Region 5 in both the consistent and inconsistent *negative* conditions. However results from Region 6 indicate that processing of a critical region inconsistency has been carried over. In this region there was a significant interaction

between polarity and set by participants only (*F1 (1,35) 8.86, p = 0.005, F2 (1, 35) = 2.18, p>0.1*). Simple main effects by participants identified more regressions out of this region when a *positive* rather then a *negative* emotion word was followed by a *reference set* reference (*F1 (1, 35) = 5.81, p<0.05*). There were also more regressions out of the post-critical region after a *complement set* reference rather than a *reference set* reference when the preceding emotion had been *positive* (*F2 (1,35) = 10.57, p<0.01*). In fact the *positive* and *complement set* inconsistent condition resulted in participants regressing from this area in almost one third of trials.

Regression path times.

There were no differences in regression path times at Regions 2, 3 and 4. There was a main effect of polarity at the critical region (*F1 (1, 35) = 7.68, p<0.01; F2 (1, 35) = 7.09, p<0.05*) with longer regression path times when the emotion word was *negative*. In the post-critical region there was a significant interaction by-participants only (*F1 (1, 35) = 8.76, p<0.01; F2 (1, 35) = 1.87, p> 0.1*) with longer regression path times for the *complement set* than the *reference set* when the emotion word was *positive* (*F (1, 35) = 5.82, p<0.05*), and longer regression path times for the *reference set* when the polarity was *negative* rather than *positive* (*F1 (1, 35) = 10.97, p<0.01*). This pattern of results is consistent with the pattern made by first pass regressions out. Regressions path times in the critical region are longer only when sentences have included a *negative* polarity emotion word. But, in the post-critical region regression path times reflect the inconsistencies of the critical region.

Total reading times.

No differences were found at Regions 2 and 3. In Region 4 (pre-critical) there was a significant interaction of polarity x set by participants only (*F1 (1, 35) = 4.27, p <0.05,*

F (1, 35) = 1.4, p>0.05). Analysis of simple main effects by participants identified shorter total reading times in this region for sentences containing a *reference set* reference than a *complement set* reference when the emotion word was *positive* (*F1 (1, 35) = 5.89, p<0.05*). Total reading times were also shorter in this region if emotion word had been *positive* rather than *negativ*e when followed by a *reference set reference* (*F1 (1.35) = 11.06, p<0.01*). In the critical region there was also a significant polarity x set interaction (F1 *(1,35) = 6.70, p<0.05, F2 (1, 35) = 6.44, p<0.05*). Simple main effects indicated longer total reading times for the *complement set* than the *reference set* when the preceding polarity was positive (*F1(1,35) = 15.05, p<0.001; F2 (1,35) = 8.56, p<0.01*). Total reading times were also longer if a *reference set* reference had been preceded by a *negative* as opposed to a *positive* emotion word (*F1 (1,35) = 4.79, p<0.05; F2 (1,35) =3.51, p=0.07*).

In the post-critical region there was a main effect of set by participants which approached significance by-items (*F1(1,35) = 9.96, p<0.01; F2 (1,35) = 3.83, p=0.06*) where *complement set* references took longer to read than *reference set* references. From this analysis and the means in Tables 2.3.1 and 2.3.2 a pattern of eye-movements emerges, such that when a *negative* emotion word has been mismatched with a *reference set* continuation the processor seems to spend less time looking at the critical and post-critical regions and instead regresses out of the critical or post-critical region. Alternatively when the mismatch is between the *positive* emotion word and the *complement set* the processor spends extra time studying the critical and post-critical regions. This pattern of eye-movements can be investigated further by analysis of the regressions into earlier regions.

Regressions In.

In Region 2 there was a main effect of set significant by participants and marginal by items, with more regressions into this region when the critical region holds a *reference set* reference (F1 *(1, 35) = 3.85, p=0.058; F2 (1,35) = 2.95, p=0.09*). Regressions into the emotion word region (3) are highest in the *negative* and *reference set* condition and a main effect of polarity indicates there are more regressive eye-movements into this region when the emotion word is *negative* (*F1 (1,35) = 5.21, p<0.05; F2 (1,35) = 6.11, p<0.05*). The interaction and the main effect of set for Region 3 were not significant in either analysis. In the pre-critical region, an increase in regressions into this region is found in the *negative/complement set* condition. Here a main effect of set was significant by-participants and marginal by items, (*F1 (1,35) = 5.31, p<0.05; F2 (1,35) = 3.75, p=0.06*) and a main effect of polarity was also seen by items (*F1 (1,35) = 3.19, p>0.1; F2 (1,35) = 4.19, p<0.05*). There was no interaction in either analysis. In the critical region there is an increase in regressions in for the *positive* and *complement set* condition which is consistent with the increase in regressions out of the post-critical region. Regressions into the critical region produced an interaction between polarity and set *(F1 (1,35) = 14.46, p<0.001; F2 (1,35) = 18.19, p<0.001*). Simple main effects indicated that there were more regressions into a *complement set* reference when the emotion word had been *positive* rather than *negative* (*F1 (1,35) = 15.18, p<0.001; F2 (1,35) = 10.99, p<0.01*) and more regressions into a *complement set* reference rather than a *reference set* reference when the emotion word was *positive* (*F1 (1,35) = 25.41, p<0.001; F2 (1,35) = 30.18, p<0.001*). This pattern of regressions supports the previous results. *Negative* emotion words lead to an increase in regressions into the emotion word region and there are a greater number of these for the inconsistent *negative* and *reference set* condition. When the emotion word is *positive* however an

inconsistency with the *complement set* leads to regressions back into the critical, set determining, region.

If a character is described as having a positive emotion about the quantity of a set having a particular property, then subsequent pronominal reference to the *complement set* (the subset which does not have the particular property) causes difficulty for the reader. This is clear from the increased reading times and regressions in this condition. In comparison processing of a *reference set* reference (to the subset which does have the property) after this type of sentence is straight forward. For example in (2) *Their meanness* refers to the set of customers who did not leave a tip. This reference is inconsistent with the waitress' *positive* emotion about the number of customers leaving a tip and therefore causes processing difficulty. If *kindness* were substituted for *meanness* in this sentence the reference would then be to the set who did leave a tip allowing straight forward processing of the sentence.

(2) The restaurant served good quality meals at reasonable prices.
The waitress was overjoyed by the number of the customers who left her a tip. Their meanness influenced how she felt about her job.

(3) The restaurant served good quality meals at reasonable prices.
The waitress was annoyed by the number of the customers who left her a tip. Their kindness influenced how she felt about her job.

When a character's *negative* emotion denies the high desired amount, by implying that the quantity is lower than that desired, processing of all regions is slowed. The inconsistency between the shortfall made salient by this denial and a *reference set*

reference is manifested in an increase in regressions out after the critical reference, *Their kindness* in (3), and an increase in regressions back to the emotion word, *annoyed*. On encountering the *reference set* reference following a denial the processor recognises that the *negative* emotion fits neither the reference nor the implicit desire and consequently readers reread the emotion word in over one fifth of the trials.

Discussion

Experiments 1 and 2 provide evidence that a preference for pronominal reference to the complement set does not depend on the presence of a negative NLQ. In fact focusing on this set does not depend on any NLQ. These experiments demonstrate that denying a high desire with a negative emotion prompts a preference for the complement set.

In Experiment 1, high and low character desires were confirmed or denied using positive or negative emotion words. In a sentence production task there was an increase in pronominal reference to the complement set when the character's high desire had been denied by a negative emotion word. In contrast there was a decrease in references to the reference set in the same condition. In the same experiment I found that denying a desire with a negative emotion led to an increase in sentences containing a Reason-why-not. Experiment 2 using eye tracking methodology showed that sentence processing was disrupted when a high desire was denied with a negative emotion. Following this denial with a reference to the reference set lead to an increase in regressions to the emotion word region. Both of these experiments demonstrate that the processor has been able to infer the implicit desire in the sentences and the denial or confirmation of this desire given by the emotion word. When a high desire is inferred and then denied with a negative emotion this has made salient a shortfall between desired and denoted amounts. The prominence of the shortfall leads to focus on the

complement set in sentence production and easier integration of the complement set in language comprehension. According to Sanford et al., (2007) complement set focusing relies on the variable property of denial which is implicit in negative quantifiers. The results of these experiments provide further evidence for and expansion of the Presupposition Denial Account. Denial of a presupposition has been induced without use of explicit expectations or NLQs.

The pattern of results found in these experiments is similar to those found in previous experiments involving NLQs. In early experiments with language production it was established that after a positive NLQ reference set references were strictly observed. After a negative NLQ, complement set references and reason-why-not content, were preferred, but the overall pattern of reference was more distributed across categories (Moxey & Sanford, 1987; Sanford et al., 1996). The extent to which an NLQ leads to a complement set reference has been correlated with the judgement of that NLQ as indicating denial (Sanford et al., 2007). In the first experiment where high character desire is denied using a negative emotion word there is a clear preference for reference to the complement set over other sets. But the preference for the complement set in this condition does not equal the preference for the reference set in the other three conditions. The size of the shortfall created by desire and emotion words may vary with the extent to which the negative emotion word is taken as a denial. This variation in the denial caused by the emotion word has led to a more diffuse pattern of reference in this condition. The asymmetry between strict licensing of the reference set only for positives and more variable references available for negatives can also be identified in previous eye tracking experiments. Paterson et al., (1998) found that processing of complement set continuations after positive NLQs was extremely difficult where as processing of reference set continuations after negative NLQs leads to some, less

obvious, problems. These authors report that rather than license a specific anaphoric reference, negative NLQs deny the preceding supposition. The processor must then access the consistency of the presented anaphor with the denied situation.

The results of Experiment 2 reveal interesting patterns of eye movements during reading which may reflect the use of implicit desire and inferred amounts as opposed to the explicit expectations and NLQs used previously (Moxey, Filik & Paterson, 2009). As with the previous study the effect of reading an inconsistent referent is manifested in regressions and later reading measures. However the difference in reading patterns across the two inconsistent categories in Experiment 2 is striking. When a high desire is confirmed with a positive emotion and this is followed by a complement set reference there is an increase in time spent processing the critical and post-critical region. This indicates that participants understand and accept the preceding sentence but find a property of the complement set very difficult to integrate into the context. Because no shortfall has been made salient the only set available for reference is the set of individuals who fulfilled the predicate of the sentence. A reference to those who did not fulfil the predicate is wholly out of place and more time is spent reading and returning to this reference in order to establish how the complement set relates to the preceding narrative. In the second inconsistent condition when a high desire is denied with a negative emotion word the pattern of processing is quite different. First processing of all regions becomes more laboured. This increase in reading times may be simply because the participant recognises that the inferred amount is inconsistent with the desire. The passage is describing an undesirable outcome for the character and the reader takes time to process this. Alternatively, in this condition there is an obvious shortfall between the implicitly desired amount and the amount inferred by the emotion. On recognising this shortfall reading may slow as the processor establishes a set for

reference which is consistent with this shortfall, the complement set. Upon encountering an inconsistent reference to the reference set participants return to the emotion word in order to resolve the ambiguity. As the emotion word in this condition is inconsistent with the implicit desire and with the reference it is likely that this is identified as the inappropriate part of the sentence and is reread as confirmation of this. Understandably implicit desire and amounts inferred from emotion words cause different patterns of reading to those seen using expectation and NLQs. In the current experiments the reader must work hard to make a number of inferences before a correct reference can be found.

The patterns of results in these two experiments suggest that in specific cases the complement set is available for reference or preferable for reference. However the asymmetry in the eye-tracking results leads to the question of how readers actually resolve pronominal reference. It is possible that rather than come to a decision regarding the correct set for reference during processing readers are able to hold a number of referents in mind only reaching a decision when the reference is reached. One way to look more closely at the millisecond by millisecond integration of these references into the preceding text is to use electrophysiological techniques. More specifically the next chapter will examine the electrical changes in the brain at the time of integrating a reference set or a complement set reference.

Chapter 3

An electrophysiological examination of complement set focusing.

Introduction

The aim of this chapter is to support the results from Experiments 1 and 2 by exploring the temporal resolution of referential inconsistencies using event related potentials (ERPs). The results of Experiment 2 indicated an increase in processing time and an increase in regressions when reference set or complement set references were encountered after an inconsistent emotion word. However the asymmetrical nature of these results has led to speculation that during reading the intelligent processor is capable of holding a number of referents in mind and subsequently they are able to integrate any of these referents smoothly into the context. The conclusions which can be drawn from the eye movement study are limited. Significant results are predominantly found with later measures and so do not provide an accurate account of how the processor interprets a reference on first reading. One way to investigate the precise integration of the critical word is to examine the brain's electrical activity during processing of the referent. To investigate the integration of the word into the context ERPs produced by these words in electroencephalographic (EEG) data will be examined. The highly sensitive nature of ERPs allow them to provide detailed information about how the human brain processes stimuli, in this case words. This non-invasive technique can be used to determine temporal differences in the processing of these references as well as the polarity and topography of these effects.

Background

Event related Potentials

Each neuron in the human brain produces a small electrical potential. The potential produced by a single neuron is incredibly small, however the post synaptic electrical potentials produced by a large number of neurons in a parallel configuration may summate to produce a dipolar field. This is a field with positive and negative charges

between which a current flows. EEG provides a continuous recording of this electrical activity at the scalp. However, this raw EEG is limited in the amount of information it can provide regarding cognitive processes. The recording tends to reflect global electrical activity and is not sensitive enough to identify minute changes in activity related to a specific event or stimulus. When trying to pin point the specific brain activity related to a stimulus, for example words in language processing, it is therefore more common to use an average waveform, or ERP elicited by recording activity which is time locked to a stimulus over multiple trials and then averaged. This procedure reduces the noise in the data related to ongoing, non stimulus related, brain activity and accentuates the properties of brain activity related to the stimulus. These ERP waveforms, also known as evoked responses, are made up of a series of positive and negative deflections which provide a precise temporal record of underlying neural activity. These deflections or peaks, sometimes referred to as components, are distinguished by their *polarity*, whether they are positive or negative, their *latency*, the time at which they reach their peak and their *topography*, or scalp distribution. These waveforms have allowed researchers to investigate the cognitive processes underlying language processing and more specifically the integration of anomalous or inconsistent words and references.

The N400 Component

Kutas and Hillyard (1980) reported the first experiment to determine a specific ERP component related to language comprehension. Using a paradigm which presented the words in a sentence one by one they found that when the final word of a sentence was semantically incongruent with the preceding context as in (2), as opposed to semantically congruent as in (1), this led to an increase in the amplitude of the negative going waveform.

(1) He spread the warm bread with *butter*.

(2) He spread the warm bread with *socks*.

This deviation began approximately 250ms post word onset, ended at approximately 550ms post word onset and was maximal at around 400ms. This effect which was largely posterior in scalp distribution was labelled the N400 effect due to its polarity and latency. Note here that each content word of a sentence elicits a negative deflection at this latency. It is therefore the increase or difference in this negativity for a semantically incongruous word compared to a semantically congruent word which is termed the N400 effect. This effect is often but not always more prevalent on the right side of the head and is generally larger over centro-posterior electrodes as opposed to frontal sites (Kutas & Federmeier, 2007).

Variation in the amplitude and latency of this negative deflection has been documented in relation to low level lexical features of language processing such as word frequency, semantic priming and repetition (Holcomb, 1988, Smith & Halgren, 1989; Van Petten, Kutas, Kluender, Mitchiner & McIssac, 1991). This component is particularly sensitive to semantic violations both of immediate sentential context (see Kutas & Van Petten, 1994 for a review) and to more global discourse level context (Van Berkum, Hagoort & Brown, 1999). An early study demonstrated a reduction in the N400 component for every word in a passage. Using descriptions which make complete sense when presented after a title (e.g. the procedure for washing clothes) St. George, Mannes and Hoffman (1994) found that when presented without the title the words in the passages generated larger N400s. Providing a suitable context by way of the title led to a reduction in the N400 allowing these authors to infer that the N400 may be sensitive to

discourse level context as well as more local sentence violations. More recently Van Berkum et al (1999) have shown that words which are equally acceptable at sentence level as in (3) elicited a smaller N400 component (quickly < slowly) when they had been made coherent by the preceding context e.g. *The cat entered the room suddenly, startling a mouse which had found a bit of cheese in the corner*.

(3) The mouse *quickly/slowly* returned to its hole.

Importantly, if sentence (3) were presented alone, neither word would be anomalous given the local context, and so the N400 can be determined to be sensitive to words made incongruent by the wider discourse context. As a consequence the N400 component allows us to examine sensitivity to words made anomalous by the global context whilst remaining consistent with local sentence information.

Investigations into discourse level anomalies using the N400 component cover many areas of discourse including real world violations and negation (Ferguson, Sanford & Leuthold, 2008; Hagoort, Hald, Bastiaansen & Petersson, 2004; Kaup, Yaxley, Madden, Zwann & Ludtke 2007; Nieuwland & Kuperberg, 2008). In an experiment combining pragmatic context, negation and world knowledge Nieuwland and Kuperberg examined the integration of negated terms into sentences. Participants read sentences such as (4) for comprehension only:

(4) a. With proper equipment scuba-diving is very *safe* and often good fun.

b. With proper equipment scuba-diving isn't very *dangerous* and often good fun.

c. With proper equipment scuba-diving is very *dangerous* and often good fun.

d. With proper equipment scuba-diving isn't very *safe* and often good fun.

Results showed a larger N400 for the critical words (in italics) in sentences where the overall meaning was false (c and d) as opposed to when the overall meaning was true (a and b). This pattern of effects occurred regardless of whether the message was presented affirmatively or using negation. The authors conclude that licensed negation has no effect on the N400 and consequently negated statements are smoothly incorporated into an unfolding context, although this holds only for pragmatically licensed sentences as opposed to pragmatically unlicensed (or trivial sentences) such as *Bulletproof vests aren't very dangerous*. This investigation shows the integration of sentence level negation.

In sum, there is a general consensus that a word which is inconsistent or anomalous to a given global context will illicit an N400 of greater amplitude than that of a consistent word. This effect has been found for anomalous words both in a sentence final position and in a central position (reference). The results of Experiments 1 and 2 suggest that when a character's desired amount is denied using a negative emotion word the reader is focused on the shortfall and so a complement set reference is consistent with the context. The current experiment examines the integration of complement set and reference set references into supporting and ambiguous contexts. When these references follow an unsupportive context, that is when a complement set reference follows a positive emotion word and when a reference set reference follows a negative emotion word, I would expect an increase in the amplitude of the N400 component most notably over central and parietal sites.

The P600 Component

This later positive going component was first identified in relation to syntactic violations (Osterhout & Holcomb, 1992; Hagoort, Brown & Groothusen, 1993) but has more recently been linked to semantic violations (Hoeks, Stowe & Doedens, 2004; Kim & Ousterhout, 2005; Kolk, Chiwilla, van Herten & Oor, 2003; Kuberberg, Sitnikova, Caplan & Holcomb, 2003; see Kuperberg, 2007 for a review). This component is generally found between 500 and 800ms, is maximal around 600ms and is centro-parietal in distribution. The relationship of this component to semantic anomalies was first identified in an experiment which investigated animacy violations. Kuperberg et al. (2003) examined differences in the neurological processing of semantic violations by presenting participants with sentences where an inanimate noun phrase was followed by a semantically inappropriate critical verb (5). Processing of this verb was contrasted with processing of a verb where there was no violation of animacy but the verb was anomalous given the global scenario (6).

(5) Every morning at breakfast the eggs would *eat*…

(6) Every morning at breakfast the boys would *plant*…

In (5) the verb *eat* is incongruous as *eggs* are inanimate and so do not eat. In (6) the verb *plant* is incongruous with the breakfast context but does not violate the animacy rule. Results found that for (6) there was a strong N400 effect but no P600. For sentence (5) processing of *eat* led to an increase in the P600 but no increase in the N400 component. At the time this result was surprising since there was no syntactic violation or ambiguity in the sentence yet there was a clear increase in the amplitude of the P600. The contrasting lack of an N400 effect for *eat* but a clear N400 for *planted* in (6) suggests an influence of the good global fit of *eats* in the breakfast situation. Therefore

where an anomalous word fits the global context of the situation it is possible that processing difficulty will manifest itself as a difference in the ERP waveform at approximately 600ms as opposed to 400ms.

Thus, in relation to my data, the results of Experiment 2 suggest that participants are able to hold a number of referents in mind during reading, particularly where a shortfall had been made available using a negative emotion word. If this is the case it is possible that both reference set and complement set references hold a good global fit with the preceding context and so no N400 will be found. In this case it is possible that inconsistent references may show differences in the P600 component. That is after a positive emotion word there will be a greater positivity at around 600ms when participants are presented with a complement set rather than a reference set reference. After a negative emotion word there will be a greater positivity at this time after a reference set as opposed to a complement set reference.

Experiment 3

Method

Participants

18 students at the University of Glasgow took part in the experiment. These included 9 males and 9 females. All participants were native speakers of British English, had normal or corrected to normal vision and did not have any reading disorders e.g. dyslexia. Testing was completed in a single session which lasted approximately 2 and ½ hours including preparation time. Each participant was paid £15 for taking part.

Design

The experiment was a 2 (polarity of emotion word) x 2 (set) within participants design. Each of the materials was placed in 4 files and appeared in a different condition in each file. Each participant saw a single file which contained 40 materials in each of the 4 conditions in a latin square design (refer to Experiment 2 for a detailed description of this presentation method).

Materials

The materials for this experiment were 160 passages made up of 3 sentences, in a similar style to those in Experiment 2. These items were made up from the 36 experimental items used in Experiments 1 and 2 as well as 124 new items. Full details of these items can be seen in Appendix 3.1. Note that the increased number of experimental items for this experiment is necessary to increase the signal-to-noise ratio in the ERP data. Thus, I adhered to guidelines from previous studies (e.g. Van Berkum et al., 2004), providing 40 items per experimental condition. Each item consisted of a neutral initial sentence, a second sentence giving details of a character and an emotion which they experience in reaction to the number of a set who fulfilled the predicate of the sentence. The third sentence was the critical sentence which began with the pronoun *Their* and continued with a property of either the reference set or the complement set. The critical word was always the second word in the sentence. An example of a single material can be seen in Table 3.1 where the critical word is marked in bold. A full list of all experimental items can be found in Appendix 3.1.

Condition	Material
Positive/ Reference Set	Some people have to wait a long time for an organ transplant. The surgeon was pleased about the number of people willing to donate organs. Their **consent** would affect a patient's chances of survival.
Positive/ Complement Set	Some people have to wait a long time for an organ transplant. The surgeon was pleased about the number of people willing to donate organs. Their **refusal** would affect a patient's chances of survival.
Negative/ Reference Set	Some people have to wait a long time for an organ transplant. The surgeon was annoyed about the number of people willing to donate organs. Their **consent** would affect a patient's chances of survival.
Negative/ Complement Set	Some people have to wait a long time for an organ transplant. The surgeon was annoyed about the number of people willing to donate organs. Their **refusal** would affect a patient's chances of survival.

Table 3.1 An example of a material from Experiment 3 in each of the 4 conditions.

Items were displayed in a single random order and were interspersed between a further 160 materials from an unrelated experiment.

Procedure

After providing experimental consent participants were seated in a comfortable chair while an electrode cap and 6 external electrodes were applied to their head and face. Once application was complete participants entered the testing booth where they were seated approximately 80cm from the display screen. Checks were then completed to ensure each electrode was transmitting a suitable signal. Participants read instructions which asked them to attend to the sentences which appeared on the screen and to read them to ensure comprehension. They then completed a practice block of 6 passages to ensure the procedure was clear after which the experimenter provided further information if needed. Experimental items were then presented in the sequence detailed in Figure 3.1. To allow participants time to rest items were presented in 8 blocks of 40. Participants were advised that they could rest for as long as they wished between blocks.

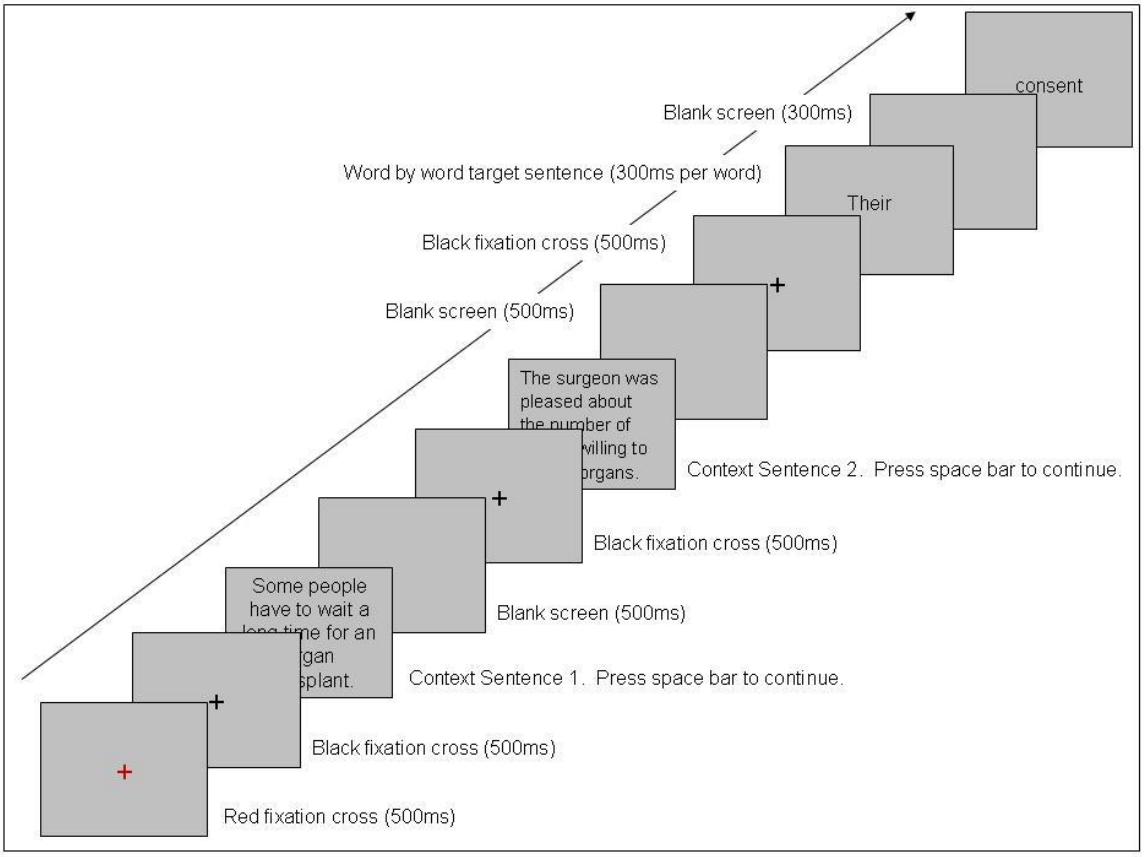

Figure 3.1 Schematic diagram of the experimental procedure for Experiment 3.

EEG Recording

A BIOSEMI Active-Two amplifier system was used for continuous recording of electroencephalographic (EEG) activity from 70 Ag/AgCl electrodes over midline electrodes Fpz, AFz, Fz, FCz, Cz, CPz, Pz, POz, Oz, and Iz, over the left hemisphere from electrodes IO1, Fp1, AF3, AF7, F1, F3, F5, F7, F9, FC1, FC3, FC5, FT7, C1, C3, C5, M1, T7, CP1, CP3, CP5, TP7, P1, P3, P5, P7, P9, PO3, PO7, O1 and from homologue electrodes over the right hemisphere (see Figure 3.3). EEG and EOG recordings were sampled at 1024 Hz. During recording the reference electrode was the Biosemi Common Mode Sense (CMS) electrode. Off-line, all EEG channels were recalculated to a linked mastoid reference. Trials containing blinks were corrected using a dipole approach (BESA Version 5.1.6) and automatic artifact detection software (BESA) was run. Trials with non-ocular artifacts (drifts, channel blockings, EEG

activity exceeding ± 120 μV) were discarded. For the remaining trials, epochs began at 200ms prior to the onset of the critical word and continued for 1500ms following critical word onset giving a total duration of 1700ms.

Results

Grand average waveforms for electrodes Fz, Cz and Pz can be seen in Figure 3.2.

The N400 Component

The N400 component was visually identified as beginning at 410ms and ending at 510ms. Analysis of this component was completed using a 2 (emotion word: positive, negative) x 2 (set: reference set, complement set) x 2 (electrode: Cz, Pz) Huynh-Feldt corrected repeated measures ANOVA. The main effect of set was significant ($F (1, 17) = 4.52, p<0.05$) with complement set references leading to a more negative pattern (-3.03 μV) than reference set references (-2.10 μV). The main effect of emotion word was not significant, nor was the interaction between these variables. Analysis of this time window over midline sites was extended to include 8 electrodes. A 2 (emotion word) x 2 (set) x 8 (electrode: AFz, Fz, FCz, Cz, Cpz, Pz, POz znd Oz) ANOVA was completed however this analysis yielded no significant interaction ($F < 1$) or main effect of either emotion word ($F (1, 17) = 1.56, p>0.1$) or set ($F (1, 17) = 2.51, p>0.1$)

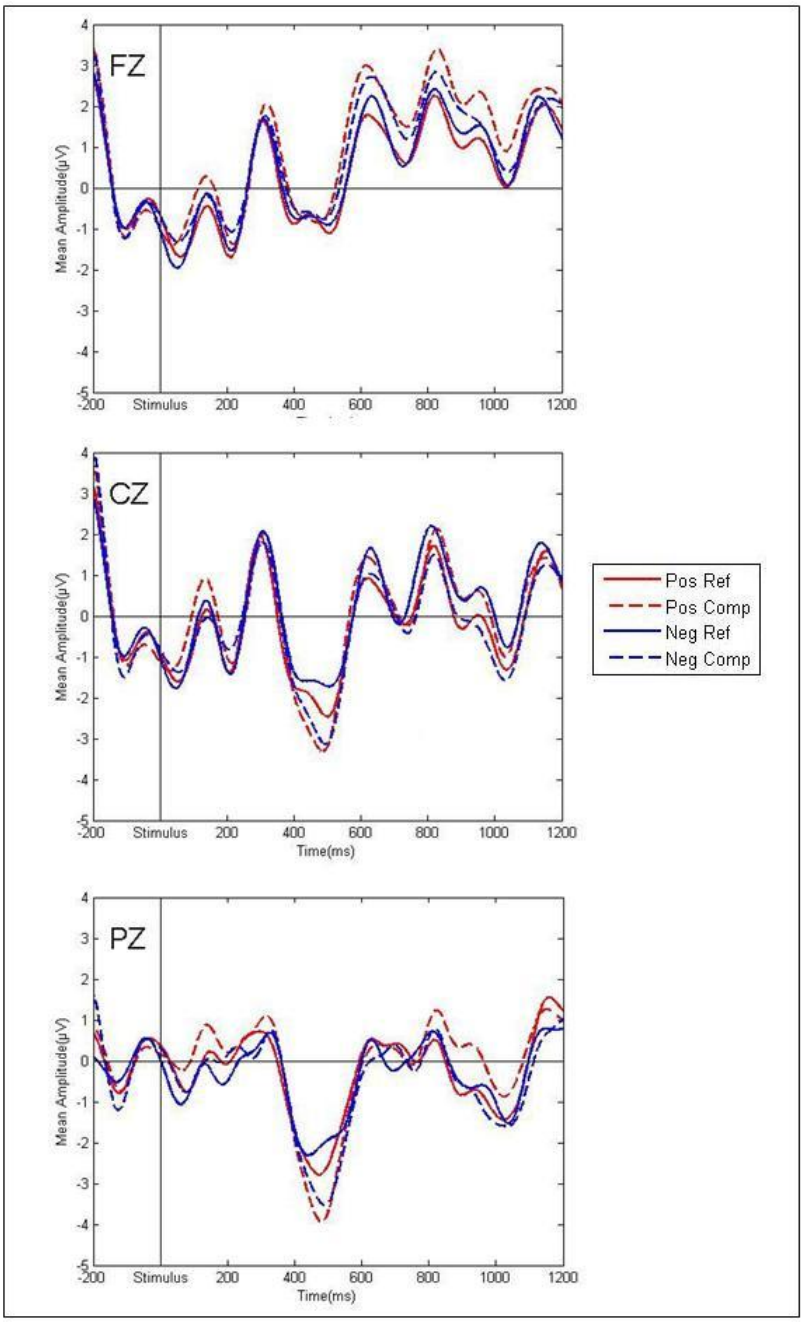

Figure 3.2. Grand average waveforms for three representative electrodes (Fz, Cz and Pz). Negativity is plotted downwards.

