A Geometry without Angles: The Case for a Functional Geometry of Spatial Prepositions

Gillian Maver Ferrier

Department of Psychology

University of Glasgow

Submitted for the Degree of Doctor of Philosophy (Ph.D.) to the Higher Degrees Committee of the Faculty of Social Sciences, University of Glasgow

September 1996

A Geometry without Angles: The Case for a Functional Geometry of Spatial Prepositions

Gillian Maver Ferrier

Department of Psychology

University of Glasgow

Submitted for the Degree of Doctor of Philosophy (Ph.D.) to the Higher Degrees Committee of the Faculty of Social Sciences, University of Glasgow

September 1996

For Mum, Dad and Matthew with love.

Abstract

This thesis develops the view that the semantics of spatial prepositions are more fully realised within a framework of functionality, incorporating knowledge of the world, than within the spatial, geometrical framework more often used to analyse prepositions. It is argued that previous approaches which support full specification of lexical entries through the use of polysemy and prototype notions are not satisfactory or psychologically valid. It will also be shown that the minimal specification Classical approaches fail to account for all uses of the locatives described. It is suggested that minimal specification of lexical entries can be achieved by means of functional controls that can provide a more psychologically valid account of the semantics of spatial prepositions.

Functional geometric control relations of fContainment, fSupport and fSuperiority are proposed for IN, ON and OVER respectively. These focus on the importance of location control in prepositional choice. It is argued that such controls underlie the use of spatial prepositions. The controls are suggested to be inherently dynamic and state that the relatum object is in some way able to control the location of the referent object. For example, the use of the preposition IN is guided by the principle of fContainment which operates on the basic premise that the relatum (y) controls the location of the referent (x) such that when y moves there will be a correlated movement in x (or uncorrelated movement within the convex hull of y) by virtue of some degree of enclosure. The control relation that guides the use of OVER is fSuperiority and it operates on the basic premise that x threatens to come into contact with y as a consequence of gravitational force. Finally, the use of the preposition ON is suggested to be guided by notions of fSupport which operates on the premise that the relatum protects the referent from the force of gravity.

A series of experiments are presented in this thesis which examine the locatives IN, ON and OVER in relation to the suggested functional controls. Both Static and dynamic scenes are examined. This was achieved by manipulating the factors that are suggested to be involved in providing either weak or strong location control. Subjects rated the likelihood of using various prepositions in response to graded video-scenes of balls (x) and bowls (y) in differing geometric relations. These scenes were also used indirectly to discover whether the suggested control relations are actually in operation. This involved examining the subjects independent perceptions of the functional relations being portrayed.

Results show that presence or absence of functional control factors do have an effect on prepositional choice and, very importantly, the suggested functional control relations do appear to be in operation, providing information used to navigate the spatial world. Implications of this research and future investigations are also discussed.

List of Contents

Page

List of Tables

List of Illustrations

Acknowledgements

I would like to thank my supervisor Simon C. Garrod for all his support, advice and patience. I would also like to thank Siobhan Campbell for her contribution to this work and Mike Burton for his help and encouragement in the final stages of this thesis.

This thesis would never have been finished without the help of my parents Joyce and Findlay Ferrier; I can never repay my debt to them (for food, warmth and love).

My big thanks to Melody M. Terras and to Eleanor M. MacConnell for being there at various points in my life when I needed them (not forgetting Alexander and Gregory of course!). Roseanna Mohammed-Azam, with whom I shared an office for two years, certainly deserves a mention for making my experience as a postgraduate all the more enjoyable. Thanks also to Margaret Martin for her much needed support at various times over the years and to Kris Doing-Harris for being such a good friend. Special thanks are due to Matthew D. Smith who has been both supportive and helpful during the final stages of this thesis, especially when it all seemed too much.

The Carnegie Trust for the Universities of Scotland supported me with a studentship without which I could not have undertaken this Ph.D. Thanks also to the Human Communication Research Centre, University of Glasgow who employed me as a Research Assistant. My thanks also go to the technicians who have helped me over the years and also the Department of Psychology in general.

Declaration

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

Chapter 1

Spatial Organisation: The Representation of Meaning

1.1 Introduction

> The purpose of Psychology is to give us a completely different idea of the things we know best[1]

Spatial organisation is important in human cognition and dominates much of our language use. We constantly require language to provide information about where we are, where others are and where objects are located in space. Spatial expressions, particularly spatial prepositions, are used to portray interactions between objects in the world and a semantic analysis of spatial language is the main focus of this thesis. The purpose of this first chapter is to present the general background to this work.

Previous theories of the semantics of spatial relations have basically followed the tenets of "Classical" or "Prototype" based views. These two approaches to meaning representation are discussed in this chapter in a historical context. Also previous accounts of spatial relations have relied heavily on geometric accounts of spatial prepositions and these geometries are briefly discussed.

The functional approach to spatial prepositions proposed within this thesis takes a slightly different view of meaning representation. This account will utilise some of the tools found in classical and prototype theories but focuses on functional information as central to an account of locatives. The main tenets of the Functional Geometric approach are presented as are the related areas that recognise the importance of functional factors. A summary of the content of the following chapters is presented at the end of Chapter 1.