In order to analyse effects over lateral sites 30 electrodes were pooled into 10 regions of interest as illustrated in Figure 3.3. These sites were chosen to maximise analysis of left and right hemispheres and anterior/posterior sites without reducing statistical power. A 2 (emotion word) x 2 (set) x 2 (anterior, posterior) x 5 (left-to-right) x 3 (electrodes)

ANOVA revealed significantly more negativity at posterior electrode sites (*F (4,68) = 6.27, p < 0.05*) across all experimental conditions as is typical of the N400. In this analysis neither the interaction between emotion word and set (*F<1*) nor the main effect of these two variables was significant (*F (1, 17) = 2.34, p>0.1)* and (*F (1, 17) = 2.38, p>0.1*) respectively.

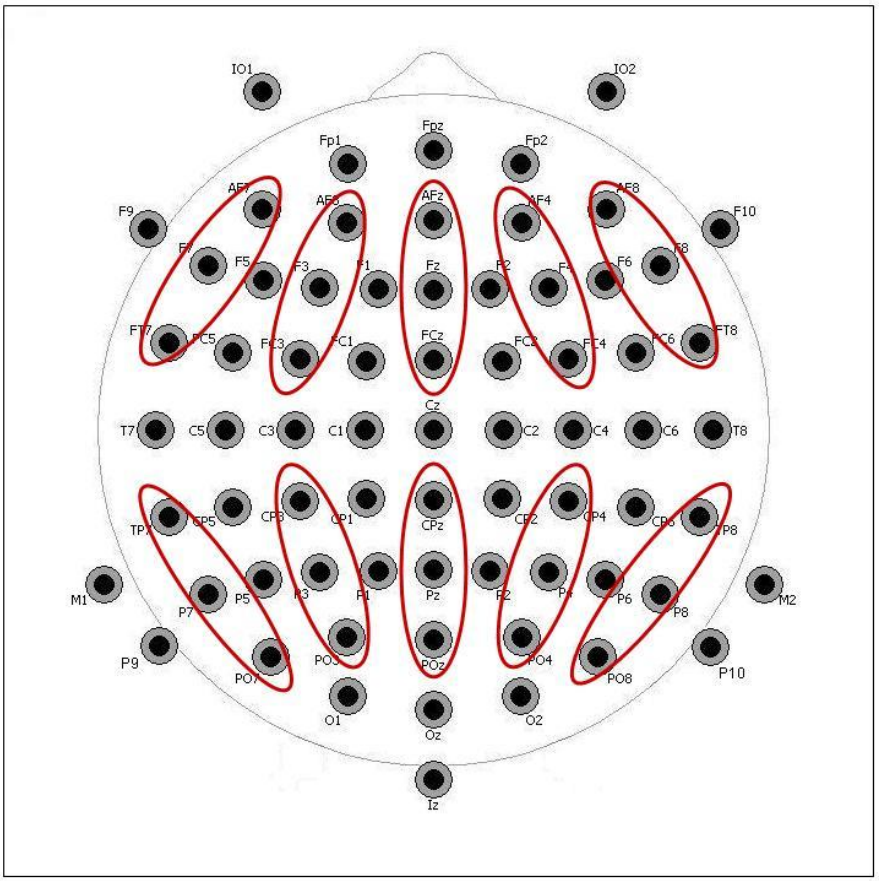

Figure 3.3 Arrangement of electrodes in Experiment 3. Regions of interest for statistical analysis are also shown.

Analysis of the N400 component determine that there is an increase in negativity of the for complement set references in a restricted central parietal area. This increase was found after both positive and negative emotion words. This was expected for complement set references after a positive emotion word but not after a negative emotion word where the shortfall was expected to make the complement set preferable. I will return to this issue in the discussion.

The P600 Component

This component was visually identified as beginning at 590ms and ending at 690ms after target word onset. Looking at the ERP waveform at electrode Cz, the evidence suggests an increase in positivity in the P600 time window in the positive/complement set and negative/reference set conditions, as predicted. Analysis of this time window was completed using 3 ANOVAs as in the previous N400 analysis. The 2 (emotion word: positive, negative) x 2 (set: reference set, complement set) x 2 (electrode: Cz, Pz) ANOVA found no significant main effect of polarity, no significant main effect of set and no interaction between these two variables (*all Fs<1*). There were also no significant effects of these variables in the 8 electrode midline analysis or in the 10 regions of interest analysis (*all Fs<1*). However, analysis of regions of interest did identify significantly more positivity at frontal electrode sites (*F (4,68) = 31.45, p<0.0001*). This is the typical topography of the P600 and does not reflect any differences between the conditions. Thus, descriptively the pattern of results for the P600 component in Figure 3.2, specifically at electrode Cz, suggests the shortfall between high desire and negative emotion has allowed a reference to the complement set to be integrated into the passage. However the robustness of this pattern is not supported by the statistical analyses, as the P600 is not significantly more positive when a reference set reference rather than a complement set reference is presented after a negative emotion.

Post Hoc Analysis

Further visual inspection of the ERP waveforms identified a prolonged decrease in positivity at frontal sites for reference set references beginning around 600ms post stimulus onset and ending around 1000ms post stimulus onset. A similar pattern has

previously been identified (Van Berkum, Brown & Hagoort, 1999) in cases of referential ambiguity and termed the Nref. Van Berkum et al., (1999) conducted an experiment to investigate ERPs during the processing of referential ambiguities. They presented participants with passages which provided either a single unique referent (7) for the critical pronoun phrase, in this case 'the girl', or two referents both of which are acceptable (8):

(7) David had asked the boy and the girl to clean up their room before lunch time. But the boy had stayed in bed all morning, and the girl had been on the phone all the time. David told *the girl* that had been on the phone to hang up.

(8) David had asked the two girls to clean up their room before lunch time. But one of the girls had stayed in bed all morning, and the other had been on the phone all the time. David told *the girl* that had been on the phone to hang up.

In conditions where establishing the correct referent was difficult the authors identified a distinct difference in the ERP waveform when compared with the single referent condition. This was a sustained frontal negative shift beginning at around 300ms after the onset of the noun. As this pattern of activity was very different from that seen with a typical N400 or P600 effect the authors took this as an indication that a different neural system is used for referential processing. These results were initially found with written sentences and were later replicated in a spoken experiment (Van Berkum, Brown, Hagoort & Switserlood, 2003). A later experiment (Van Berkum, Zwitserlood, Bastiaansen, Brown & Hagoort, 2004) also provided evidence that this result was not due to the expectation of a disambiguating relative clause (*that had been on the phone*). Finally an experiment by Nieuwland and Van Berkum (2006) went on to find a

comparable frontal negative shift for ambiguous pronouns.

As mentioned above and in the previous chapter it is possible that during reading a participant is able to keep a number of referents in mind for later discourse. If this is the case and the reader felt that the set determining reference did not identify a specific set then a possible Nref may be found. That is if the reader feels the reference is not to a unique set this may be seen in the ERP data. From Figure 3.2 it can be seen at electrode Fz that there is a prolonged deflection of decreased positivity in conditions containing a reference set reference. It is possible that this difference in the ERP waveform for reference set references indicates some increase in processing load associated with referential ambiguity. It is possible that readers require greater processing effort to identify the specific referent determined by the reference set reference. In order to test this possibility analysis was again completed using a 2 (emotion word: positive, negative) x 2 (set: reference set, complement set) x 2 (electrode: Fz, AFz) Huynh-Feldt corrected repeated measured ANOVA. There was a significant effect of set ($F\ (4,68) = 6.69, p<0.05$) with reference set references being more negative over this time period than complement set references. There was no effect of polarity or interaction between these variables (*both Fs <1*). In a further analysis including 8 midline electrodes there were no significant effects of emotion word (F<1), set ($F\ (1, 17) = 1.78, p>0.15$) and no interaction ($F<1$). Analysis across 10 regions of interest in this time window also identified no further significant differences between these variables (*all Fs<1*). However, once again there was significantly more positivity at frontal sites compared to posterior sites ($F\ (4,68) = 623.88, p < 0.0001$). Results from analysis of two frontal electrodes support the possibility that a reference set reference has led to a pattern of results similar to the Nref. Thus, during reading of a reference set reference it is possible that participants hold a number of different possible referents in mind, and

distinguish between them at some later stage of processing.

The topographic distribution of the Nref along with the N400 and the P600 can be seen in Figures 3.4 and 3.5. Figure 3.4 shows difference topographies for the positive complement set condition minus the positive reference set condition across the three time frames. In the N400 time window there is a clear increase in negativity at posterior sites in the positive complement set condition. In the P600 time frame there is only a slight difference between the two conditions at posterior sites whereas at frontal sites there is increased positivity for the positive complement set condition. This increase in positivity at frontal sites is then continued in the Nref time window. Figure 3.5 shows difference topographies for the negative complement set condition minus the negative reference set condition. In the N400 time window there is a large increase in negativity for the negative complement set condition at posterior sites. This is consistent with the analysis above where complement set references led to an increase in the polarity of the N400. In the P600 time frame there is still more negativity for the negative complement set condition, indicating that the negative reference set condition is more positive at posterior sites as identified above but not confirmed in the statistical analysis. At frontal sites there is a greater positivity for the negative complement set condition. In the Nref time frame the negative complement set condition remains more positive at frontal sites and more negative at posterior sites.

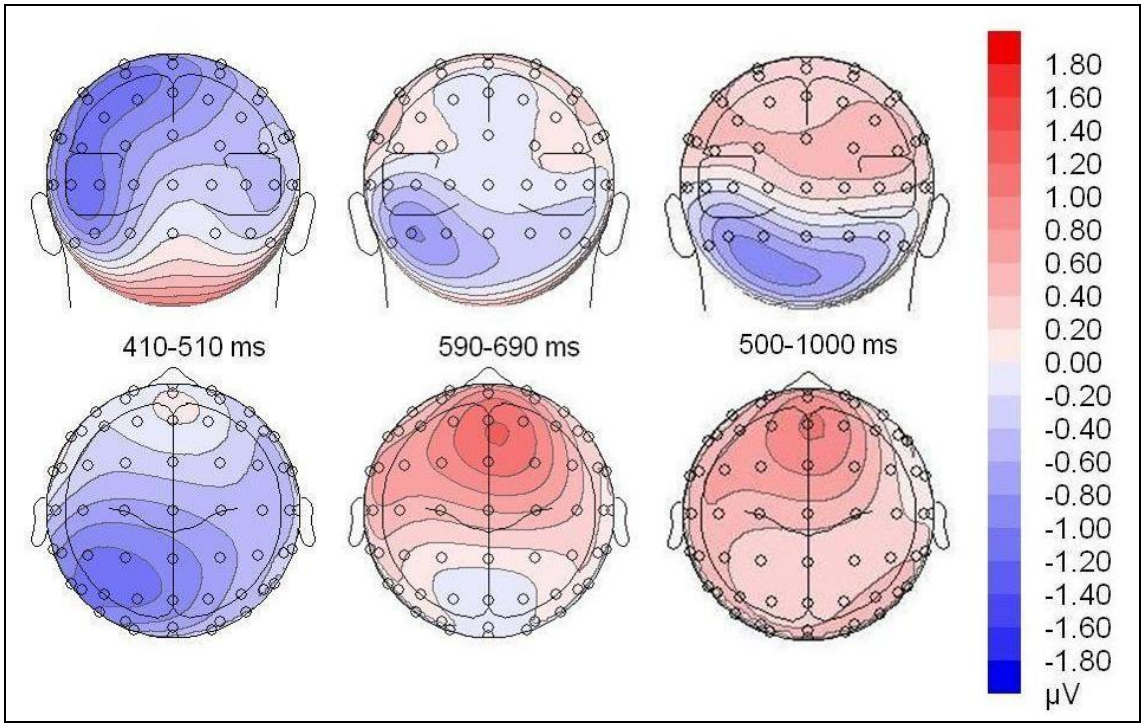

Figure 3.4. Topographic maps of ERP difference waveforms for each time period of interest (positive/complement set condition minus positive reference set condition): N400 (410 – 510ms), P600 (590 – 690ms) and Nref (500 – 1000ms).

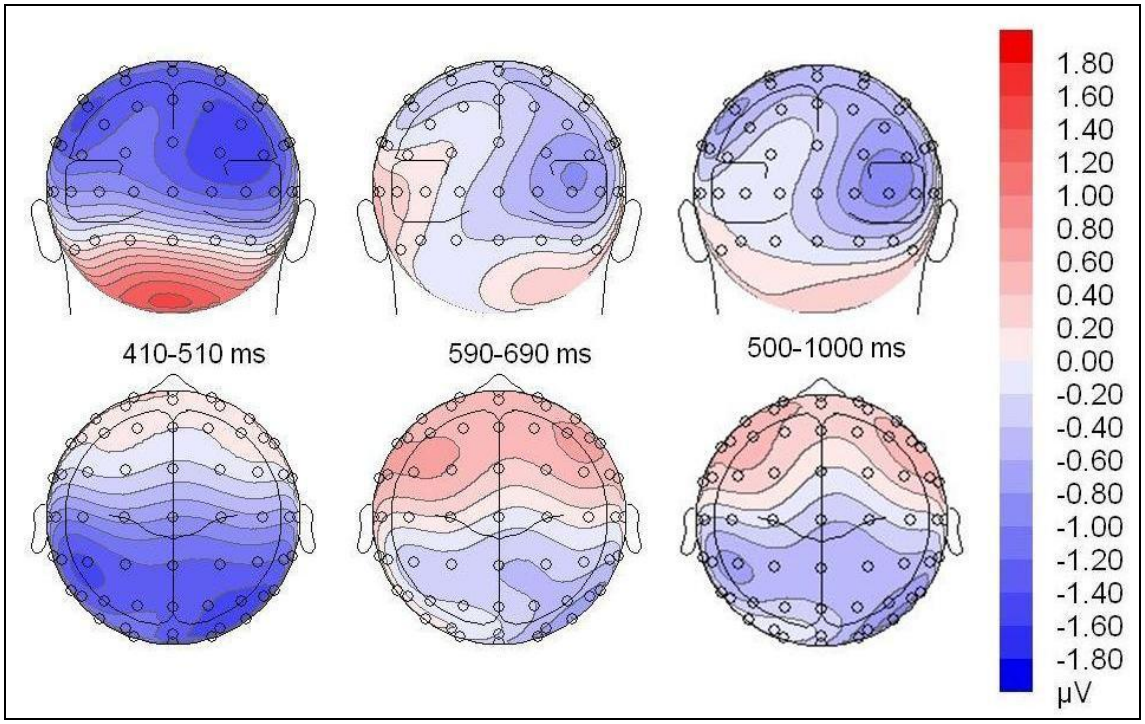

Figure 3.5. Topographic maps of ERP difference waveforms for each time period of interest (negative/complement set condition minus negative/reference set condition): N400 (410 – 510ms), P600 (590 – 690ms) and Nref (500 – 1000ms).

Discussion

The aim of this chapter was to use electrophysiological methods to investigate the millisecond by millisecond integration of reference set and complement set references into the preceding context. The initial hypothesis was that in inconsistent conditions there would be an increase in the amplitude of the N400 component, which has been shown to be sensitive to contextual mismatches. That is where a positive emotion word, indicating there is no shortfall, was followed by a complement set reference and where a negative emotion word, making a shortfall salient was followed by a reference set reference. This hypothesis was not supported by the data. In fact analysis of this timeframe found that at centro-parietal sites the amplitude of the N400 component increased after a complement set reference regardless of the prior emotion word. This result suggests that participants find a complement set reference anomalous even in situations where a shortfall between character's desired amount and a lower amount implied by a negative emotion word has been created. These results suggest that the information regarding the shortfall, which can be inferred from the emotion word, has not been integrated by the reader prior to processing of the critical word. At the time of encountering the critical word the denial of the character's desire has not been inferred and so the complement set not in focus. This conclusion is supported by the results of Experiment 2 where integration of a complement set reference appears to occur later in processing. In the eye-tracking experiment differences in processing of a complement set reference and a reference set reference were only apparent in later measures. However, due to the word-by-word presentation method in the current experiment (which is necessary to ensure data is not affected by eye movements required for normal reading) it is not possible to examine this later processing. It is therefore necessary to conclude that a shortfall created between a character's desired amount and that implied by a negative emotion word is not inferred quickly enough to allow immediate

integration of a reference to a complement set. This is not to say that a complement set reference remains anomalous in later sentence processing.

Further, following results from the eye movement studies in Chapter 2, it was also hypothesised that inconsistent references would lead to a larger P600 at central and parietal sites. If both reference set and complement set references were a good fit with the global context then inconsistent critical words may be visible in the P600 component (Kuperberg, 2007). Visual inspection of this component at electrode Cz suggested that after a shortfall had been made salient participants found a reference set reference more difficult to process than a complement set reference. However no differences were found in the statistical analysis of this component. First it must be noted that to ensure processing of the stimuli was as close to normal reading as possible word N+1, where the critical word is N, was presented 500ms post onset of the critical word. This leads to the possibility that the P600 component is modulated by early processing of word N+1. As with other ERP studies care was taken to ensure word N+1 remained as similar as possible across conditions and so it would be expected that any effect of this word would be removed during the averaging process. If the N400 component is too early to allow participants to fully infer the shortfall from the context it is likely that the P600 component would reflect integration of the complement set reference. Unfortunately this was not evident in the statistical analysis of the data.

Upon visual inspection of the data, differences in the waveforms were identified matching the pattern of the Nref component (Van Berkum et al., 1999; 2003; 2006; Nieuwland & van Berkum, 2006). This difference in processing was found at frontal sites and was not anticipated prior to completion of the experiment. It had been noted in previous research (Moxey et al., 2009) and in Chapter 2 that readers may be able to hold

a number of different referents in mind when encountering a pronoun. If this is the case it is likely that participants will experience some form of referential ambiguity, that is they may not be able to identify a single referent for the pronoun in question. Post hoc analysis of the later prolonged time window determined that reference set references were less positive than complement set references at two frontal electrodes. This leads to the possibility that a reference to the reference set is not in fact singling out a specific set but is allowing the reader to hold onto a number of different referents.

As a whole this set of results is an interesting addition to the literature on complement set focusing. The results of the N400 component were not as anticipated but I feel this does not invalidate the results of previous chapters. Note that this is not the only experiment in which negation of information has failed to allow integration of an upcoming word. Ferguson, Sanford and Leuthold (2008) demonstrated that context level negation does not lead to unaffected processing of real world violations. For example after being presented with a negated context *If cats were <u>not</u> carnivores they would be cheaper for owners to look after* participants read a sentence which was either consistent with the real world or with the negated world (5):

(9) Families could feed their cats a bowl of *fish/carrots* and listen to it purr happily.

Although the negated world might be expected to allow carrots to become consistent, a larger N400 was observed after carrots than fish. In this case details of the negated context have not been integrated at the sentence level, although the authors note that this may be due to later integration of sentence level information to the global context which is supported by an eye movements study. These results reflect the inconsistencies of the current study and support the possibility that complement set references which are seen

as anomalous on first reading may become acceptable or even preferable, as seen in Experiment 1, upon later analysis. The mode of presentation during this ERP study does not allow participants to return to previous areas of text or even to pause on a specific word. As a result the ERP waveform only reflects the electrical activity upon first reading of a word, an eye movement measure for which there were no significant results in Experiment 2.

The post hoc identification of differences between complement set and reference set references in the Nref component is an interesting addition to the literature on complement set processing. This result supports the idea that during discourse processing readers may not specifically resolve each pronoun encountered but instead keep a number of referents available. This possibility is supported by research on anaphor resolution (Levine, Guzman & Klin, 2000; Klin, Guzman, Weingarter & Ralano, 2006) where it was found that specifically resolving anaphors in situations where reading was coherent was detrimental to processing. In cases where an anaphor could refer to a non specific antecedent, participants chose not to resolve the anaphor even though this may have assisted processing (Levine et al., 2000). The current results reflect this possibility. A reference set reference may refer to the specific set that fulfilled the predicate of the sentence, but it may be taken as a more general default reference. In this case participants are not identifying a specific referent of the pronoun but are in fact allowing the possibility of a number of referents to assist future processing.

Interim Conclusions

Experiments 1-3 provide support for the Presuppositon Denial Account. In a situation where a character's implicit desire is denied without using an explicit NLQ the

complement set has been found to be salient in language production and language comprehension. Results of the ERP and Eye tracking experiments suggest that the preference for this type of reference may not be immediate but becomes clear in later processing. In processing of these passages a number of inferences must be made by the reader. These results show that these inferences are formed by the reader with little difficulty allowing the complement set to be in focus. These experiments have used neither explicit desire nor quantity but the inference of the denial has made a specific set salient.

In the following chapters the use of implicit character desire and emotion words will be applied to logically equivalent frames. As laid out in the introduction logically equivalent frames can lead a reader to focus on a specific attribute in a similar way to NLQs. The remainder of this thesis will examine the effect of these frames on reader focus when they are presented in isolation.

Chapter 4

Inferred desire and the information leakage account

Introduction

The aim of this chapter is to apply psycholinguistic methods to the framing of logically equivalent volume statements. In the preceding two chapters I have shown how manipulation of positive and negative emotion words can lead to a shift in reader focus. The following experiments demonstrate that these shifts in focus are not restricted to pronominal reference, manipulation of preceding context can make one of two seemingly equal statements favourable to the reader.

The information leakage account (Sher & McKenzie, 2006) describes how information can be leaked through a speaker's choice of a logically equivalent frame (see Chapter 1 for a full review). *Half full* and *half empty* are equivalent in that they refer to the same amount. However, by choosing to use one phrase over another a speaker may indicate (and a listener may infer) more information than is literally entailed by the phrase. For example, the previous state of the vessel or the speaker's desire regarding the fullness of the vessel. In a written experiment (McKenzie & Nelson, 2003) it was shown that if a character described a glass as now being *half full* a participant would infer that the glass had previously been *empty*. If the character described the glass as currently *half empty* the participant would indicate that the glass had previously been *full*. In a follow up more natural experiment participants were provided with a glass which was full of water and a glass which was empty. They were then asked to pour water from one glass to another in order to produce a *half full* glass. In this case participants tended to furnish the glass which had previously been empty. When asked to produce a *half empty* glass participants furnished the glass which had previously been full. In both these experiments participants have identified the volume which has increased relative to an implicit reference point. That is if given the frame *half full* participants may infer that the fullness of the glass has increased relative to the reference point of empty. Whereas

if given the frame *half empty* participants may infer that the emptiness of the glass has increased relative to the reference point of full. These changes in reference point due to the logically equivalent statement can be compared to the changes in focus which have already been seen with positive and negative emotion words. The reference point in this case was determined by the high desire. The negative emotion word has then allowed the reader to recognise the set which has increased relative to the reference point, in this case the set who do not meet the desire. This leads to reference to the complement set.

The purpose of the four experiments reported in this chapter is to begin to establish if inferences about previous volumes (the reference points) are made online during language comprehension. Inference of a reference point from given information or a given situation is obviously helpful in a choice based situation. The aim of this chapter is to establish whether these inferences can be made during reading and consequently affect the interpretation of later (or previous) text. To date experiments which investigate logically equivalent frames are choice based, that is participants determine which frame is appropriate. During communication this is not the case, readers or listeners are only presented with one frame and so must draw all necessary inferences from the frame given. If the statements were truly information equivalent then each one should be processed similarly causing readers no difficulty. Previous research suggests that the frames are not information equivalent and I do not disagree with this statement. The current experiments seek to examine if the information which is leaked from the frames in offline experiments can affect their interpretation during an online task.

Experiment 4(a)

In the previous online experiments materials were constructed such that explicitly mentioned characters would be understood to want a particular amount to be high. In

the eye movement experiment reported here a similar character desire will be inferred, in this case the desire for a container or vessel to be full, that is, a desire for fullness. The character's emotion with regard to the actual amount will be described using positive or negative emotion words. This initial sentence will be followed by the frame statement *half full* or *half empty*. These two volumes can be described as 'logically equivalent' (McKenzie & Nelson, 2003; Sher & McKenzie, 2006), that is no inference regarding the amount or volume can be made from the statement *half full* that cannot be made from the statement *half empty*. Yet in neutral situations the frames are not information equivalent, use of *half full* leads to an inference or reference point of 'previously empty' whereas use of *half empty* leads to a reference point of 'previously full'. The aim of Experiment 4(a) is to determine whether the introduction of a biasing context, in this case a character's desire for fullness, will affect the reference point which a reader infers from the frame.

As with the previous experiments the consistency of the frame with the character's desire will be manipulated via the character's emotion. In an emotionally neutral situation, where the character experiences no emotion, both frames would be consistent with the context. For example in (1) the reader will infer that the fisherman wants the nets to be full.

(1) The boat had been out at sea for a full week.
The fisherman noticed that the nets
were half *full/empty* and he wanted to return to shore soon.

Under the principles of the information leakage account, when readers encounter *half full* they will infer that the nets might have been empty and so are becoming fuller. In a

situation such as this where fullness is desirable *half full* is a good thing, if the desire was for emptiness this would be a bad thing. When the reader encounters *half empty* they will infer that the nets might have been full and so are becoming emptier, if emptiness was desired this would be a good thing but in this case it is a bad thing. In (1) although the desire may be inferred, the character has expressed no emotion with regard to the frame and so there is no information available to indicate whether the desire has or has not been met. In this case both frames, *half full* and *half empty*, are consistent with the context and should be processed without difficulty.

In the current experiment the character's emotional state was manipulated to examine whether or not the inferences described above are made during language comprehension. In example (2) the character experiences an emotion with respect to the volume of fish in the nets.

(2) The boat had been out at sea for a full week.
The fisherman was *happy/angry* because the nets
were half *full/empty* and he wanted to return to shore soon.

If the reader uses the given frame to determine a previous reference point then the positive emotion word would be consistent with the *half full* frame as this indicates an increase in the volume relative to empty. That is *half full* indicates that the fisherman's desire has been (or is on its way to being) met. If the character experiences a negative emotion with respect to the volume of fish in the nets this would be consistent with the *half empty* frame as this indicates a decrease relative to full. That is *half empty* indicates that the fisherman's desire has not been (or will not be) met. In this experiment all the sentences have been constructed so that the reader will believe the character wants

fullness. The combination of this desire and the two frames means that in half of the sentences the desire will be consistent with the frame statement and in half of the sentences the desire will be inconsistent with the frame statement. It is hypothesised that despite the equivalence of the two frame statements, when the character feels positively about the volume, *half full* will be processed easily. When the emotion word is positive, difficulty in processing is expected when reading *half empty*. In contrast, when the character experiences a negative emotion, *half empty* will be consistent, as it emphasises emptiness, and will be processed with ease whereas *half full* will cause the reader difficulty.

Method

Participants

The experiment was completed by 32 native speakers of British English. All participants were undergraduates or postgraduates at the University of Glasgow and were paid £6 or given course credit for taking part.

Materials

The experiment consisted of 32 items, (see Appendix 4.1) which were displayed along with 64 filler items from an unrelated experiment. An example of one item shown in all 4 experimental conditions can be seen in Table 4.1. Each item consisted of an initial neutral sentence. The second sentence introduced a character or characters along with an emotion they were experiencing, and provided an explanation for the emotion. The explanation in the second sentence was always in terms of a container or a vessel which was either *half full* or *half empty*.

Condition	Material
Positive/Half Full	The boat had been out at sea for a full week. The fisherman was **happy** because the nets were half **full** and he wanted to return to shore soon.
Positive/Half Empty	The boat had been out at sea for a full week. The fisherman was **happy** because the nets were half **empty** and he wanted to return to shore soon.
Negative/Half Full	The boat had been out at sea for a full week. The fisherman was **angry** because the nets were half **full** and he wanted to return to shore soon.
Negative/Half empty	The boat had been out at sea for a full week. The fisherman was **angry** because the nets were half **empty** and he wanted to return to shore soon.

Table 4.1 An example of a material from Experiment 4(a) in all 4 conditions.

The context of all sentences was manipulated so that the desirable outcome would be a full vessel. The critical word in each material was *full* or *empty* and this was always followed by the word *and*. Therefore the critical region only ever differed in length by one character. Differences in word frequency of the critical words and the emotion words were minimal. Using the British National Corpus it was found that *full* occurred 282.1 times per million words and *empty* occurred 53.79 times per million words. Due to the context of the sentences different emotion words were used to different degrees, that is some of the emotion words were used in more items than others. Positive words were *pleased, excited* and *happy*. Negative words were *ashamed, annoyed, worried* and *angry*. Emotion words had a maximum length of 7 characters and a minimum length of 5 characters. Collectively mean word length of the emotion word region was 6.94 characters in the positive emotion condition and 6.94 characters in the negative emotion condition. Again using the British National Corpus it was established that positive words had a mean frequency of 60.1 per million words and negative words had a mean frequency of 25.7 per million words. Although it is expected that any effects which are

related to word frequency will be overridden by context it is notable that both negative emotion words and the critical word *empty* have a lower word frequency than their alternative positive and *full* counterparts. Words with lower frequency (occurrence) in language tend to lead to longer reading times (Inhoff & Rayner, 1986; Rayner, Sereno & Raney, 1996; Sereno & Rayner, 2003) and this will be considered when discussing the results.

Eye-tracking

Eye movements and gaze locations were recorded from each participant's right eye using a SR Research Desktop Mount EyeLink 2K eyetracker. A chin and forehead rest were used to ensure minimal head movement during recording. Pupil and corneal reflection tracking was used to sample gaze location at 1000Hz. All materials were displayed on a flat CRT monitor situated approximately 72cm from the participant's eyes. Each experimental passage was displayed over 3 lines of text with 2 blank lines in between. Lines were a maximum of 70 characters long. Text (black letters on a white background) was displayed in Vera sans mono bold point size 12.

Design

There were 4 versions of each of the 32 materials corresponding to the conditions in Table 4.1. There were two experimental manipulations, polarity of emotion word (*positive* or *negative*) and frame (*full* or *empty*). Two of the resulting 4 conditions were considered to be consistent, **positive emotion/full** and **negative emotion/empty**, and two were considered to be inconsistent, **positive emotion/empty** and **negative emotion/full**. Each of the 32 items appeared in 4 files containing 8 items in each condition. The 4 different files allowed for the display of each material in a different condition, in a latin square design. Participants were assigned randomly to a file. Items

were displayed in random order and dispersed randomly amongst the filler items from an unrelated experiment.

Procedure

All participants were asked to read the instructions for the experiment and details of the eye-tracking procedure. Participants were told that they should read each passage at their normal silent reading pace in order to comprehend. They were informed that a comprehension question requiring a yes/no answer would be given after around 50% of the trials. Once seated at the eye tracker resting their head comfortably on the chin and forehead rests, participants completed a calibration procedure where they were asked to fixate on a series of 9 points. This calibration was used to establish the correlation between the x and y coordinates of the participant's gaze and the position on the screen. Calibration was monitored throughout the experiment and occasionally required adjustment. Prior to displaying an experimental passage participants were asked to fixate a black spot in the centre of the screen. The experimenter monitored this fixation and pressed the space bar to move on once the dot had been fixated correctly. A black square then appeared at the top left of the screen precisely where the first letter of the experimental passage was to be displayed. Once participants fixated this square the EyeLink system automatically displayed the experimental item. Problems of calibration were easily identified as this generally meant an increase in the time taken for EyeLink to pick up a correct fixation on the black square.

Each experimental item was displayed on the screen separately. Participants read the passage and then fixated at the bottom right of the screen, once fixated here they pressed one of two buttons and were either returned to the screen with a dot in the centre or were required to answer a comprehension question. Half of these questions required an

answer of 'yes' which participants could choose with a button at their right index finger. If the answer was 'no' participants answered with their left index finger. All participants answered 79% or above of these questions correctly. No feedback was given to participants regarding their performance on these questions.

Results

For analysis the sentences were broken into 7 regions as shown in Table 4.2.

The boat had been out at sea for a full week.[1]|
The fisherman was[2]| happy[3] |because the nets[4]|
|were half[5]| full and[6] |he wanted to return to shore soon.[7]|

Table 4.2 Regions of analysis for Experiment 4(a).

These regions were then used to collate reading times and determine different types of eye movements. In each material Region 1 was a neutral introduction sentence and so has not been included in any of the analyses. Region 2 introduces a character or characters and Region 3 details the emotion they are experiencing. Region 4 gives details of the vessel in question. Region 5 was the pre-critical region and always contained either the words [were half] or [was half]. Region 6 was the critical region and contained either the words [full and] or [empty and] dependent on the condition. Finally Region 7, the post-critical region, contained the remainder of the critical sentence.

As the emotion word used in Region 3 was dependent on the context it was not possible to match these exactly for length however the length of this region never varied by more than two characters. The pre-critical and critical regions varied in length by one character dependent on grammar and condition as noted above. In the post-critical

region the number of words varied depending on context but the length of this region did not differ by more than 3 characters for any one material.

Five measures were applied to the data (for a more detailed explanation of the measures and a description of how they are calculated refer to Experiment 2) these were first pass reading time, total reading time, regression path time, % first pass regressions out and % regressions in. Furthermore as in Experiment 2 before completion of the analysis an automatic procedure was applied so that fixations of less than 80ms were pooled with larger fixations within one character. Extremely short fixations <40ms were excluded if they were not within 3 characters of a longer fixation and fixations in excess of 1200ms were truncated to this time. If the participant failed to read the passage adequately or there was a large amount of tracker loss trials were excluded. These trials were determined where the participant had not fixated in two or more adjacent regions on their first pass. This accounted for 3.42% of the initial data.

Table 4.3.1 gives the mean values for each of the eye movement measures in each condition for Regions 2 – 4, Table 4.3.2 provides these values for Regions 5 – 7. Region 1 has not been included as this contained a neutral sentence in every condition. Region 2 contained only neutral details of the character(s) and this region has been excluded from the First Pass and Regression Path Analysis as these measures cannot be affected by information which has yet to be introduced. As Region 7 is the last region, regressions in are not calculated for this region. Each measure in each region was analysed using a 2 (emotion word polarity) x 2 (frame) ANOVA treating participants as a random variable (F1), and then again in a 2 x 2 ANOVA which treated items as a random variable (F2).

Measure Condition	**Region 2**	**Region 3**	**Region 4**
First Pass Reading Time			
Positive/Full	-	226.39 (10.3)	515.61 (21.6)
Positive/Empty	-	224.32 (9.1)	517.53 (27.8)
Negative/Full	-	221.81 (7.4)	472.77 (23.6)
Negative/Empty	-	222.97 (7.8)	460.95 (20.3)
Regressions Out			
Positive/Full	2.59 (1.2)	21.30 (3.5)	5.71 (1.4)
Positive/Empty	0.91 (0.6)	17.02 (3.5)	6.02 (1.9)
Negative/Full	1.95 (0.9)	11.46 (2.5)	6.81 (1.8)
Negative/Empty	0.78 (0.5)	16.38 (3.3)	9.48 (1.9)
Regression Path Time			
Positive/Full	-	329.69 (18.9)	549.11 (21.7)
Positive/Empty	-	308.67 (19.6)	559.59 (30.1)
Negative/Full	-	289.30 (15.7)	511.63 (27.1)
Negative/Empty	-	297.67 (17.9)	527.79 (21.9)
Total Reading Time			
Positive/Full	388.74 (20.7)	273.37 (12.6)	554.86 (20.2)
Positive/Empty	373.79 (21.1)	276.18 (12.9)	596.26 (27.0)
Negative/Full	402.31 (21.8)	255.01 (10.3)	522.44 (25.6)
Negative/Empty	379.43 (16.7)	260.84 (10.5)	511.76 (20.1)
Regressions In			
Positive/Full	25.00 (3.8)	9.17 (2.3)	9.09 (2.4)
Positive/Empty	22.10 (3.6)	11.35 (2.7)	17.06 (3.6)
Negative/Full	17.15 (2.9)	5.19 (1.2)	10.96 (2.4)
Negative/Empty	20.73 (3.1)	7.70 (1.9)	5.02 (1.3)

Table 4.3.1 Means and Standard Errors for all measures for regions 2 to 4.

Measure Condition	**Region 5**	**Region 6**	**Region 7**
First Pass Reading Time			
Positive/Full	302.61 (11.4)	204.72 (10.9)	1111.15 (46.8)
Positive/Empty	305.91 (13.4)	216.96 (10.5)	1070.41 (41.4)
Negative/Full	309.85 (13.9)	193.86 (9.3)	1035.72 (46.4)
Negative/Empty	303.79 (15.8)	200.97 (8.7)	1085.18 (43.6)
% Regressions Out			
Positive/Full	0.00	8.87 (2.9)	23.40 (4.4)
Positive/Empty	2.12 (0.9)	8.12 (2.4)	26.21 (4.6)
Negative/Full	2.73 (1.2)	6.42 (1.9)	20.78 (4.6)
Negative/Empty	0.45 (0.4)	8.37 (2.6)	13.69 (3.7)
Regression Path Time			
Positive/Full	302.61 (11.4)	242.65 (13.4)	1341.49 (69.0)
Positive/Empty	318.41 (13.9)	265.97 (19.7)	1351.15 (74.6)
Negative/Full	317.97 (13.7)	221.71 (12.5)	1251.98 (56.3)
Negative/Empty	307.05 (17.2)	226.54 (13.5)	1239.75 (68.5)
Total Reading Time			
Positive/Full	307.01 (13.6)	197.99 (14.1)	1188.00 (51.5)
Positive/Empty	319.92 (18.4)	228.53 (16.4)	1167.96 (47.8)
Negative/Full	310.26 (15.6)	172.97 (9.2)	1104.16 (42.7)
Negative/Empty	305.28 (18.5)	187.16 (16.0)	1138.87 (50.8)
% Regressions In			
Positive/Full	11.21 (2.9)	5.46 (1.8)	-
Positive/Empty	11.81 (2.6)	8.03 (1.9)	-
Negative/Full	6.42 (1.8)	4.91 (1.7)	-
Negative/Empty	8.37 (2.6)	2.84 (1.0)	-

Table 4.3.2 Means and Standard Errors for all measures for regions 5 to 7.

First Pass Reading Times

This measure provides details of the length of time spent fixating a region from first entering that region from the left to first exiting the region to either the right or the left. These times may indicate any difficulty experienced by readers when first encountering a region. In Region 3 no significant results were found using this measure. In Region 4, after the emotion word, there was a significant main effect of polarity by both participants and materials ($F1\ (1, 31) = 17.31, p<0.001; F2\ (1, 31) = 6.04, p<0.05$). Less time was spent in this region when the emotion word was *negative*. A significant effect of polarity was also found in Region 6 (critical region) by materials only ($F1\ (1,31) = 1.91\ p>0.1; F2\ (1, 31) = 5.85, p<0.05$), with faster processing of this region after a *negative* emotion word. There was no main effect of frame or interaction between the two variables in Regions 4 or 6, and there were no significant effects of first pass reading time in either Region 5 or Region 7.

% First Pass Regressions Out

This measure details the percentage of trials in which the reader first exits a region to the left and it gives an indication of when a problem or ambiguity is encountered causing the processor to regress to a preceding region of text. From the means in Table 4.3.1, Table 4.3.2 and Figure 4.1 it can be seen that the mean % of regressions out in Regions 2 and 5 are very low and therefore any differences in these regions can be considered unreliable and will not be reported.

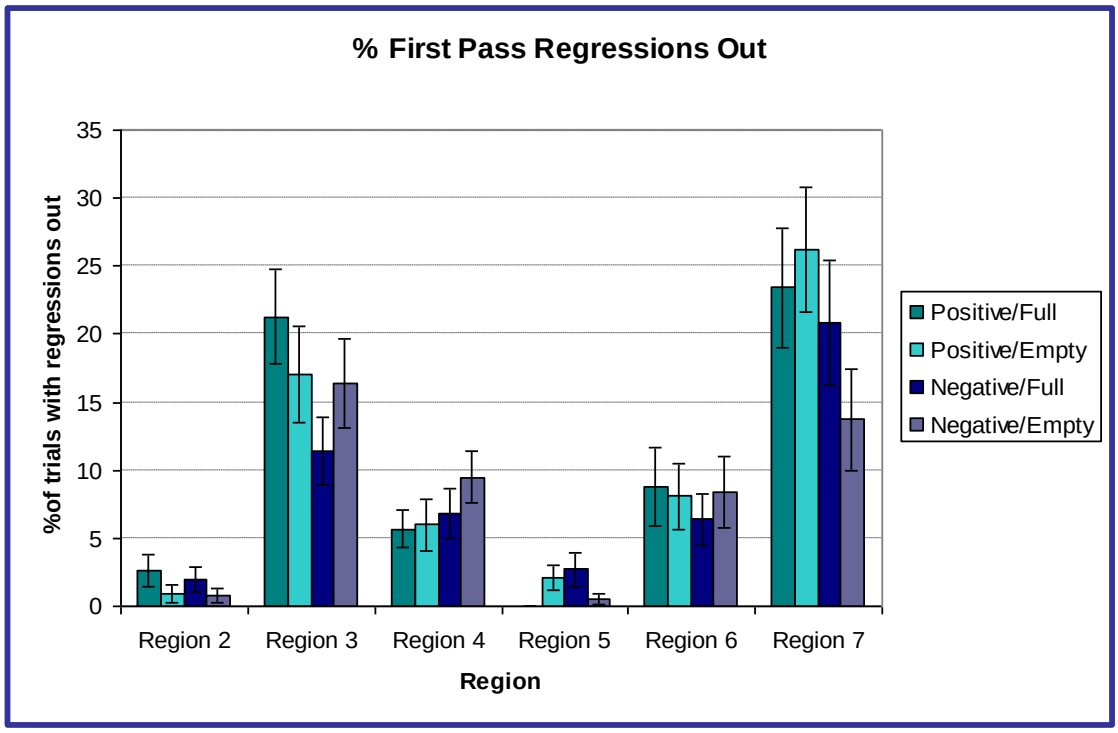

Figure 4.1 % First pass regressions out for Region 2 to 7 in Experiment 4(a).

In Region 3 an interaction between polarity and frame approached significance by both participants and materials (*F1 (1, 31) = 3.91, p=0.057; F2 (1, 31) = 2.96, p=0.09*). Simple main effects by both participants and materials found an increase in regressions out of this region for *positive* as opposed to *negative* emotion words when the frame was *full*. As the participant has not read the frame at this point few conclusions can be drawn from this result. There was also a main effect of polarity in Region 3, with *negative* emotion words leading to fewer regressions than *positive* emotion words. This effect was significant by participants and borderline by materials (*F1 (1, 31) = 5.94, p<0.05; F2 (1, 31) = 3.96, p=0.055*). In Region 4 there was also a main effect of polarity by participants only (*F1 (1, 31) = 4.63, p<0.039*; F2 (1, 31) = 1.34 p>0.1) with *negative* emotion words leading to more first pass regressions out of this region. In the critical region (6) there were no significant differences using this measure. In the post-critical region (7) there are a large number of regressions out. In this region the interaction between polarity and frame was borderline by participants and not significant by materials (*F1 (1, 31) = 3.28, p=0.08, F2 (1, 31) = 2.50, p=0.12*). The

main effect of polarity in this region was significant by both participants and materials (*F1 (1, 31) = 6.67, p<0.05; F2 (1, 31) = 8.73, p<0.01*) with more regressions out of this region when the emotion word had been *positive*. There was no significant effect of frame in this region.

The pattern of first pass reading times and % first pass regressions indicate that during initial processing of the sentences participant's reading is disrupted by *positive* emotion words. This disruption is present for both frame statements regardless of whether they are consistent *(full)* or inconsistent *(empty)* with the *positive* emotion.

Regression Path Times

This measure details fixations times from when the reader first enters a region from the left to when they exit that region to the right and so includes any first pass regressions. These times can identify where problems were encountered in the text and also give an indication of how long it took to resolve these problems before moving forward. In Region 3, where the participant first encounters the emotion word, there is an increase in regression path time when the emotion word is *positive*, this effect of polarity is seen by participants and is marginal by materials (*F1 (1, 31) = 4.92, p<0.05; F2 (1, 31) = 3.21, p=0.08*), notably as *positive* emotion words have a higher frequency than *negative* words it would be expected that they would be processed faster. In Region 4 regression path times are again longer when this region is preceded by a *positive* emotion word, although this is only significant by participants (*F1 (1, 31) = 6.70, p<0.015; F2 (1, 31) 1.93, p>0.1*). In the pre critical region (5), there is an interaction approaching significance by participants only (*F1 (1, 31) = 4.05, p<0.053; F2 (1, 31) = 1.38, p>0.01*). The means for this region suggest that participants spend longer in this area when the frame is inconsistent with the emotion word. However, this trend is not

confirmed by the simple main effects (all *ps>0.05*). The pattern of regression path times for the critical region (6) can be seen in Figure 4.2. When the emotion word is *positive* there is an increase in time taken to progress beyond the critical region (*F1 (1, 31) = 6.48, p<0.05; F2 (1, 31) = 10.10, p<0.01*). This increase is also present in the post-critical region (*F1 (1, 31) = 4.24, p<0.05; F2 (1, 31) = 6.62, p<0.05*). There is no effect of frame or interaction between the two variables in these regions.

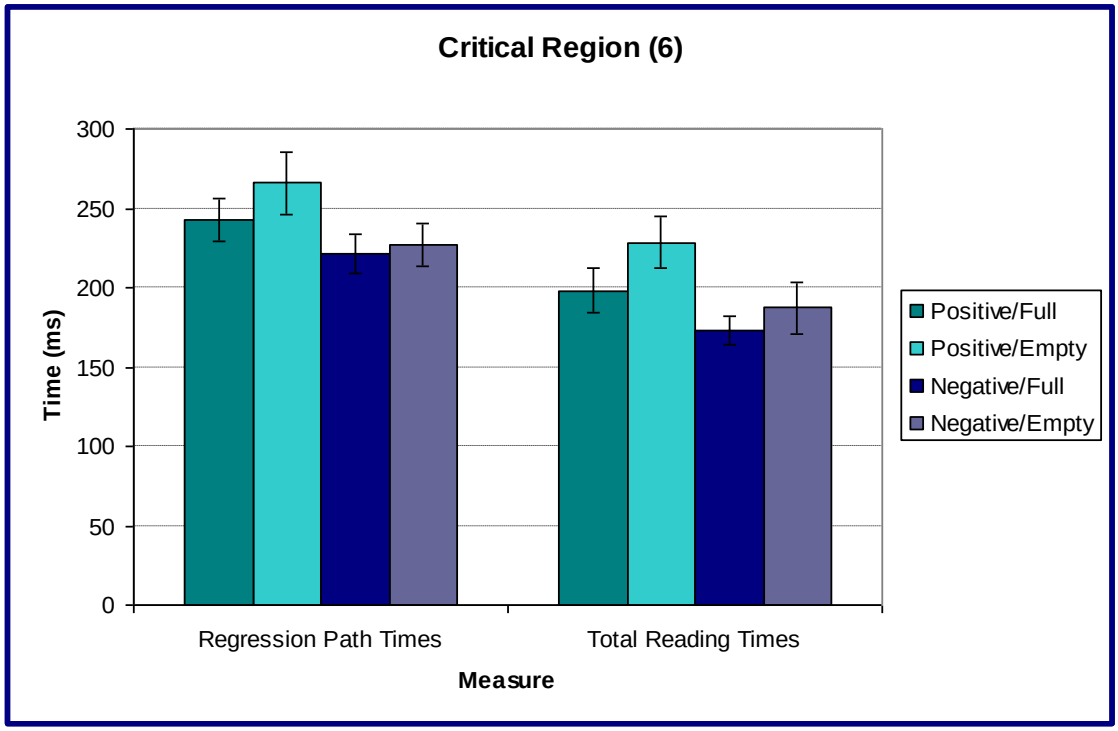

Figure 4.2 Regression Path Times and Total Reading Times for the Critical Region in Experiment 4(a).

Total Reading Times

This is a measure of all time spent fixating on a region, and can indicate which regions cause overall difficulty. There were no significant differences for this measure in Region 2. In accordance with other measures more time was spent in Region 3 when it contained a *positive* emotion word as opposed to a *negative* emotion word (*F1 (1, 31) = 3.51, p=0.07; F2 (1, 31) = 4.25, p<0.05),* this difference is particularly important as more frequent *positive* emotion words would have been expected to lead to less time spent in this region. This difference was also present in Region 4 (*F1 (1, 31) = 16.68, p<0.001; F2 (1, 31) = 9.00, p<0.005*). No differences or interaction was found

between conditions in the pre-critical region (5). Total reading times for the critical region (6) are shown in Figure 4.2. More time was spent in the critical region when it had been preceded by a *positive* emotion word (*F1 (1, 31) = 13.79, p<0.001; F2 (1, 31) = 12.27, p<0.001*). In this region there was also a main effect of frame with shorter reading times when the frame was *full* rather than *empty* (*F1 (1, 31) = 3.93, p=0.056; F2 (1, 31) = 4.78, p<0.05*), although it is possible that this is due to the difference in word length. In the post-critical region (7) total reading time was again found to be longer when the emotion word had been *positive* (*F1 (1, 31) = 5.06, p<0.05; F2 (1, 31) = 4.92, p<0.05*). There were no further significant differences in this region. Total reading times support the emerging pattern that these sentences are more difficult to process when a *positive* emotion word is used. In addition to this trend a main effect of frame in the critical region suggests that when full is presented after a *negative* emotion word this is just as easy or easier (see Figure 4.2 and means in Table 4.3.2) to process as when *full* is presented after a *positive* emotion word. However it is noted that *empty* is both a longer and less frequent word than *full* and it is possible that these factors may have increased reading time for *empty* in this region.

% Regressions In

The % of trials containing regressions into a region can provide information on the areas of text the reader chooses to return to after encountering a problem. No differences in the number of regressions in were found for Region 2. There were more regressions into the emotion word region (3) when it was *positive* (F1 *(1, 31) = 4.92, p<0.05; F2 (1, 31) = 7.1, p<0.05*). In Region 4 there was a significant interaction between polarity and frame (*F1 (1, 31) = 15.27, p<0.001; F2 (1, 31) = 9.42, p<0.01*). Simple main effects identified differences in the number of regressions in when the frame was *empty* with more regressions in when polarity was *positive* as opposed to

negative (*F1 (1, 31) = 12.05, p<0.001; F2 (1, 31) = 14.35, p,0.001*). When polarity was *positive* there were more regressions in when frame was *empty* rather then *full* (*F (1, 31) = 8.94, p<0.01; F2 (1, 31) = 7.09 p<0.05*) and when polarity was *negative* there were more regressions in when frame was *full* rather than *empty* (*F1 (1, 31) = 6.44, p<0.01; F2 (1, 31) = 4.02, p=0.052)*. In Table 4.3.2 it is clear that there are more regressions into the pre-critical region (5) when the emotion word was *positive* and this difference is significant by participants and marginal by materials (*F1 (1, 31) = 5.24, p<0.05; F2 (1, 31) = 3.72, p=0.06*). In the critical region (6) a marginal interaction (*F1 (1, 31) = 3.75, p=0.06; F2 (1, 31) = 1.95 p>0.01*) by participants indicated a difference between regressions in when the frame was *empty* (*F (1, 31) = 6.14, p<0.05*) with more regressions to this region when it had been preceded by a *positive* rather than a *negative* emotion word. This result was not supported by the materials analysis. By materials a significant main effect of polarity was found with more regressions in when the emotion word had been *positive* although this was not found by participants (*F1 (1, 31) = 3.13, p=0.09; F2 (1, 31) = 6.31, p<0.017*).

From Table 4.3.1 and Table 4.3.2 it is clear, that with the exception of Region 4, there are more regressions into every region when the emotion word was positive. This is most notable in both the emotion word region (3) and the critical region (5). Importantly in these regions there were no significant differences between the two frames after the positive emotion word.

In summary, it was anticipated that *positive* emotion words would be consistent with *half full* statements and *negative* emotion words would be consistent with *half empty* statements. However the pattern of results does not support this hypothesis. Reading of *half full* and *half empty* statements was disrupted to an equal degree when preceded by a

positive emotion. In contrast when the character experienced a *negative* emotion both frame statements were processed with relative ease. It appears that when a character desires a vessel to be *full* and this desire is confirmed with a *positive* emotion participants find neither *half empty* nor *half full* to be consistent.

It is clear that readers in Experiments 4(a) have not drawn inferences about the reference point from the logically equivalent frame in order to process the materials. One possibility is that the implicit desire in the sentences overrides any information which the reader might have drawn from the frame. That is, readers are focused on the character's desire for fullness and as a result recognise that neither *half full* nor *half empty* fulfil that desire. Both these frames are then inconsistent with a positive emotion. In this case the implicit desire is establishing a reference point of fullness and so the reader does not need to draw a reference point from the frame provided. Instead readers may have interpreted the statement *half full* pragmatically as **not full** which is a bad thing with regards to the desire. If implicit desire is solely responsible for this pattern of results then a similar pattern should be found when the character's desire is for emptiness. That is, participants will recognise that neither *half empty* nor *half full* fulfil a desire for emptiness and so neither will be consistent with a positive emotion. A second possibility is that markedness has affected participants processing of the frame *half full* in Experiments 4(a). Where the desire is for fullness readers interpret full as a default (or unmarked) term used to describe volume, this in turn leads to the interpretation of *half full* as not full. A word which is unmarked (Greenberg, 1966; Jakobson & Halle, 1956) is considered to be the more dominant or common term. In descriptions of size, for example, people refer to the tallness or bigness of a person or object as opposed to the shortness or smallness. In this case fullness is the dominant concept as opposed to emptiness. People discuss containers in terms of their fullness as

opposed to their emptiness, e.g. *How full is the bath?* This is supported by the more frequent use of the word full over empty (282.1 v.s. 53.79 respectively in the British National Corpus). If markedness is affecting the results of Experiment 4(a) it is possible that a different pattern of results will be found when there is a desire for emptiness. Empty is not the default term used to describe volume, and so a desire for emptiness may not affect processing of the frames *half full* and *half empty* in the same manner as a desire for fullness. The aim of Experiment 4(b) is to examine the processing of these frames when desire is for emptiness.

Experiment 4(b)

In this eye-tracking experiment all materials were constructed so that the reader will infer that the character desires emptiness. Positive and negative emotion words were then paired with the logically equivalent frames *half full* and *half empty*. Results of the experiment may provide support in favour of one of the two possibilities detailed above. If participants read both frames easily after a *negative* emotion word but have difficulty reading them after a *positive* emotion word this would suggest that the desire for emptiness has made both frames inconsistent with a context where the character feels good about the volume. In other words, wanting the container to be empty means that neither *half full* nor *half empty* are good because they are **not empty**. In this situation the reader will establish a reference point of empty from the context and so information from the frame will not be used to determine its consistency with the emotion. The implicit desire in this situation will lead the reader to expect a volume of *empty* after a *positive* emotion word and so in this case *empty* may be considered the default unmarked term. The use of *half* before *empty* will then lead the reader to infer that the dimension given is not enough to satisfy the desire.

In contrast if an interaction is found between the emotion word and frame variable, such that *half empty* is consistent with a positive emotion and *half full* is consistent with a negative emotion, this would indicate that participants are drawing reference point information from the frame. In other words if readers are influenced by the frame as well as the desire for emptiness *half empty* will be a good thing compared to *half full*. *Half empty* is interpreted as an increase in the emptiness of the vessel relative to the undesirable amount, full. Since the situation is becoming more favourable this is consistent with the character feeling positive about the volume. When the frame is *half full* this implies an increase in the fullness of the vessel relative to the desired amount, empty. In this case *full* will be treated as if it were the marked term as empty is what the reader expects. The use of *full*, even within the frame *half full*, is indicating an increase in the volume. Since the situation is becoming unfavourable this is consistent with the character feeling negatively about the volume. An interaction between the emotion word and frame would therefore support the view that participants are influenced by frame information differently depending on the underlying desire.

Method

Participants

A total of 32 participants completed this experiment. They were all native speakers of British English and were either undergraduates or postgraduates at the University of Glasgow. Participants were paid £6 or given course credit for taking part.

Materials

The experiment consisted of 32 items, (see Appendix 4.2) which were displayed along with 56 filler items from an unrelated experiment. An example of one item shown in all 4 experimental conditions can be seen in Table 6.1 below. Each item began with an

initial neutral sentence. The second sentence then introduced a character or characters and detailed their emotion in reaction to the volume in a vessel, that is *half empty* or *half full.* The context of all sentences was constructed so that the desirable outcome would be an empty vessel. For example it is desirable that a freezer be empty if there is a power cut.

Condition	**Material**
Positive/Half Empty	The storm had cut off all the power in the house. Mum was **pleased** because the freezer was half **empty** and the food she had frozen was going to be spoilt.
Positive/Half Full	The storm had cut off all the power in the house. Mum was **pleased** because the freezer was half **full** and the food she had frozen was going to be spoilt.
Negative/Half empty	The storm had cut off all the power in the house. Mum was **annoyed** because the freezer was half **empty** and the food she had frozen was going to be spoilt.
Negative/Half Full	The storm had cut off all the power in the house. Mum was **annoyed** because the freezer was half **full** and the food she had frozen was going to be spoilt.

Table 4.4 An example of a material from Experiment 4(b) in all 4 conditions.

As the critical words in this experiment are identical to those in Experiment 4(a) the same details of word length and word frequency apply. Emotion words were again chosen to fit the wider sentence context and this led to some words being used in more materials than others. Positive words were: *pleased, delighted, grateful, thankful* and *happy*. Negative words were *annoyed, frustrated, disappointed, frightened, worried* and *angry*. Emotion words had a maximum length of 12 characters and a minimum of 5. Collectively the emotion word region had a mean length of 7.41 in the positive condition and a mean length of 8.03 in the negative condition. Again using the British National Corpus it was established that positive words had a mean frequency of 47 per million words and negative words had a mean frequency of 24.5 per million words.

Design

There were 4 versions of each of the 32 materials corresponding to the conditions in Table 4.4. There were two experimental manipulations, polarity of emotion word (*positive* or *negative*) and frame (*full* or *empty*). At this point, for ease of comparison to results of Experiment 4(a), two of the resulting conditions will be considered to match **positive emotion/empty** and **negative emotion/full**, and two to mismatch **positive emotion/full** and **negative emotion/empty**. Each of the 32 items appeared in 4 files containing 8 items in each condition. The 4 different files allowed for the display of each material in a different condition, in a latin square design. Participants were assigned randomly to a file. Items were displayed in random order.

Eye-tracking and Procedure

Details of eye-tracking were identical to Experiment 4(a) with the exception of line length which in this case was a maximum of 80 characters.

Participants were instructed to read each passage for comprehension and that they would be required to answer a question after approximately 50% of the passages. Participants then completed a calibration procedure which allowed the eye-tracker to correlate the position of their gaze with the position of the screen. To begin reading participants fixated a dot in the centre of the screen followed by a black square at the top left. Once fixating on this square correctly the passage would appear with the first character in the position of the square. After reading each passage participants fixated the bottom right of the screen before pressing any button to move onto the next passage or a comprehension question. All participants answered 80% or above of these questions correctly.

Results

For analysis the sentences were broken into 7 regions as shown in table 6.2.

The storm had cut off all the power in the house.[1]|
Mum was[2]| pleased [3]|because[4]|
|the freezer was half[5]| empty and [6]|the food she had frozen was going to be spoilt.[7]|

Table 4.5 Regions of analysis for Experiment 4(b).

These regions were then used to collate reading times and determine different types of eye movements. In each material Region 1 was a neutral introduction sentence and so has not been included in any of the analysis. Region 2 introduces a character and Region 3 details the emotion they are experiencing. Region 5 is the pre critical region which gives details of the vessel plus the words either [were half] or [was half]. Region 6 was the critical region and contained either the words [full and] or [empty and] depending on the condition. Finally Region 7, the post-critical region contained the remainder of the critical sentence. Note in the current experiment that the lay out of the passage differs slightly from that of Experiment 4(a). In this experiment details of the vessel have been placed in Region 5, rather than Region 4. This was done to ensure a larger amount of text between the beginning of the line and the critical word to allow more natural reading. This led to variation in the length of Regions 4 and 5 between this experiment and Experiment 4(a), however, the length of the critical region did not vary.

As with the previous experiments care was taken to ensure all regions were as similar in length as possible. It was not possible to match the emotion word region exactly for length as certain emotion words are not always appropriate in the same context, see the Materials section for details of the mean length of emotion words used in Region 3. Again the critical region varied in length by only one character and the post-critical

region varied by no more than 3 characters. For each material the post-critical region remained the same across conditions. Five measures were applied to the data as detailed in Experiment 2. Fixations were then pooled, excluded or truncated inline with the procedure detailed in Experiments 2 and 4(a). This accounted for 3.03% of the initial data.

Table 4.6.1 gives the mean values for each of the eye movement measures for each condition for Regions 2 – 4, Table 4.6.2 provides these values for Regions 5 – 7. Region 1 has not been included as this contained a neutral sentence in every condition, Region 2 contained only neutral details of the character(s) and this region has been excluded from the first pass and regression path analysis as these measures cannot be affected by information which has yet to be introduced. As Region 7 is the last region, regressions in are not calculated for this region. Each measure in each region was analysed using a 2 (emotion word polarity) x 2 (frame) ANOVA treating participants as a random variable, and then again in a 2 x 2 ANOVA which treated items as a random variable.

Measure Condition	**Region 2**	**Region 3**	**Region 4**
First Pass Reading Time			
Positive/Empty	-	198.42 (7.6)	215.64 (14.0)
Positive/Full	-	199.27 (9.4)	206.26 (12.9)
Negative/Empty	-	196.65 (8.5)	212.18 (11.5)
Negative/Full	-	200.95 (9.7)	203.26 (10.6)
Regressions Out			
Positive/Empty	0.84 (0.6)	36.83 (5.3)	6.89 (1.7)
Positive/Full	1.17 (0.6)	35.49 (5.3)	8.09 (2.3)
Negative/Empty	1.67 (0.8)	35.00 (5.0)	4.07 (1.1)
Negative/Full	1.17 (0.6)	33.04 (5.4)	4.74 (1.3)
Regression Path Time			
Positive/Empty	-	346.17 (21.0)	247.35 (16.9)
Positive/Full	-	387.46 (24.6)	236.76 (16.5)
Negative/Empty	-	365.34 (22.8)	255.27 (21.7)
Negative/Full	-	347.43 (20.1)	228.04 (15.8)
Total Reading Time			
Positive/Empty	363.04 (24.2)	272.10 (10.6)	180.95 (20.2)
Positive/Full	412.80 (28.6)	279.78 (15.9)	191.50 (17.6)
Negative/Empty	384.64 (25.2)	262.58 (9.9)	182.69 (16.9)
Negative/Full	384.77 (24.5)	258.87 (10.2)	167.90 (18.9)
Regressions In			
Positive/Empty	41.99 (4.9)	8.39 (1.7)	2.34 (1.0)
Positive/Full	39.90 (5.3)	12.77 (2.7)	2.39 (0.9)
Negative/Empty	39.13 (4.8)	6.59 (1.7)	1.56 (0.9)
Negative/Full	34.59 (5.4)	5.64 (1.4)	1.56 (0.7)

Table 4.6.1 Means and Standard Errors for all measures for Regions 2 to 4.

Measure Condition	**Region 5**	**Region 6**	**Region 7**
First Pass Reading Time			
Positive/Empty	573.24 (35.8)	215.63 (11.0)	1376.04 (69.3)
Positive/Full	570.45 (33.1)	208.25 (9.7)	1359.80 (74.2)
Negative/Empty	582.95 (30.1)	223.35 (12.1)	1396.81 (66.7)
Negative/Full	591.14 (40.8)	210.80 (10.4)	1338.07 (62.9)
% Regressions Out			
Positive/Empty	3.52 (1.1)	4.85 (1.4)	19.07 (3.4)
Positive/Full	2.01 (1.0)	5.58 (1.6)	26.28 (4.0)
Negative/Empty	2.39 (1.1)	5.87 (1.6)	20.79 (3.3)
Negative/Full	2.01 (1.0)	4.29 (1.2)	18.75 (3.4)
Regression Path Time			
Positive/Empty	608.04 (39.3)	238.63 (13.0)	1673.14 (85.8)
Positive/Full	588.40 (36.1)	232.39 (12.8)	1814.65 (104.9)
Negative/Empty	599.26 (29.8)	271.33 (22.7)	1775.41 (104.8)
Negative/Full	614.53 (40.5)	236.62 (12.9)	1610.97 (85.3)
Total Reading Time			
Positive/Empty	646.78 (40.0)	215.26 (16.5)	1492.02 (74.8)
Positive/Full	656.03 (42.0)	219.27 (14.6)	1544.98 (77.7)
Negative/Empty	665.53 (42.0)	226.06 (19.7)	1550.59 (68.0)
Negative/Full	643.77 (41.8)	196.85 (15.1)	1459.22 (73.3)
% Regressions In			
Positive/Empty	11.35 (2.5)	5.42 (1.5)	-
Positive/Full	14.17 (3.0)	8.76 (2.2)	-
Negative/Empty	11.67 (2.9)	6.81 (1.7)	-
Negative/Full	9.64 (2.5)	6.75 (1.9)	-

Table 4.6.2 Means and Standard Errors for all measures for Regions 5 to 7.

First Pass Reading Times

There were no significant results with this measure in any of the analysed regions.

First Pass Regressions Out

The pattern of regressions out across regions can be seen in Figure 6.1.

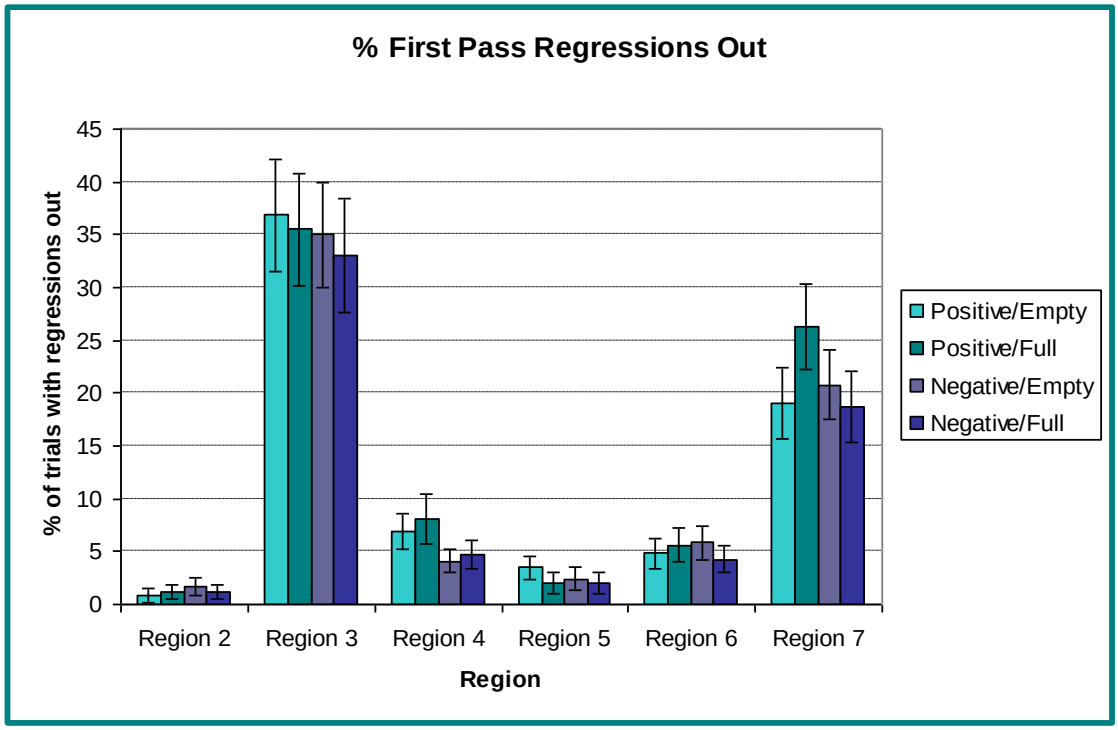

Figure 4.3 % First pass regressions out for Regions 2 to 7 in Experiment 4(b).

From Table 4.6.1 and Figure 4.3 it can be seen that there are a high number of regressions out of the emotion word region (3). This probably reflects the closeness of this region to the beginning of the second line of text. Readers progressing from line 1 to line 2 have landed in Region 3 and regressed back to Region 2 to take in the beginning of the sentence. This is confirmed by the large number of regressions into Region 2.

The number of regressions out of Region 2 was too small to justify further analysis. In Region 3 a main effect of polarity was significant by participants and approaching significance by items *(F1 (1, 31) = 5.30, p<0.05; F2 (1, 31) = 3.92, p=0.057)*. There

were more regressions out of this region when the emotion word was *positive*. There was no main effect of frame or significant interaction for this region. There were no significant differences in the percentage of regressions out for the pre critical (5) or critical regions (6). In the post-critical region there was an interaction between polarity and frame which was significant by participants but not by items *(F1 (1, 31) = 5.13, p<0.05; F2 (1, 31) = 2.84 p=0.1)*. Simple main effects by participant indicated that when volume was *full* there were more regressions out after a *positive* emotion word as opposed to a *negative* emotion word *(F (1, 31) = 4.39, p<0.05)*. When the emotion word had been *positive* there were more regressions out of the post-critical region when volume was *half full* rather than *half empty (F (1, 31) = 4.20, p<0.05)*. In summary when the character holds a desire for emptiness there were more regressions out of the final region when the character felt positively about the container being *half full.*

Regression Path Times

There were no significant differences in regression path times in Region 3, 4 or 5. In the critical region (6) there was an effect of frame significant by items only *(F1 (1, 31) = 2.59, p>0.05; F2 (1,31) 6.11, p<0.02)*. In this region regression path times were longer when frame was *empty*. Figure 6.2 shows the pattern of regressions path times in Region 7. In this, post-critical, region there was a significant interaction between polarity and frame *(F1 (1, 31) = 7.05, p<0.01; F2 (1, 31) = 13.77, p<0.001)*. Simple main effects in both analyses identified longer regression path times if the emotion word had been *positive* rather than *negative* when volume was full *(F1 (1, 31) = 11.11, p<0.01 F2 (1, 31) = 13.72, p<0.001).* Also when polarity was *negative* there were longer times when volume was *empty* rather than *full (F1 (1, 31) = 5.63, p<0.05 F2 (1, 31) = 7.09, p<0.05)*. Finally, by items only, when polarity was *positive* there were longer regression path times if volume was *full* rather than *empty (F1 (1, 31) = 3.41,*

p=0.07; F2 (1, 31) = 4.68, p<0.05). Results of first pass regressions out and regression path times indicate that *half full* is causing some processing difficulty if it has been preceded by a *positive* emotion word. *Half empty* is causing processing difficulty if it is preceded by a *negative* emotion word.

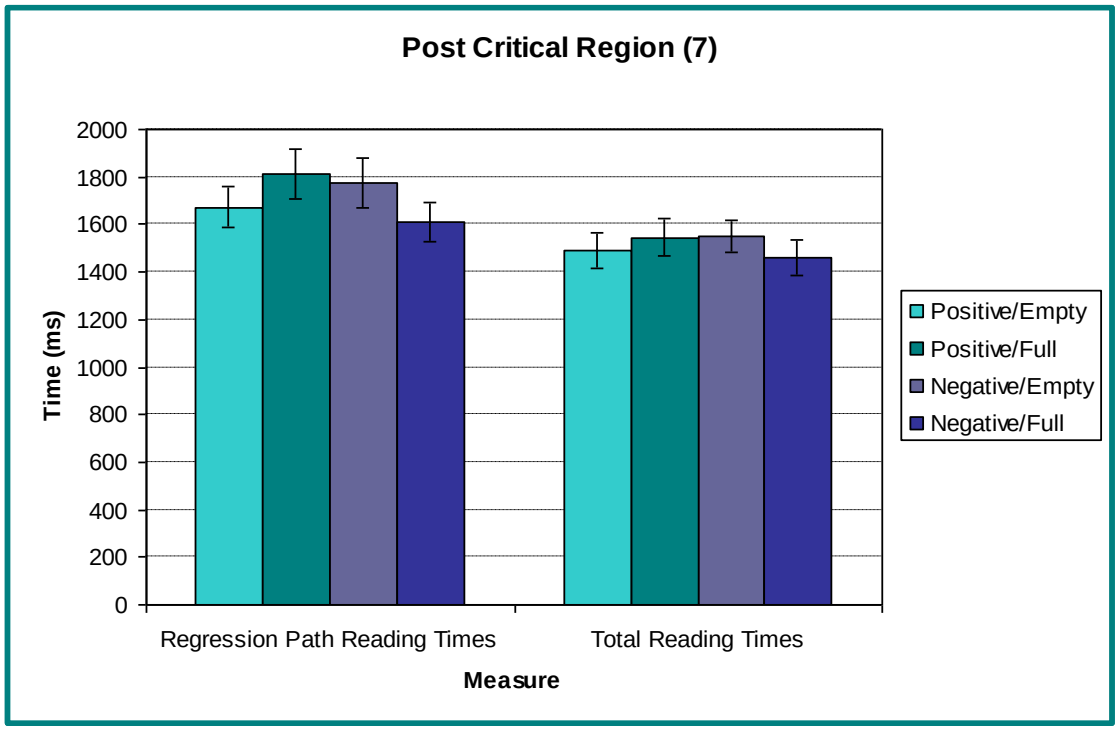

Figure 4.4 Regression Path Times and Total Reading Times for the Post-critical Region in Experiment 4(b).

Total Reading Times

In Region 2 there were longer reading times when frame was *full* rather than *empty* in the by participants analysis only *(F1 (1, 31) = 6.86, p<0.01; F2 (1, 31) = 2.75, p=0.11)*. There were no significant results for this measure in Region 3, 4 or 5. In the critical region (6) an interaction between polarity and frame was significant by participants only *(F1 (1, 31) = 5.66, p<0.024; F2 (1, 31) = 2.19, p>0.1)*. Simple main effect by participants showed that more time was spent reading this region when volume was *full* and it had been preceded by a *positive* emotion word as opposed to a *negative* emotion word *(F (1, 31) = 3.87, p=0.58)*. More time was also spent reading *empty* if polarity had been *negative* as opposed to *positive (F (1, 31) = 8.40, p<0.01)*. The

pattern of total reading times in the post-critical region was identical to that of the critical region and can be seen in Figure 4.4. In this region there was a significant interaction between polarity and frame *(F1 (1, 31) = 6.07, p<0.05; F2 (1, 31) = 8.48, p<0.01)*. Analysis of the simple main effects found more time was spent in this region after *full* when polarity had been *positive* rather than *negative (F1 (1, 31) = 5.87, p<0.05; F2 (1, 31) = 7.87, p<0.01)*. Reading time was also longer after a *negative* as opposed to a *positive* when frame had been *empty (F1 (1, 31) = 5.35, p<0.05; F2 (1, 31) = 6.11, p<0.05)*. This result suggests that the *half full* frame is causing difficulty after a *positive* emotion word, whilst *half empty* is processed relatively smoothly. Alternatively more time is spent processing a sentence containing *half empty* after a *negative* emotion word.

Regressions In

Patterns of % regressions in can identify parts of the passage which readers return to in order to resolve anomalies. There were no significant results in Region 2 using this measure. There were more regressions into the emotion word region (3) when this contained a *positive* emotion word *(F1 (1, 31) = 7.54, p<0.01; F2 (1, 31) = 5.37, p<0.05)*. There was no effect of frame on regressions into this region or interaction between the two variables. In Region 4 there were no differences using this measure. In Region 5 there was an interaction between the two variables by participants only *(F1 (1, 31) = 4.77, p<0.05; F2 (1, 31) = 1.23 p>0.1)* with more regressions into this region after *positive* rather than *negative* polarity emotion words when frame was *full (F (1, 31) = 4.63, p<0.05)*. There were no differences in regressions into the critical region.

The pattern of results in Experiment 4(b) is very different from that reported in Experiment 4(a). In this case it seems that readers process *half empty* without difficulty

in a situation where the character feels positively about the outcome. These sentences were constructed so that the reader could infer that the character wanted the vessel to be empty. The results suggest that readers found *half empty* consistent with this desire. When the desired outcome was denied, using a negative emotion word, readers processed *half full* with ease and *half empty* with difficulty. This pattern would suggest that participants are drawing inferences about the reference point from the frames themselves to establish whether or not the given volume is consistent with the characters desire.

The results of Experiments 4(a) and 4(b) are surprising. In the first instance the difficulty in processing of *half full* after a positive emotion word in Experiment 4(a) was not anticipated by this experimenter. A second surprise came in the results of Experiment 4(b) which established that in contrast *half empty* does satisfy a desire for empty. Before discussing the reasons for these unexpected results this experimenter felt it necessary to complete two further experiments. Eye-tracking is a useful tool to establish where inconsistencies are causing a reader difficulty. However the analysis include a number of measures and are reliant on the experimenters interpretation. In order to confirm the reader preferences when fullness and emptiness are desired two further written experiments were completed and are detailed below.

Experiment 5(a)

The results of Experiment 4(a) found that when a character has an implicit desire for fullness a negative emotion is consistent with the frame *half full* and *half empty*. The aim of this choice based experiment is to confirm that this is the case. After reading one of the materials from Experiment 4(a), containing either the frame *half full* or *half empty* participants will be asked whether a positive or negative emotion word is more suitable

in the passage. It is hoped that the results of this choice based task will support those of the eye-tracking experiment. It is hypothesised that a negative emotion word will be considered appropriate before the frame *half empty* and the frame *half full* when desire is for fullness.

Method

Materials and Design

In this experiment each of the 32 items from Experiment 4(a) was used a total of 12 times in the format given in Table 5.1. Each material appeared 6 times using *half full* and 6 times using *half empty*. The order of the emotion words was also counterbalanced within the 6. There were therefore a total of 384 experimental items, half with *half full* and half with *half empty*, and half giving the *positive* emotion word first and half giving the *negative* emotion word first. Each experimental item was given to a different participant making the experiment entirely between participants.

Participants

Participants were 384 native speakers of British English. They were all either undergraduates or postgraduates at the University of Glasgow and were not given any incentive to take part.

Procedure

Each participant was asked if they would agree to take part in an experiment which would take no longer than 2 minutes. If they provided verbal consent the experimenter then randomly gave them one of the experimental items to complete. Instructions were provided above the item which the participants received, as shown in Table 5.1, and the experimenter stood aside while the participants completed and returned the item.

Instructions

Please read the passage below carefully. Once read please indicate which of the two words given below would most suitably fill the gap in the passage.

The boat had been out at sea for a full week.
The fisherman was _____ because the nets
were half empty and he wanted to return to shore soon.

Please circle the word below which you feel is most appropriate.

happy **angry**

Thank you for your time, if you would like more information on this experiment please contact me at joanne@psy.gla.ac.uk

Table 5.1 Example of instructions and material given to participants in Experiment 5(a).

Results

After all experimental items were collected they were analysed by the experimenter to ensure they had been correctly completed. They were then split into the two frames *half full* vs *half empty*, before being split further into *positive* and *negative* responses. Number of responses and percentages are provided in Table 5.2 and displayed in Figure 5.1.

Positive Emotion		**Negative Emotion**	
Half Full	**Half Empty**	**Half full**	**Half Empty**
75 (19.5%)	23 (6%)	117 (30.5%)	169 (44%)

Table 5.2 Number of responses and percentages in each category for Experiment 5(a).

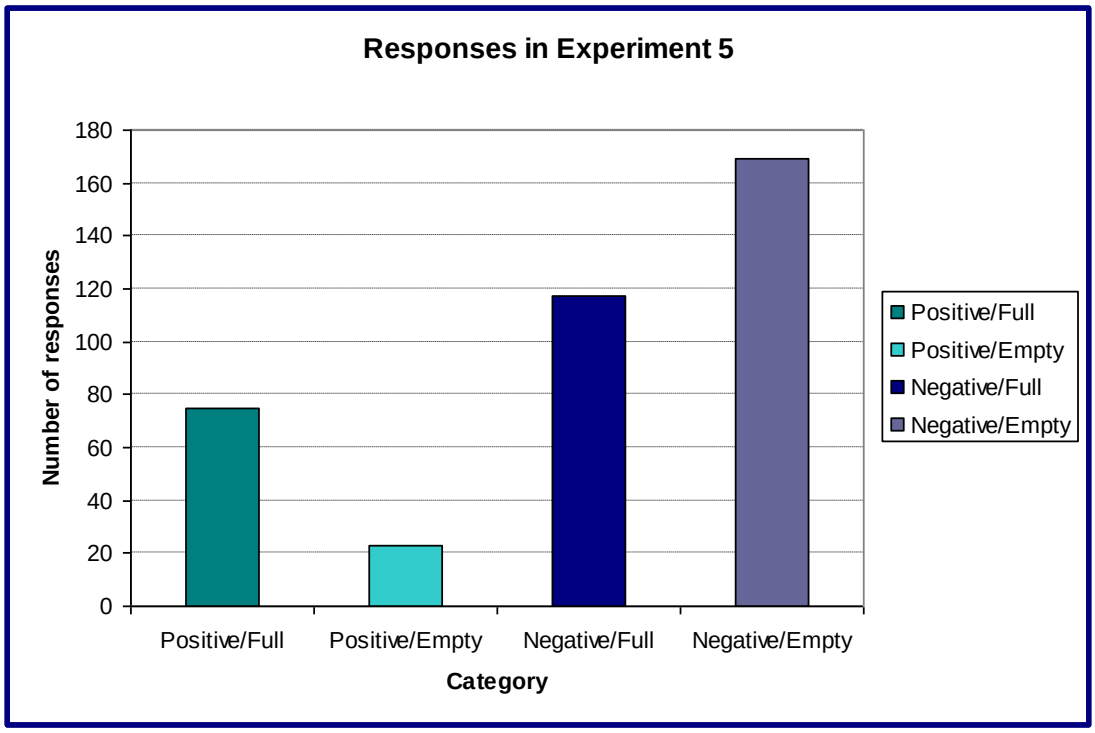

Figure 5.1 Number of responses in each category for Experiment 5(a).

Analysis of the difference between categories was completed using a 2 x 2 Chi-square which was significant (x^2 (1) = 37, p<.0.0005). Further analysis found differences between all categories to be significant, the results of these analyses can be seen in Table 5.3.

Comparison	**x^2**	**d.f.**	**P**
Positive/Full vs. Negative/Full	9.2	1	<0.01
Positive/Empty vs. Negative/Empty	111.02	1	<0.001
Positive/Full vs. Positive/Empty	27.6	1	<0.001
Negative/Full vs. Negative/Empty	27.6	1	<0.001

Table 5.3 Results of post hoc x^2 analysis for Experiment 5(a).

When the frame statement in the sentence was *half full* participants have indicated that this is consistent with a *negative* emotion word rather than a *positive* emotion word. When the frame statement is *half empty* participants again indicate that the *negative* word emotion word is consistent. These results confirm the hypothesis and support the pattern of eye movements in Experiment 4(a) where both *half full* and *half empty* were processed more quickly and led to fewer regressions when preceded by a negative emotion. In Experiment 5(a), the *negative* emotion word was preferable to the *positive*

emotion word regardless of frame. However in some cases participants considered the *positive* emotion word to be consistent. When this was the case it was likely that the sentence contained *half full* as opposed to *half empty* whereas when the *negative* emotion word was considered suitable it was more likely that the sentence contained *half empty* as opposed to *half full*. Experiment 5(b) will use the same method to confirm the results of Experiment 4(b).

Experiment 5(b)

The results of Experiment 4(b) indicated that when a character has an implicit desire for emptiness a positive emotion is consistent with the frame *half empty* and a negative emotion is consistent with the frame *half full.* The aim of this choice based experiment is to confirm that this is the case. After reading one of the materials from Experiment 4(b), containing either the frame *half full* or *half empty* participants will be asked whether a positive or negative emotion word is more suitable in the passage. It is hypothesised that the results will support those of Experiment 4(b), a positive emotion word will be considered appropriate before a *half empty* frame and a negative emotion word will be considered appropriate before a *half full* frame.

Method

Materials and Design

The materials for this experiment were the items from Experiment 4(b) displayed in the format given in Table 5.4. Each of the materials was used a total of 12 times. Each material appeared 6 times using *half full* and 6 times using *half empty*. The order of the emotion words was also counterbalanced within the 6. There were therefore a total of 384 experimental items, half with *half full* and half with *half empty*, and half giving the

positive emotion word first and half giving the *negative* emotion word first. Each experimental item was given to a different participant making the experiment entirely between participants.

Participants

The 384 participants in this experiment were all postgraduates or undergraduates at the University of Glasgow. Each participant was a native speaker of British English.

Procedure

Each participant was asked if they would agree to take part in a short experiment. If verbal consent was given the experimenter then gave them one of the experimental items at random. Instructions for completion were provided above the item, as shown in Table 5.4, and the experimenter stood aside while the participants completed and returned the item.

Instructions

Please read the passage below carefully. Once read please indicate which of the two words given below would most suitably fill the gap in the passage.

The storm had cut off all the power in the house.
Mum was _____ because the
freezer was half full and the food she had frozen was going to be spoilt.

Please circle the word below which you feel is most appropriate.

annoyed **pleased**

Thank you for your time, if you would like more information on this experiment please contact me at joanne@psy.gla.ac.uk

Table 5.4 Example of instructions and material given to participants in Experiment 5(b).

Results

The experimenter collected all the experimental items and ensured they were completed correctly before beginning analysis. The items were initially divided into those describing *half empty* situations and those describing *half full* situations. These conditions were then further divided into those where the participants indicated that a *positive* emotion word was consistent, and those where the participants indicated that a *negative* emotion word was consistent. If participants indicate that a *positive* emotion word is consistent with *half empty* this will support the results of Experiment 4(b) which suggest that *half empty* is seen as a good thing when desire is for emptiness. The number of responses and percentages are provided in Table 5.5 and displayed in Figure 5.2.

Positive Emotion		**Negative Emotion**	
Half Empty	**Half Full**	**Half Empty**	**Half Full**
115 (29.9%)	51 (13.3%)	77 (20.1%)	141 (36.7%)

Table 5.5 Number of responses and percentages in each category for Experiment 5(b).

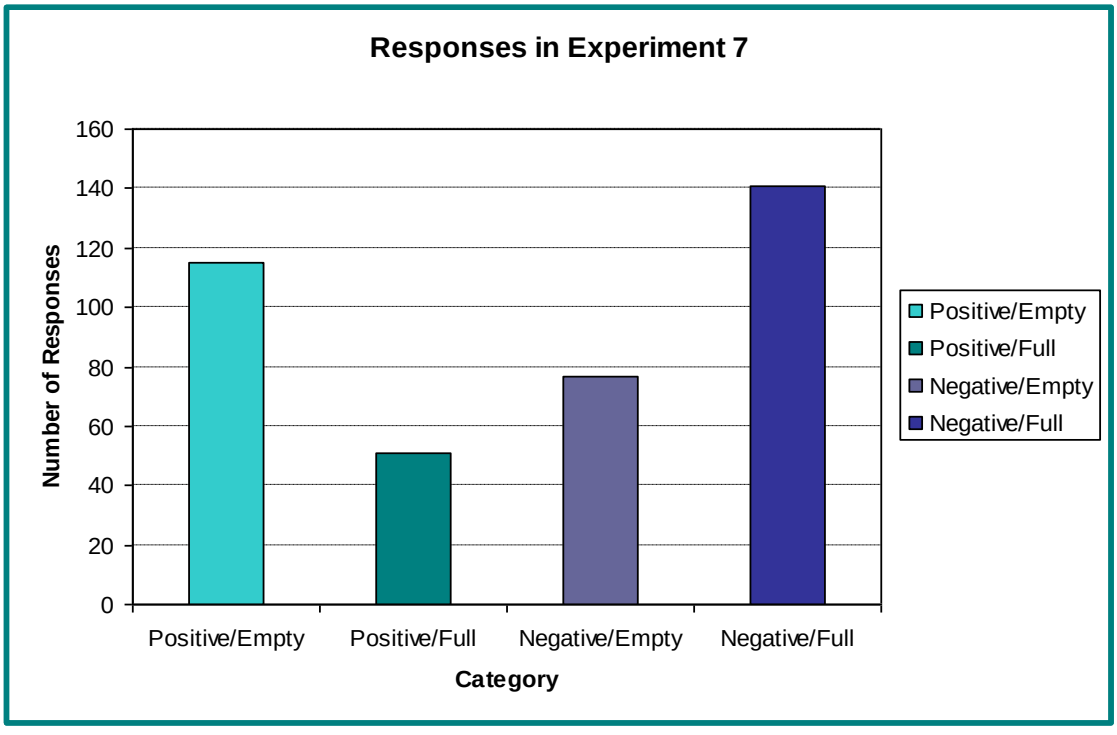

Figure 5.2 Number of responses in each category for Experiment 5(b).

Analysis of the difference between categories was completed using a 2 x 2 Chi-square which was significant (x^2 (1) = 44.46, p<.0.0005). Further analysis found differences between all categories to be significant, the results of these analyses can be seen in Table 5.6.

Comparison	**x^2**	**d.f.**	**p**
Positive/Empty vs. Negative/Empty	7.52	1	<0.01
Positive/Full vs. Negative/Full	42.18	1	<0.001
Positive/Empty vs. Positive/Full	24.68	1	<0.001
Negative/Empty vs. Negative/Full	18.78	1	<0.001

Table 5.6. Results of post hoc x^2 analysis for Experiment 5(b).

When the volume statement was *half empty* participants indicated that this was consistent with the *positive* emotion word as opposed to the *negative* emotion word. When the volume statement was *half full* participants indicated this was consistent with the *negative* emotion word as opposed to the *positive* emotion word. These results support the hypothesis and the pattern of eye movements in Experiment 4(b) which indicated a *half empty* statement was processed more quickly and with fewer regressions after a *positive* emotion word. Participants were also more likely to indicate a *positive* emotion word was suitable if the frame had been *half empty* as opposed to *half full* and they were more likely to indicate that a *negative* emotion word was consistent if the frame had been *half full* as opposed to *half empty*.

Discussion

These experiments investigated the effects of desire and emotion words on the processing of logically equivalent volume statements. In Experiments 4(a) and 5(a)

participants read passages describing situations where fullness was desired by a character. As with previous experiments this desire was implicit and had to be inferred by the reader. In Experiment 4(a) the characters emotion with respect to the current volume was detailed followed by a frame statement. In Experiments 5(a) participants were asked to identify the emotion which was consistent with the desire and the frame statement. The hypothesis was that despite the logical equivalence of the statements *half full* and *half empty* participants would determine *half full* to be consistent with a *positive* emotion, an indication that the desire had been met. Furthermore, it was hypothesised that *half empty* would be consistent with a *negative* emotion, an indication that the desire had not been met. The results of these experiments did not support these hypotheses. In Experiment 4(a) the eye movement record indicated that processing of both frame statements took longer when they had been preceded with the *positive* emotion word. This pattern was consistent across the different measures of eye movements and highlighted by an increase in regressions out of the critical and post-critical regions and into the emotion word region in the **positive/full** and **positive/empty** conditions. Although this pattern of results was expected for *half empty* longer processing times and increased number of regressions after a *positive* emotion word had not been expected for *half full.* In contrast when the emotion word was *negative* an increase in processing times was expected for *half full* but was not observed. After a *negative* emotion word both *half full* and *half empty* were processed smoothly. In order to further examine and support this unexpected pattern of results the written follow up, Experiment 5(a), was conducted. The results of this experiment confirmed that participants found both *half empty* and *half full* to be consistent with a *negative* emotion word when desire was for fullness.

The original hypothesis was drawn from McKenzie and Nelson's (2003) reference point hypothesis, that people have a tendency to describe things in terms of what has increased relative to a reference point. When a glass is described as *half full* it's fullness has increased relative to empty, whereas when described as *half empty* it is the emptiness which has increased relative to full. This hypothesis was formulated under the assumption that participants would draw information about the previous state of the vessel from the logically equivalent frame. The reader would infer that *half full* meant the volume in the vessel had increased, which is a good thing when the character's desire is for fullness. If the character then felt positively about the volume *half full* would be recognised as consistent. When encountering the *half empty* frame readers would infer that the volume has decreased, which is a bad thing when the character's desire is for fullness. In this case if the character feels negatively about the volume *half empty* will be consistent. Had the hypothesis been supported the results would have shown an interaction between emotion word and frame statement. As noted the pattern of eye movements has not supported the hypothesis. The frame *half full* has not been interpreted as consistent with a *positive* emotion but instead with a *negative* emotion. On re-evaluation it is probable that this unexpected pattern is due to the implicit desire in the passage. Previous experiments did not manipulate this factor. The choice based studies by McKenzie and colleagues all presented neutral contexts to the reader and so information leaked from the frames cannot have been affected by character desire.

It has already been demonstrated that implicit desire can be used as a focusing tool. In Experiments 1 – 3 this feature of language was used to make salient a shortfall between desired and inferred amounts. In the current experiments it appears that desire has a similar effect. The character in each sentence holds a desire for fullness, so that when this is matched with a *positive* emotion the reader may infer that the desire has been

met. When encountering the statements *half full* and *half empty* readers recognise that these amounts do not meet the desire and are therefore inconsistent with the preceding information. In the case of *half full* this means that readers have not inferred this to indicate an increase in volume relative to empty, and so a good thing with regards to the desire. Instead readers may have interpreted the statement pragmatically as **not full**, which is a bad thing with regards to the desire. In *negative* emotion word conditions the *negative* emotion indicates that the character's desire remains unfulfilled and so both *half full* (interpreted pragmatically) and *half empty* are consistent with this. The possibility that a reference point could be drawn from another source, in this case character's desire, was considered by McKenzie (2004) in his review of framing effects and their relationship to inference tasks. He noted that if there is an already established reference point this will negate a listener's need to infer this from the speakers choice of frame and so framing effects will be reduced as has been seen.

The results of these two experiments support those of the previous chapters in that desire is a strong focusing tool. The desire in each of the materials was for fullness. Experiments on framing have shown that although *half full* and *half empty* can be used to establish reference points they do not do so in equal measure (McKenzie & Nelson, 2003; Sher & McKenzie 2006). That is where *half full* indicates a previous state of empty 54% of the time, *half empty* indicates a previous state of full 69% of the time (where indication of a previous state is based on which cup was presented after a request of *half full/empty*). Although the differences between these two results are not specifically tested there is a clear preference to furnish the previously full cup. Indeed linguistically there is a preference for the unmarked term full as opposed to the marked empty, as supported by the frequency of these words (282.1 vs. 53.79 respectively). An unmarked word or phrase in a pair of opposites is the one which would normally be

used in conversation. In this case vessels are more often discussed in terms of their fullness as opposed to their emptiness. It is then likely that where a passage contains an implicit desire for fullness readers can easily make this inference and so determine that *half full* is not enough. That is when the reader can easily identify that the character desires fullness they are able to recognise that *half full* is not consistent with the character feeling *positive*. In this case *half full* has not been treated as an increase in the volume relative to empty but instead the unmarked expression full relates to the dimension of fullness and half is a point on this dimension. This unmarked, default expression *full,* should be easier to read than *empty*. In this case the strong desire leads the reader to focus on the quantity *half* which focuses the reader on the part of the vessel which is not full. *Half full* then becomes difficult to read after a positive emotion but easy to read after a negative emotion. If this argument is correct it is possible that use of a desire for fullness is what has led to the observed results. If true this would indicate that it is the reader's easy identification of the character's desire for *fullness*, which has led to *half full* being difficult to process, or marked, after a *positive* emotion word. In order to address this question Experiments 4(b) and 5(b) assessed whether a desire for **emptiness** leads to a similar pattern of results as a desire for fullness.

Experiments 4(b) and 5(b) investigated the effect of positive and negative emotion words on the acceptability of logically equivalent volume statements when emptiness is desirable. Materials were constructed so that the reader could infer that the character would want a vessel to be empty. These materials were then structured to include an emotion word and a frame statement. There were two possible hypotheses for this experiment. Either, readers could infer that neither *half empty* nor *half full* was consistent with a desire for emptiness. That is neither frame is empty enough to fulfil the desire and so they are not consistent with a *positive* emotion. Alternatively it may be that information about the reference point is drawn from the frames themselves

making *half empty* consistent with a *positive* emotion. This is because when contrasted with full, *half empty* is a good thing when emptiness is desired. *Half full* would then be consistent with a *negative* emotion as, when contrasted with empty, *half full* is a bad thing if emptiness is desired. Results of the eye tracking study support the second of these hypothesis. Participant's reading times were shorter and there were fewer regressions when *half empty* had been preceded with a *positive* emotion word and when *half full* had been preceded with a *negative* emotion word. This indicates that readers found these frames consistent with the emotion that the character experienced about the volume. This conclusion was further supported by the results of Experiment 5(b). A *positive* emotion word was considered more appropriate than a *negative* emotion word if the frame was *half empty*. A *negative* emotion word was considered more appropriate than a *positive* emotion word when the frame was *half full*. This is consistent with a statement by Sher and McKenzie (2006) that "relatively good things will be described in good terms". That is if you (or in this case a character) wants a glass to be empty then *half empty* is a good thing when you consider the possibility that the glass may have been full. In these experiments readers have recognised this. The question now remains as to why readers in this case found *half empty* to be a good thing when desire is for emptiness, whereas in Experiments 4(a) and 5(a) they did not find *half full* to be a good thing when the character's desire was for fullness.

As discussed earlier in this chapter the concept of markedness relates to a tendency for one term or category of a related or opposite pair to be more difficult, more complex and rarer than its counterpart. Clark and Clark (1977) detailed three features which can be used to identify the marked and unmarked terms in a pair of opposites. The first of these is neutralization. The unmarked term can be neutralised to refer to the entire

scale. Examples from the text are given below, possible examples using full and empty are given in brackets:

(3) NEUTRAL – How long is the movie? (How full is the glass?)

(4) NON-NEUTRAL – How short is the movie? (How empty is the glass?)

When discussing the length of a movie it is normal to use (3) but not (4). The same would apply when discussing the volume of liquid in a glass. In specific situations where emptiness is desired it is possible that information about the emptiness would be requested, but it is clear that the fullness of the glass is more likely to be mentioned. The second feature used to distinguish the marked term is scale names:

(5) FULL SCALE – length (fullness)

(6) HALF SCALE – shortness (emptiness)

When using the term length this refers to the whole scale of anything being measured. Similarly fullness can refer to any volume. If the term shortness is used this is taken to imply only the negative part of the measurement, less than half. This is also apparent for the term emptiness. Emptiness is only likely to be used if the volume is half or less than half of the possible amount. The third feature of this kind is measure phrases;

(7) POSSIBLE – Two hours long (Two thirds full)

(8) IMPOSSIBLE – Two hours short (Two thirds empty)

In (7) it is clear that to measure something in terms of its length is acceptable whereas in (8) to measure something in terms of its shortness is unacceptable. In this respect this

term is marked. In our example the default statement would again be to say 'two thirds full'. That is the volume in a vessel is generally described in terms of fullness. Using these three features as a means of diagnosis it is clear that the concept of fullness is more prominent. When a situation is described in which a character implicitly desires fullness this is easy for the reader to infer. In contrast when using the marked term empty or when there is a desire for emptiness this leads the listener (or reader) to ask why this expression was used. That is if full/fullness is the default why describe something as empty or in terms of emptiness? It may then be that the preference for describing vessels in terms of their fullness, together with a desire for fullness can override reference point information provided by the frame. Consider sentence (9), a material from Experiment 4(a) and 5(a):

(9) The boat had been out at sea for a full week.
The fisherman was *happy/angry* because the nets
were half *full/empty* and he wanted to return to shore soon.

It is clear to the reader that the fisherman wants the nets to be full or as full as possible. In addition the reader may recognise that fullness is a more common concept with respect to a fisherman's nets*, e.g. were the nets full?* As a result it is possible that the combination of desire for fullness and the unmarked concept of fullness led readers to recognise that *half full* is not a good thing when fullness is desired and so is not consistent with the positive emotion *excited*. Specifically the word *full* in this situation is what is expected by reader, the addition of *half* to the dimension has then led to difficulty in processing.

In the materials used in these experiments the concepts of fullness and emptiness are provided as implicit character desires. The actual terms full and empty are also used as

part of the logically equivalent statements *half full* and *half empty*. This combination of implicit desires and marked and unmarked terms has led to an interesting pattern of results. In Experiments 4(a) and 5(a) where fullness is desirable, processing of the frame *half full*, which includes the unmarked term full, is difficult regardless of character emotion. This is because readers are aware that the volume is not full. In contrast processing of the frame *half empty*, which includes the marked term empty, is dependant on character emotion. Empty is read easily when the character experiences a negative emotion. This is because the implication of the frame *half empty* is that the container is not full and this is consistent with a negative emotion. In contrast processing of empty is difficult when the character experiences a positive emotion, because the implication of the frame *half empty* is that the container is not full which is not consistent with the character being positive when desire is for fullness. In Experiments 4(b) and 5(b) where emptiness is desirable, processing of both the unmarked and marked terms, within logically equivalent frames, are affected by implicit desire in the same way as *empty* in Experiments 4(a) and 5(a). That is *half full* is easy to read when the character experiences a negative emotion. This is because the implication from the frame *half full* is that the container is not empty, and being not empty is consistent with feeling negative when emptiness is desired. *Half empty* is in turn easy when the character feels positively. This is because the implication from the frame *half empty* is that the container is not full, which is good from the character's point of view where emptiness is desired. It appears that when implicit desire coincides with the situation described by the marked term (emptiness is desirable), frame interacts with character emotion symmetrically. When implicit desire coincides with the situation described by the unmarked case, it becomes difficult to process the unmarked term within a logically equivalent frame. Such that when desire is for fullness *half full* becomes difficult regardless of character emotion.

It is clear that the online processing of logically equivalent statements *half full* and *half empty* is affected by character's implicit desire, and that markedness has played a part in how the frames are interpreted. Before drawing any conclusions about the role of markedness, and implicit desire, it is necessary to look at the effect of these frames when desire information is not implied by the context. As mentioned previously it is possible that markedness has also affected the results of previous offline studies (McKenzie and Nelson, 2003; Sher & McKenzie, 2006) which show that while reference points are drawn from the frames there is still a slight preference for the term *full*. In order to further investigate these possibilities I now wish to look at the online processing of logically equivalent statements in neutral conditions. That is if there is no desire implicit in the context are the frames themselves solely responsible for the inferences made by readers.

Chapter 5

The non equivalence of logically equivalent frames.

Introduction

The experiments in Chapters 4 and 5 demonstrate that processing of logically equivalent volume statements can be dependant on context. The purpose of the current chapter is to assess how these frames, along with other logically equivalent statements, are processed when the context is neutral. Previous offline experiments (McKenzie & Nelson, 2003; Sher & McKenzie, 2006), in which the context was neutral with respect to implicit desire, have shown that *half full* and *half empty* lead to inferences of *previously empty* and *previously full,* respectively. Participants in these experiments have established a reference point from the frame and from the fact that speakers tend to emphasise what has increased relative to a reference point. Inferences of this type are not restricted to volume statements. For example inferences can be made from logically equivalent statements of time in relation to the completion of a task. In an experiment relating to the time it is taking a team to complete a task, Teigen and Karevold (2005) found that when the team leader told members of the team that *half of the time was spent* participants would infer this meant that they (the team members) should work faster. In contrast if the team leader said *half of the time is left* participants inferred that this meant they were ahead of schedule and could slow down. In a related experiment participants were asked to act as the team leader and chose a statement which would indicate to the team that they were *behind* or *ahead of schedule*. When indicating that the team was *behind schedule* participants chose to frame their statements in terms of time which had been spent. When asked to indicate that the team was *ahead of schedule* participants chose to frame their statement in terms of time left.

The following eye-tracking experiments use materials which are based on the offline experiments of McKenzie and Nelson (2003) and Teigen and Kavevold (2005) to determine if the type of inferences made in their experiments can be made online during

reading. Crucially the desirability of a high or low volume or quantity is not manipulated across these materials. That is although characters are introduced in the passages there is no indication, either implicit or explicit, of their desire in relation to the situation. The results of these experiments are important in determining if inferences about prior reference points can be made during language comprehension as opposed to during decision making tasks. In previous experiments the inferences made regarding reference points have been modified depending on the character's desire. In an experiment where there is no desire it should be clearer if readers can rapidly make these inferences in order to integrate upcoming text.

To allow close comparison to previous studies involving the reference point hypothesis and information leakage account (McKenzie & Nelson, 2003, Sher & McKenzie, 2006; Teigen & Brun, 2005) a novel approach has been taken in the design of these eye-tracking experiments. It is clear in previous experiments that the reference points have been drawn by the decision maker as the authors expected, with a slight preference in McKenzie and Nelson (2003) and Sher and McKenzie (2006) to choose the glass which had previously been *full* as noted previously and by these authors. In order to determine if readers draw these same inferences online a between subjects design was chosen. In contrast to allowing a single participant to read multiple passages of the same construction across four conditions, a large sample of participants read only one passage in one condition from each experiment. This approach is unconventional in eye-tracking but necessary given the specific relevance of the particular inferences under investigation. It is clear in the previous choice based experiments (McKenzie & Nelson, 2003; Sher & McKenzie, 2006; Teigen & Karevold, 2005) that in a neutral situation participants use reference points to draw conclusions about the prior state of the glass or about the amount of time remaining to complete a task. In order to examine

if these robust effects can be found during online processing it was considered desirable to use materials as close to the originals as possible. In these original experiments each participant made only one decision and it is difficult if not impossible to imagine 32 or even 24 neutral situations which could be compared in a within participants experiment to replicate this finding. In this case a within participants design was not suitable as the construction of a variety of materials leading to this result would be evident to the participant during reading and would effect processing time. Further advantages are that the majority of regions in each experiment will be identical across conditions allowing for precise comparison. Importantly the use of this novel design may prove beneficial to future research. As far as I am aware no other eye-tracking experiment where a single material is read by each participant. If the design can be seen to produce significant results it may be replicated for situations in which a specific sentence construction or word is under investigation. In a multiple material experiment even when using extensive fillers participants can often become aware of the manipulation within the text if not the purpose of the experiment. In addition they may become tired or bored when reading from a screen for generally 30 plus minutes. Use of a single passage per reader will eliminate these problems whilst still allowing comparison of critical regions.

Experiment 6

This experiment makes use of a material used in a previous written experiment (McKenzie & Nelson, 2003) where a character witnesses a change in the volume of liquid in a glass. The original material (1) describes a character who leaves a room and returns to find the volume of liquid in a glass has changed.

(1) "Imagine that Mary was sitting at her kitchen table with a glass in front of her. She left the room briefly and came back to find that the contents of the glass had changed. When asked to describe the glass now, Mary said "The glass is half full." Given how Mary chose to describe the glass after its contents had changed, please choose the statement below in terms of what you think was most likely true about the glass before its contents changed." (pp 600)

Participants were presented with this material before being asked to choose either 'The glass was full before the contents changed' or 'The glass was empty before the contents changed'. As previously discussed participants used the information leaked from the frame *half full* to determine that the glass had previously been empty, and in the alternative *half empty* condition that the glass had previously been full. By adapting the above material to include both Mary's statement about the current state of the glass and a further statement about the previous state of the glass, for example *The glass is now half full but when I left it was empty,* it is possible to determine if participants use the leaked information in a similar way during reading of the statements. In the current experiment, volumes of *half full* and *half empty* were followed by previous volumes of *full* and *empty*. If the frames *half full* and *half empty* leak information about the previous state of the glass as detailed in the information leakage account (Sher & McKenzie, 2006) then a previous volume of *empty* will be easy to read after a *half full* statement and a previous volume of *full* will be easy to read after a *half empty* statement. Where the current volume is *half full* a previous volume of *full* should be difficult to read, and when current volume is *half empty* a previous volume of *empty* should be difficult to read.

Method

Participants

These were 120 native speakers of British English from the University of Glasgow community. All participants had normal or corrected to normal vision and were paid £1 or given course credit to take part.

Materials

The experiment consisted of a single material adapted from McKenzie and Nelson's written experiment. This material was then changed to allow four conditions as detailed in Table 6.1. The first three sentences of the material describe a character who witnesses a change in the volume of liquid in a glass. In the fourth sentence the character makes a statement about the current and previous volumes of liquid in the glass. In two of the four conditions the character infers the prior state of the glass as detailed by the information leakage account (Sher and McKenzie, 2006). That is, **half full** indicates previously **empty** and **half empty** indicates previously **full**. In the other two conditions the same volume term is used to describe both the current and the previous state. that is **half full** and **full**, and **half empty** and **empty**.

Condition	Material
Half Full/ Full	Imagine Mary is sitting at the kitchen table with a glass in front of her. Mary then leaves the room briefly and when she returns the contents of the glass has changed. When Mary is asked to describe what has happened she says: 'The glass is now **half full** but when I left it was **full** and I did not touch it.'
Half Full/ Empty	Imagine Mary is sitting at the kitchen table with a glass in front of her. Mary then leaves the room briefly and when she returns the contents of the glass has changed. When Mary is asked to describe what has happened she says: 'The glass is now **half full** but when I left it was **empty** and I did not touch it.'
Half Empty/ Full	Imagine Mary is sitting at the kitchen table with a glass in front of her. Mary then leaves the room briefly and when she returns the contents of the glass has changed. When Mary is asked to describe what has happened she says: 'The glass is now **half empty** but when I left it was **full** and I did not touch it.'
Half Empty/ Empty	Imagine Mary is sitting at the kitchen table with a glass in front of her. Mary then leaves the room briefly and when she returns the contents of the glass has changed. When Mary is asked to describe what has happened she says: 'The glass is now **half empty** but when I left it was **empty** and I did not touch it.'

Table 6.1 Details of the material used in Experiment 6 in all 4 conditions.

Design

This eye-tracking experiment was a 2 (current volume) x 2 (previous volume) between participants design. Each participant read a single material in one of the four conditions. This material was preceded and followed by an unrelated filler passage. Participants were assigned randomly to a condition. In order to assist analysis the passage was displayed to the participants in the format shown in Table 6.2.

Eye-tracking and Procedure

The eye-tracking apparatus and procedure for completion of this experiment was identical to that of Experiments 4(a) and 4(b). After being seated comfortably a calibration procedure was completed before participants were asked to read the sentences carefully for comprehension. The experiment contained only 3 materials in total and so participants were not asked to answer comprehension questions.

Results and Discussion

For analysis, the final sentence of the passage was broken into 6 regions as detailed in Table 6.2.

Imagine Mary is sitting at the kitchen table with a glass in front of her.
Mary then leaves the room briefly and when she returns
the contents of the glass has changed.
When Mary is asked to describe what has happened she says:
|'The glass is now**[1]**| half full **[2]**|but**[3]**|
|when I left it was**[4]**| empty and **[5]**|I did not touch it.'**[6]**|

Table 6.2 Display format and Regions of analysis for Experiment 6.

Reading times and regressions were then collated using these regions. Regions 1, 3, 4, and 6 were identical across conditions. Region 2 always contained details of the current volume of liquid in the glass either [half full] or [half empty]. Region 5 always gave details of the previous state of the glass either [full and] or [empty and]. Due to the length and frequency differences of full and empty as discussed in previous chapters it was not possible to match Regions 2 or 5 for either property.

Five measures of eye movements were applied to the data as detailed in Experiments 2, 4 and 6 these were first pass reading time, % first pass regressions, regression path reading time, total reading time and % regressions in. Eye movements were also truncated and pooled as detailed previously. Where data was missing for first pass reading times, total reading times and regression path reading times this was replaced with the condition mean. This accounted for 1.6% of the data for these measures. As Region 3 was small this was skipped in a large number of trials and so has been excluded from further analysis.

Table 6.3.1 and Table 6.3.2 give the mean values for each of the five measures in each condition for each Region. First pass regressions out are not detailed for Region 1 as these would indicate rereading of the earlier neutral sentences, similarly as Region 6 is the final region there are no regressions into this region. As there was only one material in the experiment analysis of each measure for each region was completed using a 2 (current volume) x 2 (previous volume) between participants ANOVA.

Measure Condition	**Region 1**	**Region 2**
First Pass Reading Time		
Full/Full	449.43 (37.1)	423.40 (41.0)
Full/Empty	499.20 (39.2)	372.57 (45.2)
Empty/Full	512.13 (30.6)	360.43 (37.0)
Empty/Empty	486.47 (38.2)	371.63 (36.4)
Regressions Out		
Full/Full	-	16.67 (6.9)
Full/Empty	-	36.67 (8.9)
Empty/Full	-	26.67 (8.2)
Empty/Empty	-	20.00 (7.4)
Regression Path Time		
Full/Full	449.43 (37.1)	527.40 (51.4)
Full/Empty	499.20 (39.2)	593.23 (55.5)
Empty/Full	512.13 (30.6)	526.80 (59.5)
Empty/Empty	486.47 (38.2)	497.57 (50.7)
Total Reading Time		
Full/Full	495.37 (35.3)	521.40 (42.5)
Full/Empty	608.40 (44.0)	532.27 (43.7)
Empty/Full	581.80 (49.9)	509.73 (58.1)
Empty/Empty	592.37 (51.9)	639.33 (74.2)
Regressions In		
Full/Full	20.00 (7.4)	13.33 (6.3)
Full/Empty	40.00 (9.1)	16.67 (6.9)
Empty/Full	33.33 (8.7)	10.00 (5.6)
Empty/Empty	33.33 (8.7)	20.00 (7.4)

Table 6.3.1 Means and Standard Errors for all measures for Regions 1 and 2.

Measure Condition	**Region 4**	**Region 5**	**Region 6**
First Pass Reading Time			
Full/Full	530.20 (43.5)	220.73 (15.7)	662.13 (83.6)
Full/Empty	517.87 (46.6)	259.90 (28.2)	692.97 (68.9)
Empty/Full	529.13 (41.6)	290.03 (25.9)	699.10 (73.8)
Empty/Empty	521.83 (58.8)	267.77 (38.9)	717.37 (83.3)
Regressions Out			
Full/Full	0.00	23.33 (7.8)	36.67 (8.9)
Full/Empty	0.00	26.67 (8.2)	50.00 (9.3)
Empty/Full	0.00	13.33 (6.3)	30.00 (8.5)
Empty/Empty	0.00	30.00 (8.5)	36.67 (8.9)
Regression Path Time			
Full/Full	530.20 (43.5)	327.43 (39.6)	1212.87 (123.9)
Full/Empty	517.87 (46.6)	397.17 (48.7)	1447.67 (197.9)
Empty/Full	529.13 (41.6)	357.83 (43.8)	1229.00 (198.6)
Empty/Empty	520.77 (58.8)	527.13 (101.8)	1826.47 (323.3)
Total Reading Time			
Full/Full	688.90 (55.0)	282.47 (24.0)	1002.63 (91.6)
Full/Empty	760.43 (90.3)	384.50 (35.6)	978.77 (62.3)
Empty/Full	655.67 (71.6)	357.40 (41.6)	891.97 (90.0)
Empty/Empty	943.57 (121.9)	478.77 (62.3)	1061.10 (94.9)
Regressions In			
Full/Full	36.67 (8.9)	13.33 (6.3)	-
Full/Empty	50.00 (9.3)	33.33 (8.7)	-
Empty/Full	20.00 (7.4)	16.67 (6.9)	-
Empty/Empty	50.00 (9.2)	20.00 (7.4)	-

Table 6.3.2 Means and Standard Errors for all measures for Regions 4 to 6.

First Pass Reading Times

There were no significant results using this measure in any of the regions.

% First Pass Regressions Out

There were no significant results using this measure in Region 2 and there were no regressions out of Region 4. The means for Regions 5 and 6 suggest a higher number of regressions out when the glass was described as previously *empty* rather than *full*, however this trend is not supported by the statistical analysis (all *ps >0.1*).

Regression Path Times

There were no significant differences in regression path reading times in Regions 1, 2 and 4. The main effect of previous volume approached significance in the critical region (5) ($F (1, 116) = 3.52, p = 0.06$) and the post-critical region (6) ($F (1, 116) = 3.51, p = 0.06$). Readers took longer to bypass these regions when the previous volume was *empty* as opposed to *full*. Figure 6.1 displays the means for the critical region. The interaction and the main effect of current volume for these regions were not significant. Results of regression path reading times and first pass regressions out suggest that readers are having difficulty processing a previous volume of *empty* as soon as they encounter it causing them to return to a previous section of text.

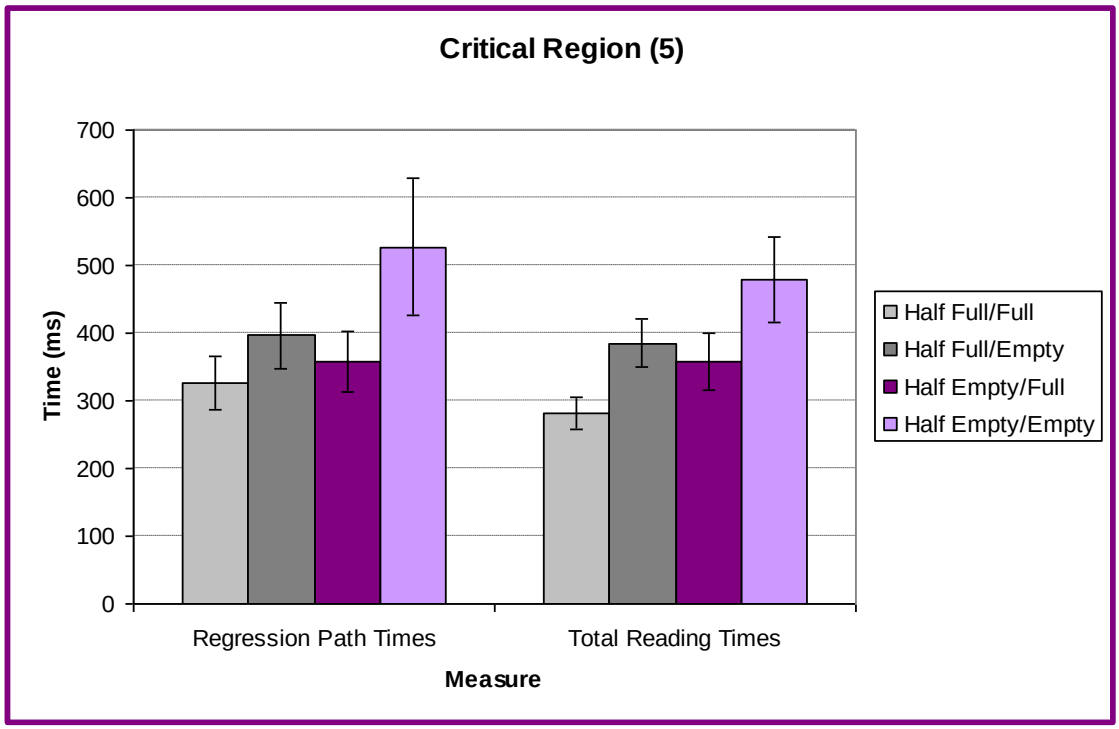

Figure 6.1 Regression Path Times and Total Reading Times for the Critical Region in Experiment 6.

Total Reading Times

There were no significant differences for this measure in Regions 1 and 2. In Region 4, the pre-critical region, there was a main effect of previous volume ($F(1, 116) = 4.15$, $p<0.05$) with longer total reading times when the previous volume was *empty* rather than *full*. There was no interaction or main effect of current volume in this region. The means for this measure in the critical region (5) can be seen in Figure 8.1. In this region the main effect of previous volume was significant ($F(1, 116) = 6.68$, $p<0.01$) with longer reading times for *empty* as opposed to *full*. The main effect of current volume was also significant ($F(1, 116) == 3.84$, $p<0.05$) with longer reading times when this had been *half empty* rather than *half full*. There was no significant interaction in this region and no significant differences in Region 6. These results indicate that participants have difficulty processing a previous volume of *empty*. Total reading times when the previous volume was *empty* were also higher in the pre-critical region which may be the result of a high number of regressions into this region.

% Regressions In

There were no significant differences for this measure in Regions 1, 2 and 4. In the critical region (5) there was a significant main effect of previous volume with more regressions into this region when it contained *empty* rather than *full*. There was no main effect of current volume or significant interaction in this region.

The results of this experiment suggest that processing of a previous volume of *empty* is difficult regardless of the way the current volume is framed. That is *empty* is considered inconsistent with both *half empty* and *half full.* This is contrary to the prediction that when the frames were presented without a biasing context they would be interpreted using the information leakage account. What is most noticeable is that a previous volume of *full* is processed with ease after a current volume of *half full*. Readers do not find it inappropriate for Mary to describe the glass in this way. It is clear that the concept of full or fullness allows for easier processing of text. There were no differences in reading times or regressions in Region 2, which held the current volume *half full* or *half empty*. This would suggest that these terms are equally acceptable and it is only later when the prior state of the glass is mentioned that *empty* causes problems. These results are surprising when compared to those of Mckenzie and Nelson (2003) and Sher and McKenzie (2006) who found that participants easily drew these inferences from the frames given.

In the current experiment the time allowed between the description of the current and previous volumes is short and so it is possible that there has not been enough time for the reader to infer the previous volume such that markedness of the concepts has driven processing. The alternative is that the concept of emptiness is marked meaning a previously *empty* vessel is unacceptable or at least bizarre regardless of time elapsed.

Notably it appears that the problem in processing *empty* is present only when *empty* is the previous state of the glass, as determined by the main effect of previous volume. That is to say that the frame *half empty* is no more difficult to read than *half full* as there were no processing differences in this region. Moreover there was no interaction to suggest that a current volume of *half empty* lead to more difficulty in processing a previous volume of *empty*, although there is a trend in this direction as can be seen in Figure 6.1. The differences between *full* and *empty* have affected the results of this and previous experiments. The following experiment attempts to address this issue by using two very different logically equivalent frames.

Experiment 7

The results of Experiment 6 have shown that in the case of *half full* and *half empty* logically equivalent frames do not necessarily lead to the same inferences online as they do offline. It is possible that information has been leaked from these frames whilst reading but other factors have allowed a previous volume of *full* to be processed more smoothly. The current experiment aims to use a different set of logically equivalent frames to further assess the reader's ability to draw inferences online. The material in this experiment has been created by drawing on a number of experiments relating to time management by Teigen and Karevold (2005) as mentioned in the introduction to this Chapter. Importantly these materials involved time and speed which although logically equivalent cannot be considered to be opposites in the same manner as *full and empty*. The aim of this experiment is then to eliminate any effects of markedness on the processing of the frames.

The material in Experiment 7 involves a team which is attempting to complete a task within a specific time period. The team leader then makes a statement about how much

time the task is taking. One of the team members (Patrick) then makes a statement which reveals what he has inferred from the leader's statement. For example, if the team leader says that *'half of the time is over'* Patrick may reply with a statement such as *'So you think we are taking too long'*. In this case Patrick has inferred that the leader thinks they are behind schedule and so need to hurry up i.e. the task is taking too long. In contrast if the leader states *'half of the time is left'* it is likely that Patrick will infer they are ahead of schedule and that the leader thinks they are *'going too fast'*. If this is the case the results will provide further evidence that information is leaked from a speaker's use of a frame, as in this case there is no issue of markedness to consider. If participants use the leader's statement to make inferences similar to Patrick's about the teams performance results will show easier processing of a *taking too long* statement than a *going too fast* statement when the leader has used the term *time is over*. When the leader has used the term *time is left* it is expected that *going too fast* will be easier to process than *taking too long*.

Method

Participants

These were 120 members of the University of Glasgow community. All participants were native speakers of British English and had normal or corrected to normal vision. They were either paid £1 or given course credit for taking part.

Materials

There was a single material which was based on the experiments completed by Teigen and Karevold (2005). This material was adapted to make four conditions as detailed in Table 7.1. The first two sentences in each condition introduce a situation where a group must complete a task within a given amount of time. The third sentence contains a

statement from the group leader indicating how much time the task has taken so far, *half of the time is over* or *half of the time is left*. The final sentence contains the inference which Patrick has made based the leader's statement, either that the group is *taking too long* or *going too fast*. In two of the conditions Patrick's inference is congruent with the leaders comments, that is **time is over** indicates **taking too long** and **time is left** indicates **going too fast**. In the other two conditions the inference and statements are incongruent.

Design

Each participant in this experiment read a single material which meant the experiment was entirely between participants. The experiment had 2 factors each of which had two levels, the Leader's statement (time is over and time is left) and Patrick's inference (taking too long and going too fast). Participants were assigned randomly to a condition and the passage was displayed in the format given in Table 7.2. The passage was always preceded by two unrelated passages.

Condition	Material
Over/Too Long	Patrick is part of a group of students who are working together on a project. The project, if done correctly, will take exactly one hour to complete. The leader of the group mentions that **half of the time is over**. Patrick then replies: "So you think we are **taking too long** and will not get it done properly?"
Over/Too Fast	Patrick is part of a group of students who are working together on a project. The project, if done correctly, will take exactly one hour to complete. The leader of the group mentions that **half of the time is over**. Patrick then replies: "So you think we are **going to fast** and will not get it done properly?"
Left/Too Long	Patrick is part of a group of students who are working together on a project. The project, if done correctly, will take exactly one hour to complete. The leader of the group mentions that **half of the time is left**. Patrick then replies: "So you think we are **taking too long** and will not get it done properly?"
Left/Too Fast	Patrick is part of a group of students who are working together on a project. The project, if done correctly, will take exactly one hour to complete. The leader of the group mentions that **half of the time is left**. Patrick then replies: "So you think we are **going too fast** and will not get it done properly?"

Table 7.1 The material used in Experiment 7 in all four conditions.

Eye-tracking and Procedure

The eye-tracking apparatus and procedure for completion of this experiment was identical to that of Experiments 4(a) and 4(b). Participants were asked to read the sentences carefully for comprehension. As the experiment contained 3 materials in total there were no comprehension questions.

Results and Discussion

For analysis the last three lines of the passage were broken into 6 regions as shown in Table 7.2.

Patrick is part of a group of students who are working together on a project.
The project, if done correctly, will take exactly one hour to complete.
The leader of the group mentions that
|half of the**[1]**| time is over. **[2]**|
|Patrick then replies: **[3]**|
|"So you think we are**[4]**| taking too long **[5]**|and will not get it done properly?"**[6]**|

Table 7.2 Display format and Regions of analysis for Experiment 7.

In each material Region 1 contained the words [half of the] and Region 2 contained the leader's statement about the time, either [time is over] or [time is left]. Regions 3, 4 and 6 were identical across conditions. Region 5 gave details of the inference that Patrick has made from the leader's statement either [taking too long] or [going too fast]. Regions 1, 2, 3, 4 and 6 were identical in length across conditions, Region 5 varied in length by one character depending on the inference made. Where participants had failed to fixate a region this data point was replaced with the group mean, this was necessary for less than 1% of the data. As with the previous eye tracking experiments five measures of eye movements were calculated after fixations were pooled and truncated. The mean values for each measure in each Region and for each condition are given in Table 7.3.1 and 7.3.2.

Measure Condition	**Region 1**	**Region 2**	**Region 3**
First Pass Reading Time			
Time is over/Taking too long	434.60 (48.6)	399.43 (47.5)	591.23 (49.4)
Time is over/Going too fast	398.80 (33.6)	422.70 (39.2)	593.33 (55.2)
Time is left/Taking too long	407.33 (32.2)	399.13 (36.6)	590.57 (35.3)
Time is left/Going too fast	370.17 (31.4)	390.23 (40.1)	500.00 (35.2)
Regressions Out			
Time is over/Taking too long	-	36.67 (8.9)	3.33 (3.3)
Time is over/Going too fast	-	33.33 (8.7)	6.67 (4.6)
Time is left/Taking too long	-	46.67 (9.2)	0.00
Time is left/Going too fast	-	33.33 (8.7)	3.33 (3.3)
Regression Path Time			
Time is over/Taking too long	434.60 (48.6)	643.80 (65.6)	618.70 (56.4)
Time is over/Going too fast	399.30 (33.6)	669.10 (56.6)	739.80 (136.9)
Time is left/Taking too long	414.70 (34.6)	676.00 (58.4)	590.57 (35.3)
Time is left/Going too fast	463.70 (60.1)	602.33 (74.7)	513.93 (33.9)
Total Reading Time			
Time is over/Taking too long	542.20 (53.0)	558.80 (44.4)	632.67 (49.8)
Time is over/Going too fast	526.27 (46.4)	545.33 (44.0)	602.70 (53.9)
Time is left/Taking too long	533.33 (44.1)	543.57 (41.5)	600.53 (37.0)
Time is left/Going too fast	494.97 (42.2)	541.73 (63.6)	558.23 (38.8)
Regressions In			
Time is over/Taking too long	36.67 (8.9)	3.33 (3.3)	3.33 (3.3)
Time is over/Going too fast	33.33 (8.7)	0.00	0.0
Time is left/Taking too long	46.67 (9.3)	0.00	3.33 (3.3)
Time is left/Going too fast	40.00 (9.1)	10.00 (5.6)	10.00 (5.6)

Table 7.3.1 Means and Standard Errors for all measures for Regions 1 to 3.

Measure Condition	**Region 4**	**Region 5**	**Region 6**
First Pass Reading Time			
Time is over/Taking too long	492.30 (57.4)	487.33 (49.6)	1063.07 (81.2)
Time is over/Going too fast	624.47 (61.1)	449.93 (35.7)	1248.57 (99.4)
Time is left/Taking too long	538.43 (45.5)	435.07 (31.1)	1046.83 (107.3)
Time is left/Going too fast	494.13 (59.5)	447.93 (29.9)	1301.10 (140.4)
Regressions Out			
Time is over/Taking too long	3.33 (3.3)	20.00 (7.4)	20.00 (7.4)
Time is over/Going too fast	0.00	13.33 (6.3)	16.67 (6.9)
Time is left/Taking too long	3.33 (3.3)	6.67 (4.63)	16.67 (6.9)
Time is left/Going too fast	3.33 (3.3)	3.33 (3.33)	20.00 (7.4)
Regression Path Time			
Time is over/Taking too long	528.37 (61.7)	620.40 (62.5)	1543.00 (171.4)
Time is over/Going too fast	624.47 (61.1)	556.47 (52.3)	1557.73 (108.6)
Time is left/Taking too long	568.70 (46.4)	474.07 (37.8)	1258.63 (106.9)
Time is left/Going too fast	523.83 (63.5)	461.43 (31.9)	1727.93 (205.2)
Total Reading Time			
Time is over/Taking too long	630.67 (74.2)	588.27 (62.4)	1182.50 (87.4)
Time is over/Going too fast	752.17 (77.3)	562.43 (51.8)	1387.07 (88.5)
Time is left/Taking too long	601.37 (46.8)	497.50 (36.3)	1192.57 (93.4)
Time is left/Going too fast	551.67 (60.5)	468.20 (27.8)	1423.63 (129.6)
Regressions In			
Time is over/Taking too long	20.00 (7.4)	3.33 (3.3)	-
Time is over/Going too fast	23.33 (7.8)	6.67 (4.6)	-
Time is left/Taking too long	13.33 (6.3)	16.67 (6.9)	-
Time is left/Going too fast	3.33 (3.3)	6.67 (4.6)	-

Table 7.3.2 Means and Standard Errors for all measures for Regions 4 to 6.

Analysis was completed by means of a 2 (Leader's statement) x 2 (Patrick's inference) between participants ANVOA for each measure and each region.

First Pass Reading Times

There were no significant differences using this measure in Regions 1, 2, 3, 4 and 5. In Region 6, the post-critical region, there was a main effect of Patrick's inference (*F (1, 116) = 4.05, p<0.05*). The post-critical region took longer to read on first pass when Patrick's inference was *going too fast* as opposed to *taking too long*. There was no main effect of leader's statement or interaction in this region.

% First Pass Regressions Out

There were no significant differences using this measure in Regions 1, 2, 3, 4 and 6. In the critical region (5) there was a significant main effect of Leader's statement (*F (1, 116) = 4.27, p<0.05*). There were more regressions out of this region when the leader had stated half the *time is over* as opposed to *time is left*. There was no significant interaction or main effect of Patrick's inference in this region.

Regression Path Times

There were no significant differences in regression path reading times in Regions 1, 2, 3, 4 and 6. The means of the critical region can be seen in Figure 9.1. In this region there is a main effect of Leader's statement (*F (1,116) = 6.41, p = 0.01*) with more time taken to by pass this region when the leader had stated half the *time is over* as opposed to *time is left*. There was no significant interaction or main effect of Patrick's inference in this region. The results of these three measures indicate that a Leader's statement of *time is over* is causing processing difficulty on first reading the passage, as is an

inference of *going too fast*. There is no evidence of an interaction between the two variables.

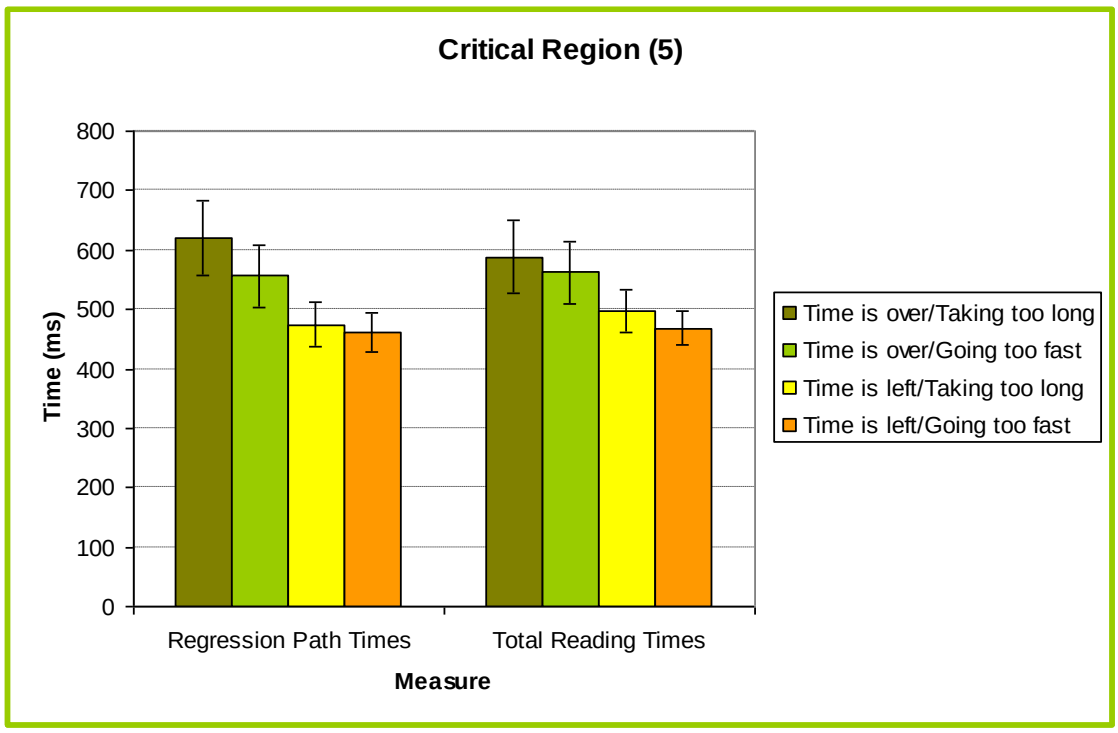

Figure 7.1 Regression Path Times and Total Reading Times for the Critical Region in Experiment 7.

Total Reading Times

There were no significant differences in total reading times in Regions 1, 2 and 3. In Region 4, the pre-critical region, the main effect of Leader's statement was approaching significance ($F\ (1, 116) = 3.05, p=0.08$). More time was spent fixating this region when the leader had stated *time is over* rather than *time is left*. There was no main effect of Patrick's inference or significant interaction in this region. Mean total reading times for the critical region (5) can be seen in Figure 7.1. In this region there was a significant main effect of Leader's statement ($F\ (1,116) = 3.95, p<0.05$) with longer reading times when the leader had stated half the *time is over* as opposed to *time is left*. There was no main effect of Patrick's inference or interaction between the two variables in this region. In the post-critical region (6) there was no main effect of Leader's statement, however the main effect of Patrick's inference was significant ($F\ (1,116) = 4.63, p<0.05$). Reading times were longer for this region when Patrick had said *going too fast* rather

than *taking too long*. These result suggest that both a statement of *time is over* and an inference of *going too fast* increase reading time and so suggest difficulty in processing. Again there is no evidence of an interaction between the statement and inference variables.

% Regressions In

There were no significant results using this measure in Regions 1, 3 and 5. The number of regressions into Regions 2 and 4, as seen in Table 7.3.1 and 7.3.2, were considered too low to complete inferential analysis.

There are two clear patterns of reading in the data. A Leader's statement of *time is over* rather than *time is left* has increased processing difficulty across the remaining regions and Patricks inference of *going too fast* rather than *taking too long* has led to greater time spent in the final region and greater regressions out of this region. There is no interaction between the variables or pattern of results in the data to indicate that participants have used information leaked from the leader's statement to make an inference. The factors which may have led to this result are different from those of previous experiments. As the frames in this case relate to phrases as opposed to a single word it is less clear whether frequency or markedness is involved. In the framework of task completion it is intuitive that time will be discussed in terms of what is remaining and it is unlikely that a leader thinks a team is going too fast, unless it is made explicit that going too fast will lead to a poor end result. Again although in offline experiments these logically equivalent frames lead to specific inferences these inferences are ignored in favour of the commonality of terms in online processing.

Discussion

The results of these experiments indicate that during online processing information leakage from logically equivalent frames is not solely responsible for readers' inferences. In Experiment 6 it is clear that readers find it easier to consider a glass as having previously been *full* as opposed to *empty* regardless of the way in which the current volume is described. In Experiment 7 it seems preferable for a task to be described in terms of *time left* and, regardless of how time is framed, an inference of *taking too long* is easier. The use of eye movements to investigate participants online processing of logically equivalent frames is novel and so these results extend rather than contradict previous research. However, there is a clear difference between the effect of these frames in decision making tasks and their processing during reading even in this chapter where context has been kept neutral.

In McKenzie and Nelson's (2003) experiment participants make a decision regarding the prior state of a glass having read Mary's observations. When Mary states "The glass is now *half full*" participants indicated that the glass had previously been *empty* in 50% of trials. In this condition participants also indicated that the glass was previously *full* in 50% of trials. When Mary stated "The glass is now *half empty*" participants indicated that the glass had previously been *full* in 80% of trials. Information leakage has occurred from these frames allowing participants to establish a reference point, or in other words to determine the previous state of the glass. In addition it is clear that even when the glass is described as currently *half full* participants are somewhat less willing to describe the glass as having previously been *empty*. This unwillingness is reflected in the results of Experiment 6 where a previous volume of *empty* is difficult to process regardless of the current volume denoted. In addition McKenzie and Nelson's first experiment which looked at a speaker's choice of frame rather than a listener's

interpretation of a frame found across three conditions that regardless of whether a cup had begun as *full* or *empty* there was a general tendency for speaker's to use the frame *half full*. This preference is also apparent in the current data where later regions are processed more easily when the current volume had been *half full* as opposed to *half empty*. Similar albeit less pronounced differences in frame preference can be seen in Teigen & Karevold (2005). In their initial experiment participants took a statement of "We have spent half the time", roughly equivalent to our statement of *half the time is over,* to mean "now we should hurry up a little" 87.9% of the time. When the time statement said "We have half of the time left", participants took this to indicate "we can take it more easy" 72.4% of the time. In the second condition there is a preference for the take it easy statement however the framing effect is not consistent across the two conditions as in 27.6% of trials *hurry up* was considered appropriate after a frame detailing time which was left. In their final experiment participants were asked to act as listeners who had to infer information from another speaker's statement. Their results showed that when the listener was told a team were "ahead of schedule" and so could "slow down" the participant chose to pass this information to the team in terms of *time left* 70.6% of the time. In the alternative condition when told they were "behind schedule" and should "hurry up" participants chose to frame their statement in terms of *time spent* 52.2% of the time. In this condition there is a significant preference for *time spent* however the number of participants choosing to use *time left* statements is still high. These patterns in Teigen and Karevold's data are similar to those in our data. Participants have found the critical region easier to read after a statement of *time is left* rather than *time is over*. Also in the post-critical region there was an increase in processing time after statements of *going too fast* which indicates this has caused the reader difficulty.

In their discussion Sher and McKenzie (2006) postulate that the experiments they have presented provide unequivocal evidence that information is leaked from frames leading to the preference for information detailed using a positive frame as seen in the majority of valence based framing studies (see Levin, Schneider & Gaeth 1998 for a review). Results from Experiments 6 and 7 suggest that during online processing, in addition to this possibility, there is a preference for the concept which is more common, unmarked or pragmatically more acceptable. That is not to say that the two factors are unrelated. A preference for the positively framed information will obviously lead to this term becoming more common and if the positive frame is the most common then it is likely to be preferred. Consider the situation in Experiment 6 in practical terms. If Mary were to leave a full glass of water on a table, what are the reasons that the volume may decrease, a spill or someone has taken a drink from the glass. If Mary were to leave an empty glass on the table, what are the reasons that the volume may increase, someone has filled it up. In Experiment 7, in both cases the reader must assume that someone else has entered the room and changed the volume in the glass. In the short time spent processing the passage perhaps questions about the reasons behind these changes have arisen to the reader. Were this the case they are less likely to draw inferences from the frames themselves and more likely to consider the most likely possibility for that situation. That is, readers may focus on the reason(s) for the change of state, rather than focusing on the consistency between the actual previous state and information about the previous state inferred from the description of the current state. A reduction in the volume of a full glass seems more probable than a more mysterious increase in the volume of an empty glass. This would lead to the result shown as the concept that the glass was previously full is salient to the reader.

Although not dealing with as precise frames the results of Experiment 7 can be attributed to the same reader preferences. Without having more information about completion of the task or the leader's thoughts on the task, participants have used their pragmatic knowledge of the situation to determine that a leader is more likely to remind his team of how much time remains. A team member is more likely to interpret any such reminder as a message to work faster or that the task is *taking too long*. If this is the case the results of Experiment 7 have been driven not by word frequency but by pragmatic knowledge of what is important in a task situation. That is it is important and problematic if a team is working too slowly and so taking too much time to complete the task. In situations where a task is precise and can be done badly it may be important if the job is being done too quickly, however this is less common and more dependant on context.

Overall the results of these experiments provide evidence that in reading the processing of logically equivalent frames is dependant on more than valence and reference points. Readers pick up on all contextual information during processing which leads to differences in which terms are appropriate. As with may other areas of Psycholinguistics it appears that context plays a crucial role in the acceptability of logically equivalent statements during reading.

Chapter 6

Summary and Conclusions

The experiments presented here have used a number of different methods to answer questions which arise from previous studies of pronominal reference and attribute framing. Research involving natural language quantifiers (NLQs) has identified that after a negative NLQ a particular pattern of reference is preferred. That is, a reference to a set which does not fulfil the predicate of the sentence, or what has become known as the complement set (Moxey & Sanford, 1987; Moxey & Sanford, 1993a; Paterson et al., 1998). Later research attributed this focusing preference to denial, a property held to different degrees by most negative NLQs (Sanford et al., 2001). That is a negative NLQ denies that a larger expected amount is the case. This was supported by an increase in Reason-Why-Not (RWN) content in continuation sentences when a negative NLQ had been used. Participants were providing content which explained why the larger amount was not the case. Later still Presupposition Denial Account detailed the conditions under which the occurrence of a complement pattern of reference would be maximal, when a shortfall was created between a large expected amount and a smaller denoted amount (Moxey, 2006; Sanford et al., 2007). One implication of the Presupposition Denial Account is that it is the shortfall rather than the NLQ itself which leads to this type of focusing. This possibility was the basis for the questions asked in the early part of this thesis: *Can complement set reference be found without specifying quantity?* The experiments in Chapters 2 and 3 answered this question using sentence continuations, eye-tracking and ERPs. In doing so the experiments provide support for the Presupposition Denial Account and extend the circumstances under which complement set references are known to be found.

The information leakage account (McKenzie & Nelson, 2003; Sher & McKenzie 2006) provides evidence that frames which may be logically equivalent such as *half full* and *half empty* are not necessarily information equivalent. That is although the frames

determine the same volume, a listener (reader) is able to draw different inferences from a speaker's choice of term. In written and situational experiments these authors were able to show that when a speaker uses the frame 'half full' a listener will determine this vessel to have previously been empty. When the frame 'half empty' is used a listener will determine this vessel to have previously been full. The principles of the information leakage account state that participants are able to infer these prior reference points because of a tendency in the English language to mention something which has increased. That is if something is described as 'half empty' the emptiness has increased. The results of these experiments are important to accounts of attribute framing which assume that positively framed information is always preferred. The question which arose while reviewing this literature asked: *How are these frames understood in isolation during reading?* That is if only one of the frames was given to a reader, as would happen in natural communication, would the reader be able to draw the same inference about the reference point? Previous research on the understanding of frames in isolation (van Buiten & Keren, 2009) has shown that negative frames may have as important an impact when they are presented in isolation. The experiments in Chapters 4 to 6 of this thesis attempted to answer the above question predominantly using eye-tracking to investigate reader comprehension of these frames.

Complement set without specifying quantity

Summary

Experiments 1 to 3 examined whether a complement pattern of reference was possible and/or preferable in a situation where specific quantity (in the form of an NLQ) had not been included. In previous cases the Presupposition Denial Account had been tested by presenting participants with sentences such as (1) where a specific high amount is

mentioned before being denied using a negative NLQ or in some cases a positive NLQ which denotes a small amount.

(1) Robert expected *all/none* of the people in the audience to applaud. *Few* of them clapped. They

In the current set of experiments both the high amount (all) and the smaller about (few) had to be inferred from the context. That is the large amount was determined by the character's desire, for example. a waitress wants all of her customers to leave a tip, and the smaller amount which denies this desire is determined by the characters emotion. In this case the waitress is unhappy with the number of customers who left a tip. Experiment 1 presented participants with sentences in which characters held a high or low desire and experienced a positive or a negative emotion in relation to this desire. Participants were asked to provide a continuation sentence beginning with the plural pronoun They. The results of this experiment found that in situations where a character's desire for a high amount was denied with a negative emotion word there was an increase in references to the complement set. In the above example this would be the customers who did not leave the waitress a tip. In addition in this condition the sentence continuations were more likely to contain a RWN indicating that participants had answered the implicit question: *Why such a small number?* In the other conditions where there was no denial of the character's desire complement set reference and RWN content was much less common. This language production experiment provides evidence that when a shortfall between two amounts is made salient participants become focused on the shortfall set and so refer to this group in the form a complement set reference.

Experiments 2 and 3 examined the comprehension of complement set and reference set references after a shortfall had been made salient as in Experiment 1. Experiment 2 paired high desire sentences which contained either a positive or a negative emotion word with a reference to the reference set or the complement set. Participants read references which were either consistent or inconsistent with the preceding context while their eye movements were recorded. The results of this experiment showed that processing of a complement set reference was difficult when the character had experienced a positive emotion. That is if the waitress was happy about the number of customers who left her a tip it was then inappropriate to continue with a reference to the customers who did not leave a tip. This was reflected in an increase in total reading times and regressions in this condition. In an alternative condition where the emotion word was positive and the second sentence contained a reference set reference processing was straight forward. In conditions where a negative emotion word was paired with a high desire, where the waitress was unhappy about the number of customers who left a tip, the pattern of results was different. Processing of all regions was slower in these conditions regardless of the reference which followed. A reference set reference then led to an increase in regressions out of the critical region and an increase in regressions into the region containing the emotion word. The denial of a high desire in this case has been noted by the reader and a shortfall has been made salient. A reference to the reference set then becomes inappropriate and this is reflected as an inconsistency of the preceding emotion with a reference set reference. The results of this experiment were asymmetrical in that the problems caused by an inconsistent reference set reference were less severe and more specific than those of a complement set reference. In order to further examine the integration of these references into the context Experiment 3 was conducted.

Experiment 3 used ERPs to examine high desire sentences with positive and negative emotion words as in Experiment 2. It was hoped that the electrophysiological record would determine a more precise time course of the integration of references into the context by readers. Three different ERP components were examined. The N400 occurring approximately 400ms post word onset has typically been know to reflect anomalies in both sentence and global level processing (e.g. Kutas & Hillyard, 1980; St George et al., 1994). Experiment 3 identified a significant increase in the amplitude of the N400 at restricted sites for complement set references regardless of the preceding context. This result indicates that the processor did not integrate a complement set reference into the prior context in both positive and negative emotion word conditions. Further analysis examined the P600 component which has more recently been linked with semantic processing. This component is known to show an increase in positivity in cases where an anomalous word fits the global context (Kuperberg et al., 2003). In Experiment 3 the waveform for the electrode Cz appeared to show the expected interaction between polarity of emotion word and set between 590ms and 690ms post stimulus onset, however there were no significant results with this component. Further analysis of the Fz waveform identified a clear separation of activity after a reference set as opposed to a complement set reference. This separation began around 600ms post stimulus onset and finished around 1000ms post stimulus onset. Analysis of this component which was similar to the Nref identified by van Berkum and colleagues (1999; 2003; 2004) who found a difference between the two sets for two frontal electrodes. In this case the reference set references led to a less positive waveform than the complement set reference. This indicates that when encountering a reference set reference the reader may have more than one referent available for processing. This is similar to the effect of referential ambiguity found by van Berkum et al. This pattern of activity has been observed when a pronoun has two or more possible referents.

Discussion

Together Experiment 1, 2 and 3 provide an interesting picture of how complement set reference is understood after a shortfall has been made salient. The three experimental methods used have led to somewhat different results which will now be discussed. First let us address the differing patterns of results across the three experiments. There is clear preference for complement set reference after a shortfall has been made salient in the sentence continuation task of Experiment 1. In addition there is an increase in sentences with RWN content in this condition. In these circumstances it is not unreasonable to conclude that participants have indeed focused on the shortfall set during reading and in turn have preferred to produce references to the complement set. In Experiment 2 this preference is less clear, although present, in the eye tracking data. Previous online experiments which used NLQs to examine complement set references have found asymmetries in how inconsistent references to the reference set and complement set are manifested (Paterson et al., 1998; Moxey et al., 2009). A complement set reference in a situation where there is no shortfall is extremely disruptive to reading. In contrast a reference set reference after a situation where a shortfall has been made salient causes some problems with reading although these are less severe and are most evident in measures of regression. It has always been noted that negative NLQs have a more diffuse pattern of reference than positive NLQs, that is both complement set and reference set references may be available during reading (Paterson et al., 1998) and so the current results are consistent with this. One assertion of the Presupposition Denial Account is that it is the property of denial, held by negative NLQs, which leads to this type of reference (Sanford et al., 2007). Denial is a variable property and so it is not unexpected when using NLQs that a reference set reference after a salient shortfall is on occasion suitable during reading. The current

experiments use implicitly denoted high and low quantities as opposed to NLQs. The high desire is implied in the sentence and then denied with a negative emotion. It is likely that this implicit denial varies dependant on the reader's interpretation of both the desire and the emotion word and so asymmetrical disruption of reading in Experiment 2 is expected. On the whole Experiments 1 and 2 support and extend the Presupposition Denial Account by determining that a shortfall made salient without use of a specific quantity can lead to a preference for complement set reference.

The results of Experiment 3 appear to be in contrast to the two previous studies. There is an increase in the amplitude of the N400, thought to be sensitive to global contextual anomalies, in conditions where pronominal reference is to the complement set. As mentioned previously it is not always the case that negation is recognised by readers upon first reading (Ferguson et al., 2008) and due to the presentation paradigm used here readers are unable to regress or spend a longer amount of time on each word. Participants must work hard to make inferences about both the character's desire in the situation and about the negative implications of the emotion word used. Participants are unable to spend an increased amount of time on the reference or refer to the previous context in order to make the necessary inference. This brief inconsistency has manifested itself as an increase in the N400 component for references of this type. The Nref component (Van Berkum et al., 1999) was examined in a post hoc analysis. It was found that a reference set reference led to a less positive signal than the corresponding complement set reference at frontal electrodes for a prolonged time (600ms to 1000ms). This was linked to the previously reported Nref component related to referential ambiguity. It is possible that in the case of reference set references participants are holding more than one referent in mind as they continue to read the sentence. Rather than disambiguate between two or more salient sets the reference set may be viewed as

merely the default set for pronoun resolution. If this reference fails to make a more specific set salient it is likely that readers are treating it as the default rather than as a specific set which has been inferred from the prior context. Overall the results of the ERP study indicate that understanding inference is extremely complex. Tight control must be kept over materials to ensure any effects found are due to the experimental manipulation alone. In a situation where many experimental materials are required per condition it becomes difficult if not impossible for readers to make a number of inferences from each sentence. Although helpful to establish the time course of integration of a reference into the previous context this method of investigating language is possibly too far removed from normal reading to gain accurate insight.

The results of these experiments make an exciting addition to the studies on complement set reference and can in addition be related to the work on information leakage completed in the second part of this thesis. The authors of the information leakage account (McKenzie & Nelson, 2003; Sher & McKenzie, 2006) suggest that participants are able to identify a reference point from a speaker's choice of frame. Our research suggests that a reference point can be based on the reader's perception of what is desirable for a character mentioned in text. A negative emotion word then denies this desire and in turn emphasises what has increased relative to the reference point, and this increase represents a shortfall. For example, our reference point is the waitress' desire for a high number of customers to leave a tip, and when this reference point is denied with a negative emotion word, salience of the set of customers who did not leave a tip increases. This increase in salience is observed in language production by an increase in complement set references and in language comprehension by easier resolution of a pronoun to the complement set. The complement set represents the group which has increased relative to the reference point. The manner in which the information in our

sentence is framed allows readers to draw inferences about the situation just as McKenzie and colleagues found with logically equivalent frames. In their experiments the frame itself gives more information than simply the volume in the glass. In our experiments the emotion words give more information about the situation than simply how the character feels.

Information leakage during reading

Summary

The experiments in Chapters 4 and 5 examined the processing of logically equivalent statements during reading. The aim of Experiment 4(a) was to determine if reference point information which can be inferred from the terms half full and half empty in decision making experiments can also be inferred online during reading. It was hypothesised that in a situation where a character wanted a vessel to be full a statement of half full would be consistent with the character experiencing a positive emotion about the volume. This is because, in contrast to empty, half full indicates that the vessel is becoming fuller. A statement of half empty would then be considered to be consistent with the character experiencing a negative emotion about the volume. This is because, in contrast to full, half empty indicates that this vessel is becoming emptier. The results of this eye-tracking experiment did not confirm these hypotheses. Participants found statements of half full difficult to read when they were preceded by a positive emotion word and easy to read when they were preceded by a negative emotion word. Statements of half empty were easy to read when following a negative emotion word and difficult to read when following a positive emotion word as predicted. Experiment 5(a) was a written experiment completed to confirm this pattern of results. Together these experiments found that in a situation where a completely full vessel is desirable participants do not consider half full to represent an increase in volume relative to

empty. Instead of drawing this inference participants may feel that the expression full in the term half full, has been used merely as the default description of the volume dimension and so half full represents a lesser amount than full. In order to more fully examine this possibility Experiments 4(b) and 5(b) investigated the patterns of processing when the desired volume was empty as opposed to full. These experiments found that when the characters desire was for an empty vessel, participants found a statement of half empty to be consistent with the character experiencing a positive emotion. In this case they found half full to be consistent with the character experiencing a negative emotion.

In the final experimental chapter two further eye-tracking experiments were completed. Experiment 6 was based on the original work of McKenzie and Nelson (2003) and used an adapted version of one of their materials to examine whether participants could draw reference point information from logically equivalent frames in neutral situations. The results of Experiment 6 show that when provided with the current volume in a glass, for example half full or half empty, participants find it difficult to process a statement in which the previous volume is described as empty. A statement of empty was difficult to read after a volume of both half empty and half full. If the previous volume was described as full this was found to be acceptable after both frames. It is most important to note that a previous volume of full was read most quickly after a current volume of half full. It is then possible that both full and half full are considered default expressions requiring no inferences and so are easily understood by readers regardless of the context.

Experiment 7 attempted to address the issues of the previous chapters by using different logically equivalent terms which would not be affected by markedness in the same

manner as half full and half empty. As an alternative this experiment used frames which described the completion of a project in terms of either time which had passed or time which was remaining. It was hypothesised that speaking of a team's progress in terms of 'time is over' would allow participants to infer that the team were behind schedule and so were 'taking too long'. If the team's progress was described in terms of 'time is left' participants should be able to infer that the team were ahead of schedule and so were 'going too fast'. The results of the experiment were not as expected, participants found it easier to read statements of 'taking too long' as opposed to 'going too fast' regardless of how the time had been described. Participants also found later portions of the passage easier to read when the task had been described in terms of 'time is left' rather than 'time is over'. This result was related to the possibility that descriptions of 'taking too long' and 'time is left' were more common and more likely than descriptions of 'going too fast' and 'time is over'.

Discussion

This set of experiments attempted to address whether the different inference patterns associated with logically equivalent statements which are evident in the decision making literature would also be apparent in measures of online comprehension. The aim was to assess if readers could draw the same inferences about reference points from these statements during reading. From the results it is clear that under specific conditions participants do make these inferences during reading, however, information from the context as well as the frame has an influence on processing.

The results of Experiments 4(a) and 5(a) differ from those of Experiments 4(b) and 5(b). In a situation where empty is desirable readers use the frame to establish a reference point. In a situation where full is desirable readers use the frame to establish a reference

point when the frame in question is half empty, but not when the frame in question is half full. The issue of markedness has already been introduced and discussed in detail. In the case of full and empty, empty is considered the marked term and so when this is used the reader may easily recognise that this is not the default term. That is the reader or listener can infer that the speaker chose to use empty for a specific reason. The reader is then able to make inferences based on the use of empty. In Experiments 4(b) and 5(b), where the character's desire is for emptiness, the reader recognises that the speaker has used half empty intentionally, that is they specifically want to emphasise the emptiness of the vessel in contrast to full. This emptiness is then consistent with the character's desire for an empty vessel. In contrast use of the unmarked term full may lead to one of two possibilities. The reader may infer that full, as in half full, has been used by the reader specifically to emphasis the fullness of the vessel, or they may simple consider this to be the default term to be used when discussing volume. In the latter case, readers interpret half full merely as an indication of quantity on the volume dimension and no inference is made regarding the reference point. It appears that in a situation where full is desirable half full is indeed treated as the default. Participants infer only the volume from the term. They then recognise this is not full and so the character should not feel positively about the volume.

The results of Experiments 6 and 7 are also affected by markedness. In both cases participants seem to find the default (more common) situations easier to process. That is they can draw on their pragmatic knowledge to identify the more likely situation and so find this easier to read. In Chapter 4 markedness is discussed and introduced from a linguistic perspective (Greenberg 1966; Jakobson & Halle, 1956). I have also mentioned a number of times that the term or phrase which is more frequent is easier for readers to process. Ours is not the first research to introduce the possibility that the

frequency of a term makes it preferable. In a review of 154 pairs of words Zajonc (1968) found that for 126 pairs the more frequent word was considered the more desirable. That is the more frequent word had the more favourable meaning. The words full and empty were compared in this study and 96 out of 100 participants found full to have the more favourable meaning. Zajonc even notes that in language things which can be filled are described as full three times as often as they are described as empty (currently over 5 times as often). The author (Zajonc, 1968) interprets these results as evidence that people favour the things which they are familiar with. That is the more they come in contact with a stimulus the more favourable, or positive they will find it. Positive information is then thought to be processed faster than negative information because it has a higher density in memory (Unkelbach, Fiedler, Bayer, Stegmuller & Danner, 2008). As noted before this leads to a circle of processing preference, a statement is considered more positive because it is more frequent and becomes more frequent because it is positive.

What is clear from the current experiments is that on encountering certain words or phrases participants are able to determine if this expression has been used in order to infer something specific or simply because this is the default. In the case of the less frequent terms, i.e. empty or going too fast, there is always an inference to be made. Participants recognise that these terms are used in specific cases only. Where the term used is more frequent, i.e. full or taking too long, participants may make an inference from the statement but may also treat the statement as the default term. Indeed participants may be able to recognise both inferential and default interpretations which will ultimately lead to an ambiguity between the two interpretations. The most sensible way to solve an ambiguity of this type would be to rely on the context.

Desire and emotion as a focusing tool

In four of the five experimental chapters implicit character desire coupled with an explicit emotion have been used to focus readers on a specific reference or frame in the text. In both the experiments on complement set reference and those on logically equivalent frames the reader had to infer the characters desire and in doing so an amount (a high or low number or volume) became salient to the reader. The emotion word used always confirmed or denied whether this desire had been met. In the case of complement set reference this confirmation or denial allowed a contrast between the implicitly desired and denoted amounts. If this contrast made a shortfall salient then this would result in complement set reference. In the case of logically equivalent frames it was the volume provided by the frame itself which was contrasted with the implicit desire and emotion word during processing. It is clear that this combination of desire and emotion has allowed particular amounts or volumes to become salient and important.

There has been some previous research on implicit desire and the complement set (Shearer, unpublished). This research found that when a high implicit desire was denied with a negative NLQ complement set focusing became prevalent. In this case the smaller amount was denoted using an NLQ. The current research has extended this study by allowing the participants to infer both amounts.

In previous studies (Moxey et al., 2009; Ingram, 2006) expectation has also been linked with desire as a focusing tool. When a character's expectation is explicitly mentioned as in (1) this can then be denied in order to create a shortfall. However, previous research using implicit expectation and negative NLQs did not lead to as strong a result. For example consider (2) where you would expect the number of children to be high.

(2) Few of the children get excited about Christmas. They

When participants are asked to provide a continuation sentence for this type of material complement set references were only marginally more prominent than references to the reference set or some other set. In contrast in Experiment 1 implicit desire lead to a clear preference for a complement set continuation when denied by a negative emotion. More recently research involving NLQs has been presented in which both implicit expectation and implicit desire were controlled for (Moxey, Filik & Ingram, 2009). Results of this language production experiment showed that when both implicit expectation and desire are high and the negative NLQ few is used there are more references to the complement set than when implicit expectation and implicit desire are low. It is clear that implicit desire is an excellent way of making a high amount salient.

Participants are clearly able to recognise a character's implicit desire and to make inferences from this desire to understand later text. In this thesis an emotion word has also been used to confirm or deny the desire implied. A full review of emotion processing is beyond the scope of this thesis. Rather, I have used emotion as a tool and do not wish to investigate how the words themselves are processed.

Directions for future research

The current set of experiments demonstrate how slight contextual manipulations can affect processing of both pronominal references and logically equivalent frames. The possibilities for further research in this area are extensive especially when considering methodologies which can now be employed by a psycholinguist. It has already been noted that explicit desires can have an influence on the preference for complement set reference. That is when a character is explicitly known to want a high number the

denial of this may lead to a preference for complement set reference. Explicit desire is possibly easier to process than implicit desire as no inference has to be made. As a follow up to this thesis it would be interesting to examine the effect of explicit desire on logically equivalent frames. For example if participants were to be presented with sentences where character's explicitly wanted a vessel to be full or empty would the effect of the desire overrule any influence of the frame itself. Participants may be presented with sentences such as (3) and (4) in which characters explicitly want a vessel to be either full or empty.

(3) Duncan wanted the opening night to be a sell out.
He was *pleased/disappointed* because the theatre
was half *full/empty* when the curtain went up.

(4) Evelyn wanted to have a quiet swim.
She was *pleased/disappointed* because the pool
was half *empty/full* when she left the changing room.

In previous experiments the inferences readers made from the logically equivalent frame were affected by the character's desire when implicit desire was for full but not when it was for empty. It will be interesting to examine if this is the case when the character's desire is made more explicit.

In all the experiments reported it is clear that participants have been affected by some form of markedness an by pragmatic knowledge. This is also reflected in factors such as word frequency and valence. In the future it would be interesting to complete highly controlled and normed experiments to deconstruct these features. The materials in such

an experiment would have to be precisely constructed in order to find an answer to the puzzle of markedness. This feature of words has been discussed at length by the linguistic community but has yet to be subjected to rigid experimentation. An empirical investigation would be an interesting addition to the linguistics literature as well as Psychology.

Concluding Remarks

The experiments presented were designed to establish if subtle contextual manipulations, based on the implicitly held desire of a character, would be sufficient to allow a preference for certain information. That is could this manipulation, along with information taken directly from logically equivalent frames in the final two experiments, focus the reader on a specific aspect of the situation, in turn allowing a particular reference or volume to become appropriate. From the evidence presented it can be asserted that this is possible under certain conditions. In each experiment the reader was required to make a number of inferences in order to reach the hypothesised conclusions. In situations where inferences were required, where an unfamiliar term or situation was introduced, participants made the inferences with ease. In contrast in situations where participants could recognise a default term or apply their pragmatic knowledge the inferences were made less often. The subtle manipulation of context has therefore been effective when inferences are required but less so when the situation in question is familiar and possibly preferable to the reader. As noted above, an empirical investigation which seeks to separate the effects of frequency and valence is clearly required.

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Appendix 1.1. Items used in Pilot Experiment A.

Mr. Smith was delighted by the number of his guests who finished their meal.

Robert was disappointed by the number of people in the audience that applauded.

The policeman was irritated by the number of witnesses who made a statement.

The teacher was impressed by the number of pupils who attended school everyday.

John was surprised by the number of his answers which were correct.

The chemist was irritated by the number of the chemicals which were in the cupboard.

Jill was pleased by the number of the glasses which had been washed.

Martin was thrilled by the number of the coins which were priceless.

Andrew was happy about the number of the bluebirds that sang.

Trevor was frustrated by the number of the parking spaces which were empty.

Kathy was amused by the number of the ladies who were wearing hats.

The bartender was puzzled by the number of the customers who ordered vodka.

Scott was indifferent to the number of the bottles of champagne which needed chilled.

The student was pleased by the number of her exams which she found difficult.

Gary was impressed by the number of the books which were on the hold shelf.

The coach was overjoyed by the number of his players who attended training.

Jackie was frustrated by the number of the skirts which were the correct size.

The driving instructor was happy about the number of his students to pass the test first time.

Mr. Johnston was annoyed about the number of the kittens that were asleep.

The lecturer was excited by the number of the students who took notes in class.

The shopkeeper was delighted by the number of his newspapers which were bought.

Michael was offended by the number of his brothers who bought him a gift.

Barry was thrilled by the number of the girls who were pretty.

The painter was unimpressed by the number of the tins of paint which were mixed.

The gardener was disappointed by the number of the weeds which were dead.

Maria was excited by the number of the lipsticks which were red.

The doctor was angry about the number of his patients who finished the course of antibiotics.

The bus driver was surprised by the number of the passengers who had the correct change.

The waitress was upset about the number of the customers who left her a tip.

The author was flattered by the number of his novels which were best sellers.

The director was unimpressed by the number of the actors who remembered their lines.

The manager was angry about the number of the staff who were punctual.

Colin was amused by the number of the students who were at the lecture.

The coach was annoyed by the number of the players who were fit to play.

The singer was flattered by the number of the fans who had written letters.

The prisoner was puzzled by the number of the inmates who were friendly.

Angela was overjoyed by the number of her paintings which were sold.

The surveyor was upset by the number of the original buildings which had been demolished.

The politician was offended by the number of the people who chose to vote for him. T

Sharon was indifferent about the number of the men at the party who were good looking.

Appendix 1.2. Items used in Pilot Experiment B.

Mr. Smith was delighted by the number of his guests who finished their meal.

Robert was disappointed by the number of people in the audience that applauded.

The teacher was impressed by the number of pupils who attended school everyday.

The station master was annoyed by the number of trains which were delayed.

Joan was irritated by the number of people in the queue for a taxi.

Martin was thrilled by the number of the coins which were priceless.

The Midwife was happy about the number of mothers who had complications during childbirth.

Trevor was overjoyed by the number of people on the motorway in the morning.

Kathy was offended by the number of the sculptures which were worthless.

The coach was irritated by the number of his players who attended training.

Jackie was frustrated by the number of the skirts which were too small.

The driving instructor was happy about the number of his students to pass the test first time.

The lecturer was excited by the number of the students who took notes in class.

The shopkeeper was thrilled by the number of his newspapers which were left on the shelf.

Michael was offended by the number of his brothers who bought him a gift.

The waiter was unimpressed by the number of customers who were still eating after midnight.

The surgeon was disappointed by the number of the patient who died that night.

Maria was excited by the number of the children who misbehaved at the park.

The doctor was pleased by the number of his patients who finished the course of antibiotics.

The waitress was upset about the number of the customers who left her a tip.

The author was flattered by the number of his novels which were slated by the critics.

The director was unimpressed by the number of the actors who remembered their lines.

The manager was angry about the number of the staff who were punctual.

The lecturer was delighted by the number of the students who did not turn up for the lecture.

The policeman was impressed by the number of protestors who were violent.

The coach was annoyed by the number of the players who were fit to play.

The singer was flattered by the number of the fans who had written letters.

Daniel was pleased about the number of the guests who could not make it to the party.

Angela was overjoyed by the number of her paintings which were sold.

The surveyor was upset by the number of the original buildings which had been demolished.

The politician was frustrated by the number of the people who chose to vote for him.

The teacher was angry about the number of the pupils who failed the exam.

Appendix 1.3. Sentence items and emotion words used in Experiment 1.

High Desire Sentences

The waitress was happy about the number of customers who left her a tip.

Michael was happy about the number of his brothers who bought him a gift.

The politician was happy about the number of the people who chose to vote for him.

Mr Smith was happy about the number of his guests who finished their meal.

The doctor was happy about the number of his patients who finished the course of antibiotics.

Angela was happy about the number of her painting which sold.

The manager was happy about the number of the staff who were punctual.

Robert was happy about the number of people in the audience that applauded.

The teacher was happy about the number of pupils who attended school everyday.

The coach was happy about the number of his players who attended training.

Martin was happy about the number of the coins which were priceless.

The director was happy about the number of actors who remembered their lines.

Low Desire Sentences

Maria was happy about the number of children who misbehaved at the park.

The shopkeeper was happy about the number of his newspapers which were left on the shelf.

The midwife was happy about the number of mothers who had complications during childbirth.

The policeman was happy about the number of protestors who were violent.

The lecturer was happy about the number of students who did not turn up for the lecture.

Kathy was happy about the number of sculptures which were worthless.

Joan was happy about the number of people in the queue for a taxi.

The surgeon was happy about the number of the patients who dies that night.

Trevor was happy about the number of people on the motorway in the morning.

The teacher was happy about the number of the pupils who failed the exam.

The waiter was happy about the number of customers who were still eating after midnight.

The stationmaster was happy about the number of trains which were delayed.

Positive Emotion Words

happy

delighted

overjoyed

impressed

thrilled

excited

Negative Emotion words

upset

annoyed

angry

unimpressed

irritated

frustrated

Appendix 2.1. Items used in Experiment 2 with emotion words and set determiners in [ ].

The dishes had been done and everyone was enjoying a glass of wine.
Mr Smith was [happy/angry] about the number of his guests who enjoyed the meal. Their [compliments/criticisms] were a topic of conversation all evening.

It was winter and the waiting room was full of infectious people.
The doctor was [delighted/frustrated] about the number of his patients who finished the antibiotics. Their [persistence/negligence] would determine the speed of recovery.

At Christmas most businesses have a gathering for staff to attend.
The manager was [overjoyed/annoyed] about the number of the staff who came to work the next morning. Their [presence/absence] would be recorded in their work history.

The Weight Watchers class was always busiest after Christmas.
The dietician was [impressed/unimpressed] by the number of the people who had shed pounds that week. Their [losses/gains] were recorded by the helpful assistant.

It was the opening night of the new Shakesphere production.
Robert was [thrilled/irritated] about the number of the people in the audience that applauded. Their [cheers/silence] said a lot about his performance that evening.

The birthday party had been in full swing for hours.
Michael was [excited/upset] about the number of his brothers who bought him a gift. Their [kindness/meanness] came as a big surprise to him and his wife.

The team played on Saturday mornings and trained on Wednesdays.
The coach was [happy/angry] about the number of his players who attended training. Their [presence/absence] would affect their chance of playing on Saturday.

The nurse's station was always busiest during a shift change.
The surgeon was [delighted/frustrated] about the number of the patients who survived the night. Their [recovery/decline] would not have been predicted the day before.

The restaurant served good quality meals at reasonable prices.
The waitress was [overjoyed/annoyed] about the number of the customers who left her a tip. Their [kindness/meanness] influenced how she felt about her job.

The building of the new Math department had almost been completed.
The teacher was [impressed/unimpressed] by the number of the pupils who came to school everyday. Their [attendance/truanting] would be reported to their parents.

It was a lovely day considering how late it was in the year.
Maria was [thrilled/irritated] about the number of the children who behaved at the park. Their [politeness/misbehaviour] amazed the elderly couple on the bench.

The theatre was open every night and for Wednesday matinee.
The director was [excited/upset] about the number of the actors who remembered the lines. Their [faultlessness/worthlessness] was ignored by the large audience.

All the students had studied very hard for that day's English test.
Kevin was [happy/angry] about the number of the questions which he knew the answer to. Their [simplicity/difficulty] would ensure the outcome of the exam.

The second term was over and everyone was looking forward to Easter.
The lecturer was [delighted/frustrated] about the number of the students who passed the exam. Their [success/failure] would reflect upon his teaching skills.

The platform was always crowded with commuters during rush hour.
The stationmaster was [overjoyed/annoyed] about the number of the trains that were on time. Their [punctuality/delay] was always noticed by passengers.

There were a lot of restaurants in the town. The environmental health officer was [impressed/unimpressed] by the number of the kitchens which passed his inspection. Their [cleanliness/filthiness] would be reported to his superiors that day.

The wedding ceremony was lovely and the band were just starting to play.
The chef was [thrilled/irritated] about the number of the guests who praised the food. Their [compliments/criticisms] had been passed on by the waiting staff.

The country was in ruins and the invasion had been planned for weeks.
The sergeant was [excited/upset] about the number of his soldiers who made it across the battlefield. Their [survival/downfall] would have a big impact on the war.

The maternity ward was always full of visitors.
The mother was [happy/angry] about the number of the nurses who were interested in her baby. Their [concern/coldness] changed her opinion of the NHS from then on.

The stadium was full to capacity every Saturday afternoon.
The manager was [delighted/frustrated] about the number of the players who scored in the match. Their [goals/misses] received a loud reception from supporters.

The traffic in the city was always busy at that time of day. The instructor was [overjoyed/annoyed] about the number of his students who passed the driving test. Their success reflected his competence as an instructor.

The crime was extremely serious and the atmosphere was heavy.
The judge was [impressed/unimpressed] about the number of the people who had turned up for jury duty.
Their [presence/absence] would affect when case could commence.

The church had a beautiful stained glass window.
The priest was [thrilled/irritated] about the number of the people who attended Sunday worship. Their [loyalty/laziness] would affect the charity collection.

Thousands of passengers traveled through the airport each day. The engineer was [excited/upset] about the number of the aeroplanes which passed the security checks. Their [safeness/problems] would be reported to the press.

It is well known that moving house can be extremely stressful. Martha was [happy/angry] about the number of the appliances in her new house which were working. Their [function/malfunction] would be reported to the landlord.

The new Harry Potter book was due to be published soon. The librarian was [delighted/frustrated] about the number of the children who withdrew books regularly. Their [enthusiasm/illiteracy] was discussed at the staff meeting.

The return flight was uneventful and landed on time. Alison was [overjoyed/annoyed] about the number of her holiday photographs which were good. Their [clarity/hazyness] proved what kind of a photographer she was.

The centre of town was always busy on Saturday night. Christopher was [impressed/unimpressed] by the number of the pretty girls who went to the local disco. Their [beauty/ugliness] had been noticed by the other men too.

The pilot was making the final check prior to departure. The stewardess was [thrilled/irritated] about the number of the passengers who's boarding cards were ready. Their [eagerness/lethargy] would affect takeoff time.

Some people had bought their tickets for the concert in advance.

The rock singer was [excited/upset] about the number of the people in the crowd who sang along to his songs. Their [singing/silence] made him play even louder.

Today was a final practice before the recruits were tested at graduation.

The sergeant was [happy/angry] about the number of the recruits who completed the assault course. Their [stamina/weakness] would be obvious on the test day.

The new summer house was almost completed.

The housewife was [delighted/frustrated] about the number of the workmen who's boots were removed if they came inside. Their [consideration/insensitivity] was reported to the boss.

Parents watched as the children lined up to take turns at the competition.

The dance teacher was [overjoyed/annoyed] about the number of the pupils who regularly practiced the routine. Their [determination/hopelessness] added to the atmosphere.

All of the third year pupils had to have their teeth checked.

The dentist was [impressed/unimpressed] by the number of the children who could relax in his chair. Their trust was a result of how they had been brought up.

The summer festival had all different types of performers.

The magician was [thrilled/irritated] about the number of the spectators who were fooled by his illusion. Their [surprise/boredom] earned the trick a reputation.

The wedding would be a lavish affair held in summer.

The bride-to-be was [excited/upset] about the number of the guests who had said they would attend. Their [acceptances/rejections] were delivered over several days.

Appendix 3.1. Items used in Experiment 3 with emotion words and set determiners in [ ].

There had been a large fight outside the nightclub.

The manager was [pleased/annoyed] about the number of police who turned up.

Their [presence/absence] was noted by the dancing crowds.

The warehouse was ablaze because of a stray cigarette.

The owner was [pleased/annoyed] about the number of firefighters who came.

Their [presence/absence] would decide the fate of the building.

The lecture was going to be about quantum physics.

The lecturer was [pleased/annoyed] about the number of students who came.

Their [presence/absence] would affect the grade they received.

The weekend football match was very important.

The coach was [pleased/annoyed] about the number of players who came to training.

Their [presence/absence] would decide who got a place in the team.

The murder mystery party had been really good fun.

The host was [impressed/unimpressed] by the number of his guests who had solved the crime. Their [success/failure] was an indication of intelligence.

The traffic in the city was always busy at that time of day.
The instructor was [happy/angry] about the number of his students who passed the driving test. Their [success/failure] would reflect on his teaching ability.

The team were climbing Mount Everest without any oxygen.
The leader was [impressed/unimpressed] by the number of climbers who reached the top. Their [success/failure] reflected effort and determination.

Every bride wanted to be slim and beautiful on her big day.
The dietician was [impressed/unimpressed] by the number of women who reached the target weight. Their [success/failure] was entirely related to mindset.

After the accident there were a lot of relatives in the waiting room.
The doctors were [pleased/annoyed] about the number of people who were prepared to give blood. Their [consent/refusal] would influence the success of medical treatments.

Market research was a tedious and difficult job.
Catherine was [pleased/annoyed] about the number of people who agreed to take part in the survey. Their [consent/refusal] would affect her target for the day.

The postgraduate needed to have strict ethics when conducting experiments.
She was [pleased/annoyed] about the number of people who agreed to take part in the study. Their [consent/refusal] would determine when the results were available.

Some people have to wait a long time for an organ transplant.

The surgeon was [pleased/annoyed] about the number of people willing to donate organs. Their [consent/refusal] would affect a patient's chances of survival.

The rich family at the top of the road were moving house.

Mrs Smyth was [pleased/annoyed] by the number of removal men who could lift her oak furniture. Their [strength/weakness] would affect how long the move took.

The gym was always full of bodybuilders trying to look good.

The trainer was [pleased/annoyed] about the number of men who could easily lift the weights. Their [strength/weakness] reflected the effort they put in during the week.

The friends went to the slimming world meeting every week.

The counselor was [happy/angry] about the number of women who had avoided chocolate and crisps. Their [strength/weakness] was recorded efficiently by the assistant.

The alcoholics anonymous meeting was busy after Christmas.

The counselor was [happy/angry] about the number of people who had avoided drinking. Their [strength/weakness] was most significant to themselves.

The bookmakers was always very busy on a Saturday.

Kevin was [pleased/irritated] about the number of his horses who came in first. Their [winning/losing] would affect his bank balance.

Criminals are often able to walk free from court on technicalities.

The prosecutor was [delighted/disappointed] about the number of drug dealers who were sent to prison. Their [conviction/acquittal] was a reflection on the legal profession.

A group of boys were suspected of shoplifting chocolate and Irn Bru.

The shopkeeper was [impressed/unimpressed] by the number the teenagers who owned up. Their [honesty/lying] would be passed on to the police.

Great Britain had high hopes of doing well in the Olympics.

The Prime Minister was [delighted/disappointed] by the number of athletes who returned with medals. Their [winning/losing] could send a message across the nation.

The little league baseball game was very exciting for the children.

The coach was [pleased/annoyed] about the number of parents who eagerly supported. Their [cheers/silence] would mean a lot to the young players.

The FA cup final was the team's most important game in years.

The players were [happy/angry] about the number of fans who believed they could win. Their [cheers/silence] definitely affected the motivation of the team.

The band had been nervous about making a come back.

The lead singer was [pleased/worried] about the number of people who seemed to like the concert. Their [cheers/silence] would determine if a new album was released.

It was the opening night of the new Shakespeare production.

Robert was [pleased/ashamed] about the number of people in the audience that applauded. Their [cheers/silence] spoke volumes about his performance.

The comedy club had an amateur night on Thursdays.

The comedian was [pleased/irritated] by the number of people who enjoyed his jokes. Their [laughter/silence] would shape his act in the future.

The wedding ceremony was finished and it was time for the speeches.

The best man was [happy/angry] about the number of guests who enjoyed his comments. Their [laughter/silence] would be noticed by the happy couple.

A new comedy sitcom was to be shown to a varied focus group.

The writer was [pleased/worried] about the number of people enjoying the show. Their [laughter/silence] would determine whether it was shown nationwide.

Jeremy and Gavin were always trying to chat up ladies.

Jeremy was [pleased/irritated] by the number of women who found him funny. Their [laughter/silence] was an indicator of how much they fancied him.

At the Healthy Summer Camp the campers were weighed regularly.

The counselors were [pleased/annoyed] at the number of children who had worked hard. Their [losses/gains] were reported back to parents every week.

A group of international experts were sent to find survivors of an earthquake.
The team leader was [pleased/irritated] about the number of his team who volunteered to enter an unsafe building. Their [courage/cowardice] would affect how many people survived.

The whole family had been looking forward to the holiday in Las Vegas.
Trevor was [pleased/annoyed] about the number of his relatives who still had plenty of gambling chips. Their [gains/losses] would make the holiday memorable.

The property market was usually a very solid investment.
The financial adviser was [pleased/irritated] about the number of his clients who had made a profit. Their [gains/losses] would be reported to the financial services authority.

Children were extremely temperamental when it came to making friends.
Jim was [pleased/embarrassed] about the number of boys who wanted to play with him. Their [kindness/meanness] was typical of children that age.

Many teenagers are obsessed with popularity and can be nasty.
Donna was [pleased/ashamed] about the number of girls who came to her sleepover. Their [kindness/meanness] showed how may people really liked her.

Collecting for charity is a time consuming and difficult task.
Mrs Davidson was [happy/angry] about the number of people who contributed to the cause. Their [kindness/meanness] would greatly affect those in need.

The man had murdered someone and it was time to serve his sentence.

Barry was [happy/upset] about the number of prisoners who were nice to him.

Their [kindness/meanness] would not be easily forgotten.

China is a huge country but the bamboo forests are in danger.

Marion is [pleased/annoyed] about the number of Giant Pandas remaining in the wild.

Their [survival/decline] is also affected by breeding habits.

It worries many people that some species may become extinct.

Adrian was [pleased/annoyed] about the number of Siberian tigers still alive in India.

Their [survival/decline] correlated directly with hunting activities.

The nurse's station was always busiest during a shift change.

The surgeon was [pleased/worried] about the number of the patients who made it through the night. Their [survival/deaths] would not have been predicted the day before.

The school had very high fees and even higher standards.

The headmaster was [delighted/disappointed] about the number of pupils who went on to Cambridge. Their [brilliance/stupidity] would surely affect next years intake.

The school was going on a fun but informative excursion.

The teacher was [pleased/irritated] about the number of children looking forward to it.

Their [interest/boredom] would mean a lot to the organiser.

An eight year olds birthday party was a hectic event.

The parents were [happy/angry] about the number of children who enjoyed the magician. Their [cheers/boredom] would be noticed by the birthday boy.

The talk was attended by the leading researchers in the field.

The speaker was [pleased/ashamed] about the number of people who liked his presentation. Their [interest/boredom] would determine if the work was published.

It had been a while since the football team had won a match.

The manager was [pleased/annoyed] about the number of fans who came to the games. Their [presence/absence] was clear when ticket sales were counted.

The annual school trip was always to an outdoor centre.

The teacher was [pleased/worried] about the number of children happily waving goodbye to parents. Their [smiles/tears] indicated how they would manage a week away.

Exam results are always nerve racking in the final year.

The tutor was [pleased/worried] about the number of students who were happy with the grades. Their [smiles/tears] were a comment on his teaching ability.

Bonuses and appraisals are given to workers annually.

The manager was [happy/angry] about the number of staff who agreed with his pay review. Their [smiles/tears] were a reflection of the work put in on a daily basis.

The monument was a drain on the town's resources and would be destroyed.
The mayor was [pleased/annoyed] about the number of people who agreed with his decision. Their [smiles/frowns] would affect his votes in the next election.

Campaigning for the election was tiring but rewarding work.
The politician was [happy/angry] about the number of supporters who had confidence in his victory. Their [optimism/pessimism] inspired him to keep on trying.

The clinic specialised in treating people suffering from cancer.
The doctor was [pleased/annoyed] about the number of patients who were positive about the therapy. Their [optimism/pessimism] could affect the success of the treatment.

The A-level exams had been particularly difficult that year.
The teacher was [happy/angry] about the number of students who thought they had passed. Their [optimism/pessimism] reflected his expertise in the subject.

The warship had been torpedoed in the middle of the pacific.
The captain was [pleased/annoyed] about the number of sailors who thought they would be rescued. Their [optimism/pessimism] was affecting the mood in the lifeboat.

The secretaries were planning on entering a charity fun run.
The gym instructor was [pleased/annoyed] about the number of the ladies who trained regularly. Their [fitness/laziness] would affect the money raised for the cause.

The outdoor centre was an exciting place for a school trip.

The counselor was [delighted/disappointed] by the number of children who climbed the hill with little effort. Their [fitness/laziness] would determine the rest of the weeks activities.

The police applicants went through a difficult recruitment process.

The sergeant was [pleased/annoyed] about the number of hopefuls who passed the physical. Their [fitness/laziness] would definitely affect the application outcome.

High school sports are very competitive and important in the US.

The coach was [pleased/annoyed] about the number of boys who were prepared for the new football season. Their [fitness/laziness] indicated what they had done in the holidays.

The Robertson family had moved to a new town because of Dad's job.

Jason was [happy/angry] about the number of kids who had spoken to him on the first day of school. Their [acceptance/rejection] was very important to a boy his age.

Mrs Smyth was planning a high society dinner party at her home.

Mr Smyth was [pleased/annoyed] about the number of club members who were going to attend. Their [acceptance/rejection] affected his chances of membership.

Three girls from the same school were having a joint 18th birthday party.

Alison was [pleased/ashamed] about the number of popular kids who said they would come. Their [acceptance/rejection] was important to help the girls look cool.

The wedding was a lavish affair at a large country house.
The bride was [pleased/annoyed] about the number of her friends who had bought new outfits. Their [enthusiasm/disinterest] would be captured in the photographs.

The conference was a stage for presenting new research.
The speaker was [pleased/irritated] about the number of the audience who listened to her talk. Their [enthusiasm/disinterest] would be noted by the research funding committee.

The family were all going to a restaurant for dinner on Saturday.
Mum was [pleased/ashamed] about the number of her children who spoke nicely to the waiter. Their [politeness/rudeness] was a reflection of her parenting skills.

The local teenagers often worked in the orchard in the summer.
The farmer was [happy/angry] about the number of apples which tasted ripe.
Their [sweetness/sourness] would affect the final taste of the cider.

Millions of Jewish people were held in concentration camps during world war two.
Issac was [pleased/frustrated] about the number of his friends who stayed optimistic.
Their [faith/despair] would be visible to the guards.

The girl guides were trying to recruit entrants to a sponsored walk.
Mary was [pleased/annoyed] about the number of people willing to give up time for the needy. Their [enthusiasm/reluctance] would affect the work the charity could do.

The cheerleaders were constantly trying to get dates for the dance.

Pamela was [delighted/embarrassed] about the number of boys who asked if she wanted to go. Their [enthusiasm/reluctance] affected her self confidence.

Little league baseball was a lot more competitive than it should be.

The coach was [pleased/irritated] about the number of parents who encouraged the children. Their [support/criticism] meant more to the kids than the score.

The new play was considered quite rude and had some displays of nudity.

The director was [pleased/annoyed] about the number of the audience who accepted it.

Their [pleasure/disgust] was a reflection of how the play was understood.

Football hooligans often start fights when travelling abroad.

The manager was [pleased/ashamed] about the number of fans who behaved well.

Their [restraint/violence] was reported in the international press.

As usual Scotland were doing very badly in the football world cup.

The striker was [delighted/disappointed] about the number of people who still supported the team. Their [pride/shame] would be identified easily by the players.

Speed dating had become an exciting way to meet people.

Dennis was [delighted/disappointed] by the number of women who were ordinary.

Their [modesty/arrogance] was noted by all the men in the room.

The sooner the field was ploughed the sooner they could go home.

The farmer was [pleased/annoyed] about the number of farm hands who wanted to get started. Their [eagerness/reluctance] would affect the chance of finishing on time.

In prison the thought of a visitor can get you through the week.

The warden was [happy/angry] about the number of prisoners who behaved well.

Their [reward/penalty] was a change in the number of visiting hours.

Entry to Mensa was coveted by some very intelligent people.

Jeremy was [pleased/annoyed] about the number of puzzles he could complete.

Their [simplicity/difficulty] might determine the outcome of his application

It was always a mistake to hold a Christmas party on a week night.

The boss was [pleased/annoyed] about the number of the staff who were drinking sensibly.

Their [control/excess] would affect how much work got done tomorrow.

The birthday party had been in full swing for hours.

Michael was [delighted/disappointed] by the number of his brothers who bought him a gift. Their [kindness/meanness] came as a big surprise.

The election was over and most of the votes had been counted.

The politician was [pleased/annoyed] about the number of people who chose to vote for him. Their [support/dissent] would have a big impact on the campaign.

The dishes had been done and everyone was enjoying a glass of wine.
Mr Smith was [happy/angry] about the number of his guests who enjoyed the meal. Their [compliments/criticisms] were duly noted for his next dinner party.

It was winter and the waiting room was full of people.
The doctor was [pleased/annoyed] about the number of his patients who finished the course of antibiotics. Their [attention/negligence] would determine how fast they recovered.

The new Math department had almost been completed.
The teacher was [happy/angry] about the number of pupils who attended school everyday. Their [presence/absence] made her job a lot easier.

The theatre was open weekly from Tuesday to Sunday.
The director was [pleased/irritated] about the number of the actors who could be clearly heard. Their [faultless/worthless] delivery would be mentioned in the review.

The restaurant served good quality reasonably priced meals.
The waitress was [happy/angry] about the number of the customers who left her a tip. Their [kindness/meanness] really influenced how she felt about her job.

The art gallery was always busy on a Saturday afternoon.
The artist was [delighted/disappointed] by the number of people who admired his paintings. Their [compliments/criticisms] meant everything in the art world.

All the students had studied very hard for the Chemistry test.

Kevin was [pleased/worried] about the number of questions which he found easy.

Their [simplicity/difficulty] would affect the outcome of the exam.

Thousands of travelers went through the airport each day.

The engineer was [pleased/worried] about the number of aeroplanes which passed the security checks. Their [safety/faults] would be made known to the passengers.

The waiting room was quiet and the nurse sang along to the radio.

The dentist was [happy/angry] about the number of strong teeth he came across.

Their [health/decay] was largely due to the patient's diet.

The crime was extremely serious and the atmosphere was heavy.

The judge was [happy/angry] about the number of people who had turned up for jury duty. Their [presence/absence] would be important to the defendant.

Compulsory bag checks were in place to ensure staff were not stealing.

The manager was [pleased/worried] about the number of staff who happily complied.

Their [eagerness/reluctance] would affect levels of trust in the workplace.

The Weight Watchers class was always busiest after Christmas.

The dietician was [impressed/unimpressed] by the number of the people who had shed pounds that week. Their [losses/gains] were recorded by the helpful assistant.

It was a lovely day considering how late it was in the year.

Maria was [pleased/ashamed] about the number of the children who behaved at the park. Their [politeness/rudeness] amazed the elderly couple on the bench.

The country was in ruins and the invasion had been planned for weeks.

The sergeant was [happy/upset] about the number of his soldiers who survived the battle. Their [luck/deaths] would be reported to families back home.

The children's critical illness ward was always full of visitors.

The mother was [happy/angry] about the number of the nurses who showed genuine compassion. Their [concern/apathy] changed her opinion of the NHS from then on.

The church had a beautiful stained glass window.

The priest was [delighted/disappointed] about the number of the people who attended Sunday worship. Their [enthusiasm/reluctance] would be noted by the bishop himself.

The new Harry Potter book was due to be published soon.

The librarian was [delighted/disappointed] by the number of the children who withdrew books regularly. Their [enthusiasm/disinterest] was discussed at the staff meeting.

The flight had been very turbulent and many passengers were scared.

Ivy was [happy/upset] about the number of stewardess' who were sympathetic to her fears. Their [sweetness/sourness] was typical of the airline company.

Students often volunteer in Africa where many people are starving.

Russell was [impressed/unimpressed] by the number of the native people who managed to stay positive. Their [optimism/despair] was incredible to observe.

The centre of town was always busy on Saturday night.

Christopher was [pleased/ashamed] about the number of pretty girls who agreed to dance with him. Their [acceptance/rejection] would make a difference to his ego.

Today was a final practice before the recruits were tested at graduation.

The sergeant was [happy/angry] about the number of the recruits who completed the assault course. Their [fitness/laziness] would be obvious to his superiors.

Gavin had invited all his friends from school round to play his X-box.

His Mum was [impressed/unimpressed] by the number of the teenagers who said please and thank you. Their [politeness/rudeness] would quickly get back to the other parents.

Parents watched as the children lined up to take turns at the competition.

The dance teacher was [pleased/annoyed] about the number of the pupils who regularly practiced. Their [enthusiasm/disinterest] added to the atmosphere.

All of the third year pupils had to have their teeth checked.

The dentist was [impressed/unimpressed] by the number of the children who could relax in his chair. Their [smiles/tears] were a result of how they had been brought up.

The summer festival had all different types of performers.

The magician was [pleased/annoyed] about the number of the spectators who enjoyed his illusion. Their [cheers/silence] earned the trick a reputation.

The comedian was well know for being extremely rude.

The compare was [pleased/ashamed] about the number of people who laughed at the dirty jokes. Their [pleasure/disgust] would determine whether the act was hired again.

It was the army recruits test day at the shooting range.

The instructor was [impressed/unimpressed] by the number of soldiers who hit the target. Their [accuracy/inaccuracy] would be reported to his superiors.

The drug company always needed guinea pigs to try out new medicines.

The doctor was [pleased/annoyed] about the number of people who agreed to the test the drug. Their [consent/refusal] was noted by a nearby nurse.

The children were beginning swimming lessons at the local pool.

The instructor was [impressed/unimpressed] by the number of pupils who jumped straight in the water. Their [confidence/uncertainty] was typical of the age range.

The friends decided they would enter a golf competition.

Stewart was [impressed/unimpressed] by the number of his friends who made it to the semi-finals. Their [success/failure] would mean lots of whiskey drinking later.

Many people consider evangelists to be a little crazy.

The Preacher was [pleased/irritated] by the number of people who thought he could heal the sick. Their [belief/doubt] would affect his reputation with the religious community.

High impact aerobics was a great way to stay healthy.

The instructor was [impressed/unimpressed] by the number of ladies who could keep up with the routine. Their [fitness/laziness] was really quite astounding.

The company had started making a big deal of time keeping.

The manager was [pleased/annoyed] about the number of workers who arrived on time. Their [punctuality/tardiness] would affect the summer bonuses.

It was possible that new policies in Eastern Europe would cause rioting.

The Prime Minister was [happy/angry] about the number of people who protested peacefully. Their [restraint/violence] would show the world what the country was really like.

The cruise liner sank due to an iceberg in cold and rough waters.

The Captain was [happy/upset] about the number of passengers who had been picked up by life boats. Their [survival/deaths] would be remembered for years to come.

Winter is always a difficult time for the elderly as they may become sick.

The doctor was [happy/upset] about the number of his patients who had avoided the flu. Their [health/illness] was very important to him.

The parents were trying to work out who had broken the window.

Dad was [pleased/annoyed] about the number of the children who told the truth.

Their [honesty/lying] would affect who paid for the new pane.

There was a new campaign to get people cycling to work instead of taking the car.

The councillor was [pleased/irritated] about the number of motorists who gave up driving. Their [eagerness/reluctance] came as a surprise to him.

Rangers had just lost the Scottish cup to rivals Celtic.

The Rangers manager was [impressed/unimpressed] about the number of fans who still applauded the team. Their [pride/shame] was evident throughout the stadium.

The music department wanted to put on a production of Oliver Twist.

The music teacher was [pleased/annoyed] about the number of pupils who came to the auditions. Their [enthusiasm/disinterest] was typical of children that age.

Gymnastics was a difficult sport to compete in at international standard.

The coach was [impressed/unimpressed] by the number of his gymnasts who were confident. Their [optimism/pessimism] would easily be picked up by the judges.

The airplane had crashed on a very remote south pacific Island.

Jack was [impressed/unimpressed] about the number of survivors who thought they would be rescued. Their [faith/doubt] would spread through the camp.

The catholic church is often involved in scandals involving child abuse.

The bishop was [pleased/worried] about the number of parishioners who ignored the claims. Their [faith/doubt] would affect the strength of the church.

McDonalds were trying to develop a new healthier burger.

The consultant was [pleased/annoyed] about the number of people who enjoyed eating it. Their [pleasure/disgust] was noted by the market researcher.

The end of the school year was always exciting.

The English teacher was [pleased/annoyed] about the number of pupils who thanked him for his help. Their [politeness/rudeness] affected his job satisfaction.

Grandpa and Grandma were coming to stay for the weekend.

Mum was [pleased/annoyed] about the number of the children who had tidy bedrooms. Their [tidiness/messiness] would affect how much pocket money she gave.

The valentines disco was traditionally organized by the teenagers.

The teacher was [delighted/disappointed] by the number of pupils who offered to help. Their [eagerness/reluctance] reflected the popularity of the event.

Selling timeshares in Spain is not an easy profession.

The saleswoman was [pleased/annoyed] about the number of holiday makers who looked interested. Their [excitement/disinterest] would reflect the next months sales.

The vote to lower taxes was bound to be very close.

The politician was [delighted/disappointed] by the number of MPs who agreed with his proposals. Their [support/criticism] was clear from the show of hands.

The campsite was already set up when the storm started.

The scoutmaster was [happy/upset] about the number of boys who had managed to stay dry. Their [efficiency/stupidity] would be a story to tell when they got home.

The restaurant had just opened and was booked solid for a month.

The chef was [delighted/disappointed] at the number of critics who praised his food. Their [compliments/criticisms] were reported in the local press.

When patients are on life support someone must make a difficult decision.

The doctor was [pleased/annoyed] about the number of families who allowed the apparatus to be switched off. Their [consent/refusal] would affect the hospitals resources.

The supermarket was very busy and incredibly understaffed.

The manager was [happy/angry] about the number of staff who agreed to work overtime. Their [enthusiasm/reluctance] would be remembered on pay day.

The school wanted to teach sex education at a young age.

The headmaster was [impressed/unimpressed] by the number of parents who allowed children to attend. Their [consent/refusal] might make a big difference in a few years.

The church was organizing a pro-life rally at a local clinic.

The Priest was [pleased/annoyed] about the number of parishioners who agreed with the cause. Their [support/dissent] demonstrated strength of faith.

A rally against war in the middle east was held on Saturday.

Frank was [impressed/unimpressed] by the number of his colleagues who attended.

Their [presence/absence] showed him how much they car about the issue.

Many elderly people are afraid to live in care homes.

Agnes was [impressed/unimpressed] by the number of nurses who were helpful.

Their [support/neglect] would determine the comfort of her final days.

Being a single mother was hard and having a baby made people put on weight.

Jane was [happy/upset] about the number of men who still found her sexy.

Their [attraction/revulsion] affected her confidence at that time.

The charity telethon was shown annually on the BBC.

The presenter was [impressed/unimpressed] by the number of viewers who called to donate money.

Their [generosity/meanness] was evident in the hourly total.

In the Australian Outback there are a number of strange foods.

The guide was [impressed/unimpressed] by the number of tourists who enjoyed eating snake. Their [pleasure/disgust] would be described in details to friends back home.

Harrods sale was an event attended by the elite of London.

The cashier was [impressed/unimpressed] by the number of women who managed to restrain themselves. Their [moderation/greediness] was an accurate display of character.

Sports day was always good fun and quite competitive.

The sports master was [impressed/unimpressed] by the number of children who managed to be good sports. Their [maturity/immaturity] was noted by the crowd of parents.

It had snowed a great deal during the night and travel would be affected.

The stationmaster was [pleased/annoyed] about the number of trains which arrived on time. Their [punctuality/tardiness] would be important to commuters.

Chelsea football team are known to have very aggressive fans.

The police were [happy/angry] about the number of spectators who avoided fighting. Their [restraint/violence] would affect the clubs reputation.

The storm on the Atlantic ocean was one of the worst in history.

The coastguard was [happy/upset] about the number of boats which had stayed afloat. Their [survival/misfortune] was accredited to the god of the sea.

The group were going bungee jumping in New Zealand.

The instructor was [impressed/unimpressed] by the number of students who jumped straight off the bridge. Their [confidence/reluctance] was recorded by the photographer on DVD.

The agricultural community was afraid that foot and mouth disease would spread.
The farmer was [pleased/irritated] about the number of his cows who had the illness.
Their [health/sickness] was assessed by the local vet.

The park was very busy on the hottest day of the year.
The park keeper was [impressed/unimpressed] by the amount of picnickers who picked up litter. Their [tidiness/messiness] would be important to the environment.

Internet fraud is becoming more and more common these days.
The judge was [happy/angry] about the number of fraudsters who were sent to prison.
Their [conviction/acquittal] would send a message to similar criminals.

Gossip is usual in the work place and rumours are common.
Lizzie was [pleased/annoyed] about the number of her friends who kept her secret.
Their [discretion/indiscretion] would affect her reputation.

There were many applicants for only one position at the company.
The chief executive was [pleased/annoyed] about the number of applicants who were truthful on the application form. Their [honesty/lying] determined whether they got an interview or not.

There was a chance the festival would be cancelled due to rain.
The bands were [impressed/unimpressed] by the number of campers who pitched tents anyway. Their [optimism/pessimism] would make atmosphere of the festival.

Many parts of Glasgow are extremely poor and drug use is common.

The councilor was [impressed/unimpressed] by the number of addicts who felt a recovery could be made. Their [hope/doubt] was what affected the city most.

In the army they are very strict about keeping things in order.

The Captain was [impressed/unimpressed] by the number of recruits who's bed and locker were tidy. Their [neatness/messiness] was very important to the training.

The theme of the 21st birthday party was tarts and vicars.

The host was [pleased/annoyed] about the number of guests who came in fancy dress. Their [enthusiasm/reluctance] let her know who her friends were.

Sometimes it was very difficult to locate things in the library.

The student was [pleased/irritated] about the number of books which were in the right place. Their [organisation/untidiness] affected how easily essays could be written.

Girls have a tendency to put on weight when they go to University.

Catherine was [pleased/annoyed] about the number of her friends who said she looked heavier. Their [honesty/lying] would change the way she ate in future.

Teenagers always think it's funny to ridicule teachers.

James was [pleased/annoyed] at the number of the other pupils who liked his impression. Their [laughter/silence] echoed round the whole school yard.

The sex offender would only be convicted if witnesses gave testimony.
The prosecutor was [happy/upset] about the number of his victims who gave a statement. Their [strength/weakness] would be important to other women.

The towering inferno was dangerous but many people were trapped inside.
The fire chief was [impressed/unimpressed] by the number of his men who volunteered to go in. Their [courage/cowardice] affected the number of survivors.

The new Will Ferrell film was referred to as a gross out comedy.
The director was [delighted/disappointed] by the number of viewers who laughed at the dirty jokes. Their [amusement/disgust] was an indication of future DVD sales.

Al Capone was a notorious gangster who terrorised the Chicago community.
The judge was [impressed/unimpressed] by the number of people willing to testify against him. Their [cooperation/reluctance] would determine if a conviction was possible.

The homeless shelter was open daily to feed, cloth and house people.
The volunteer was [delighted/disappointed] by the number of people willing to donate clothes. Their [kindness/meanness] made a huge difference to the poor.

Appendix 4.1. Items used in Experiment 4(a) and 5(a) with emotion words and logically equivalent frames in [ ].

Mrs Jones was pouring champagne for the guests.
Mr Jones was [pleased/ashamed] because the glasses
were half [full/empty] and people were bound to talk about it.

The director was watching the audience arrive through the curtains
The actor was [excited/annoyed] because the theatre
was half [full/empty] and his wages depended on ticket sales.

Miss Smith was arranging the mugs for the coffee morning.
Mrs Thomson was [worried/pleased] because the biscuit tin
was half [full/empty] and she had bought nothing else to offer.

The teaching assistant was reviewing her notes for the lesson.
The teacher was [pleased/annoyed] because the class
was half [full/empty] and she had planned to begin a new topic.

The students were enjoying drinking vodka at a party.
Craig was [worried/pleased] because the bottle
was half full/empty and he had planned to drink a shot soon.

The walking club was excited about the trip to Ben Nevis.
The bus driver was [annoyed/pleased] because the coach
was half [full/empty] and they would need to depart very soon.

David was looking forward to a barbeque on a nice warm day.
Carol was [pleased/annoyed] because the swimming pool
was half [full/empty] and she was ready to jump in for a swim.

The boat had been out at sea for a full week.
The fisherman was [happy/angry] because the nets
were half [full/empty] and he wanted to return to shore soon.

Each child had been collecting a list of sponsors for the walk.
Erin was [pleased/worried] because her sheet
was half [full/empty] and she had to hand it in the next day.

The team were in the dressing room making final preparations.
The manager was [pleased/worried] because the stadium
was half [full/empty] and his team played better with a crowd.

The hotel manager was happy as everyone was enjoying the wedding.
The waiter was [worried/pleased] because the soup pot
was half [full/empty] and he still had lots of people to serve.

Their Mum had been refusing to let them have chocolate for days.
The children were [pleased/annoyed] because the sweet tin
was half [full/empty] and they were still hungry after dinner.

The entire Bridge Club had just popped round for a gossip.

Mrs McDonald was [pleased/worried] because the milk bottle

was half [full/empty] and she could not offer tea without any.

James was going round to play with a friend he had made at school.

Martin was [pleased/ashamed] because the toy box

was half [full/empty] and they needed something to play with.

Colin had arrived home from work and was in the shower.

Janet was [pleased/worried] because the fridge

was half [full/empty] and she was about to start making dinner.

The men were enjoying a night out without their wives.

Tony was [pleased/annoyed] because the beer bottle

was half [full/empty] and he was next in line to buy a round.

The girls had planned a night in watching movies for ages.

Clare was [pleased/annoyed] because the wine bottle

was half [full/empty] and they had forgotten to chill another.

The flight to Mexico would take almost a whole day.

The pilot was [pleased/annoyed] because the plane

was half [full/empty] and they would have to start moving soon.

It had been a long and tiring day at the office.

Gemma was [pleased/annoyed] because the bath

was half [full/empty] and she was ready to lie back and relax.

As usual the main street of town was busy on a Saturday night.

The manager was [pleased/worried] because the nightclub

was half [full/empty] and he needed to double his bar takings.

It was a lovely day an the kids were desperate to play outside.

Helen was [pleased/annoyed] because the paddling pool

was half [full/empty] and they wanted to jump in and cool off.

Andrew had invited some colleagues home for dinner.

Sarah was [pleased/ashamed] because the cupboards

were half [full/empty] and she always gave guests a good meal.

Winter was near and the cattle needed to be brought inside.

The farmer was [pleased/worried] because the barn

was half [full/empty] and he knew it would be a frosty night.

The containers were all being loaded onto the ship.

The Captain was [pleased/worried] because the hold

was half [full/empty] and they would need to leave port soon.

The 18th birthday party had been organised for ages.

Alison was [pleased/ashamed] because the pub

was half [full/empty] and she had hoped to look really popular.

The truck was being loaded with frozen goods.

The driver was [pleased/annoyed] because the trailer

was half [full/empty] and he was in a hurry to get on the road.

The film had a fancy premier in Leicester Square.

The director was [excited/worried] because the cinema

was half [full/empty] and he knew that would affect the review.

The new staff were busy getting the supermarket organised.

The manager was [pleased/worried] because the shelves

were half [full/empty] and they would be open in a few hours.

It was a lovely crisp but sunny winter day.

Louise was [pleased/annoyed] because the coffee cup

was half [full/empty] and she needed the caffeine that morning.

The passengers were had been waiting in the terminal for hours.

Bob was [pleased/annoyed] because the crisp packet

was half [full/empty] and he was hungry enough to eat a horse.

The house was far out in the country and had a private water supply.

The engineer was [pleased/worried] because the well

Was half [full/empty] and he thought it might dry up in summer.

The store owner had hoped the sale would attract new customers.

The manager was [pleased/worried] because the shop

was half [full/empty] and her job would soon be up for review.

Appendix 4.2. Items used in Experiments 4(b) and 5(b) with emotion words and logically equivalent frames in [ ].

The concert was over and the stewards were waiting to go home.

Paul was [pleased/annoyed] because the

car park was half [empty/full] and he couldn't leave till all the fans were gone.

It is always difficult to run errands in your lunch hour.

Janice was [delighted/frustrated] because the

bank was half [empty/full] and she needed to be back in the office before 2.

After the kids left for school there was always a mountain of housework.

Carol was [pleased/annoyed] because the

washing basket was half [empty/full] and she planned to wash the car in the afternoon.

The group had been training each week for the charity fun run.

Adam was [delighted/disappointed] because the

gym was half [empty/full] and he only wanted to use the treadmill for half an hour.

Overnight flights are uncomfortable and can lead to jet lag.

Sara was [pleased/annoyed] because the

flight was half [empty/full] and she had hoped to sleep for most of the journey.

Many people like to exercise during their lunch hours.

Claire was [delighted/disappointed] because the

swimming pool was half [empty/full] and she hated accidentally kicking other swimmers.

It is tradition to ring a bell to signal last orders in the pub.

The barman was [happy/angry] because the

pub was half [empty/full] and he could not clear up till everybody had left.

Grocery shopping is a big part of a mother's routine.

Mrs Wallace was [pleased/annoyed] because the

car park was half [empty/full] and she had a million other things to do that day.

The shop had been burgled last night and the police had arrived.

The owner was [happy/angry] because the

safe was half [empty/full] and he wasn't sure what the insurance would cover.

Working in an office can be quite stressful.

Paul was [pleased/annoyed] because his

to do tray was half [empty/full] and he was sick of having to finish work at home.

A lorry full of baked bean cans had crashed on the motorway.

The driver was [pleased/annoyed] because the

container was half [empty/full] and this would affected the length of the delay.

Armed robbers held up the bank at 10am on Friday morning.

The manager was [grateful/worried] because the

bank was half [empty/full] and he didn't want any of the customers to be hurt.

Mum rotated the children's chores each week.

Gemma was [delighted/disappointed] because the

ironing basket was half [empty/full] and that was one of her many tasks for the week.

A waitress tripped on her way back to the kitchen.

The chef was [happy/angry] because the

tray was half [empty/full] and the dishes were all high quality and expensive.

The restaurant had just opened and there were a number of important guests.

The chef was [delighted/disappointed] because the

plates were half [empty/full] and that was an indication of customer satisfaction.

The airplane was going to make an emergency landing.

The pilot was [thankful/frightened] because the

fuel tanks were half [empty/full] and this would affect the chance of catching fire.

A discussion was required to decide upon urgent changes to the company.

Brain was [pleased/annoyed] because his

diary was half [empty/full] and this meeting was of the highest importance.

These days customer's are encouraged to complain by email.

Calvin was [pleased/annoyed] because the

inbox was half [empty/full] and it was his task to reply to all the queries.

The honeymooners wanted to take lots of photographs.

Sally was [delighted/disappointed] because the

memory card was half [empty/full] and there was still so many locations to capture.

The department had a complaints box for disgruntled employees.

The manager was [happy/angry] because the

container was half [empty/full] and this showed how satisfied his team really were.

The new barman dropped an expensive whisky on the floor.

The manager was [pleased/annoyed] because the

bottle was half [empty/full] and the owner would request the value of the loss.

Some people go to work early so they can easily park their cars.

Linda was [delighted/disappointed] because the

streets were half [empty/full] and she got out of bed at 6am to find a space.

The students took turns to take empty bottles to the recycling point.

Will was [pleased/annoyed] because the

box was half [empty/full] and he had to lug it to the far end of the street.

The storm had cut off all the power in the house.

Mum was [pleased/annoyed] because the

freezer was half [empty/full] and the food she had frozen was going to be spoilt.

Older adults are more susceptible to illness in winter.

The doctor was [delighted/disappointed] because the

ward was half [empty/full] and this reflected the severity of the flu virus.

Students are always lazy when it comes to taking out the rubbish.

James was [pleased/annoyed] because the

bin was half [empty/full] and he had to carry it down two flights of stairs.

Teachers hate taking detention as much as pupils hate going to it.

Mr Mitchell was [pleased/annoyed] because the

room was half [empty/full] and he could not be bothered with unruly antics.

Daniel was cooking his first Christmas dinner for friends.

Emma was [thankful/worried] because the

plates were half [empty/full] and she wanted him to think the guests enjoyed it.

Emergencies always lead to a back log at the surgery.

The doctor was [pleased/annoyed] because the

waiting room was half [empty/full] and he was really looking forward to heading home.

All trains were cancelled due to severe flooding.

The conductor was [thankful/worried] because the

station was half [empty/full] and it was his job to talk to the angry commuters.

The students had mixed chemicals together to cause an explosion.

The tutor was [grateful/worried] because the

lab was half [empty/full] and there could have been some serious injuries.

Hospitals can become busy over the weekend.

The nurse was [pleased/annoyed] because

casualty was half [empty/full] and there was an emergency ambulance on the way.