1.2 The Inadequacy of Geometry and Logic

Previous semantic analyses propose various systems to describe spatial expressions which focus mainly on geometry and logic. These accounts will be discussed fully in

---

[1] Valery, P. (1943). *Tel Quel.* New York: French and European Publications.

chapter 3 but at present it is important to recognise, that as Vandeloise (1991) states "seductive geometric generalisations, often based on simplified analysis, hide the true nature of the prepositions they attempt to explain" (Vandeloise, 1991, p.7). The geometric relations do not apply to the objects being discussed but rather to geometric figures (e.g. points and lines) associated with the object. Indeed it can be seen that "spatial expressions do not describe physical objects of the real world" (Cienki, 1989). Certainly no account, whether geometric or otherwise, has provided an adequate semantic explanation for the mental representation of spatial prepositions.

A major claim of this thesis is that relying on geometric information is misleading. Functional and physical notions must be recognised. Even if these previous "geometric" theories were correct Crangle and Suppes (1989) recognise that none of the geometries which they assumed are actually specified. They state that any geometry that would be involved is not as precise as Euclidean geometry.

Some previous accounts have recognised both physical and geometric notions but not in great detail. They have not attempted to specify the underlying geometry that would be required. Crangle and Suppes (1989) give Bennett (1975) as an example. He put forward a componential analysis (discussed in Chapter 3) and his components or semantic markers include <u>interior</u> and <u>surface</u>. Bennett's analysis recognises geometrical and physical notions, however, he does not present any detailed analysis of them. Crangle and Suppes note that his notions of interior and surface "function as unanalysed wholes" (p.402).

Herskovits (1986) proposes geometric ideals but does not make her geometric notions, such as <u>interior</u> and <u>contiguous</u>, explicit. These notions are not analysed and therefore "no underlying geometrical or computational framework is provided", (Crangle and Suppes, p.402). Herskovits' work is discussed in Chapter 5.

Various geometries are discussed but Crangle and Suppes do realise that a purely geometric account of spatial prepositions is by no means sufficient. Even prepositions that appear to be mainly spatial do rely on assumptions that we make about the world around us. They state that the notion of support in connection with ON is physical in nature rather than geometrical. Another important non-geometric factor is context. Crangle and Suppes recognise that the meaning of spatial prepositions is closely tied to geometric and physical notions. A discussion of the kind of geometry that Crangle and Suppes feel is required to explain the semantics of spatial prepositions is presented in Chapter 6. However, it is vital to recognise the central importance of functionality in order to fully analyse spatial prepositions.

1.3 Recognising the Importance of Functionality

1.3.1 The Spatial World

Spatial prepositions represent how we interact with the world around us and directly involve the concrete objects they relate. I will argue that a semantic analysis of this class of words must recognise and incorporate the following factors:

1. For human beings, interaction with the world is heavily dependent on functional and physical factors.

2. The meaning of concrete terms must reflect the way that we interact with the environment as well as being closely tied to our physical and functional limitations.

Functionality is of prime importance in the spatial world. Our language for space is understood with reference to how we interact with the world around us and what objects in the world are used for. Language users often say things that do not reflect the physical world directly and they are easily understood. In Chapter 6 it will be argued that mental models of space, rather than directly reflecting the real world, reflect the functional geometry of a situation. We use language in a functional manner and any meaning representation for spatial prepositions should reflect this. Certainly other areas have recognised the importance of functionality and it is to these that I now turn.

1.3.2 The Functional Link to Perception and Causality

In the area of perception such functional and physical factors are fully recognised. Marr (1982) recognises that perception is closely linked to functionality and notes that it is important to understand what vision is for, that is, the function of vision. He points out that vision is not concerned with "sense-data" or "molecules of perception" but rather "the senses are for the most part concerned with telling one what is there" (p.6). Marr (1982) states that the algorithmic level can be more easily understood by understanding the problem that needs solved, the whats and whys rather than looking at the hardware (the physical side of things).

Gibson (1979), an ecological psychologist, stresses the importance of interaction between human beings and their environment. This interaction is constant and inseparable. His work deals with perception rather than cognition but it is suggested that the same conclusions can be applied to the cognitive framework. Gibson (1979) makes an important distinction between physical reality and the environment. Physical reality is independent of animate beings, however the environment "is defined relative to how beings interact with it" (Lakoff, 1987, p.215). Gibson (1979) terms such opportunities for interaction with the environment as "affordances". These affordances are always there as possibilities for us - the affordance is always there to be perceived. Meaning is found in the interaction between us and the environment. This approach has close links with the functional approach to spatial prepositions proposed within this thesis. As Gibson (1979) argues one cannot view the eye as simply a camera and similarly one cannot define the field of lexical semantics as a dictionary.

Michotte (1963) recognises the importance of functional relations in the area of causality and space. What we perceive things can be is extremely important in how we represent them and their inter-relations. He also notes that functional interaction with the world is an important factor, indeed, it is the functional relations, involved with what things do, that give the things around us significance. We need a knowledge of what things can do and what we can do with them. As Michotte himself comments:

> We need to know that things can be moved, e.g. by pushing them, causing them to slide, lifting them, or turning them over, by hurling,

> breaking, bending or folding them, by leaning on them, and so on....we need to know that one object goes up to another or withdraws from it, that one person pursues another or hides from him, that people lock up objects in drawers or chests, pour wine into glasses, and so on. These examples are taken from situations which occur regularly in everyday life, and they are so ordinary that they do not seem at first to raise any special problems, This, however, is not the case. Although these events all have a spatial and kinematic aspect, the most important feature about them is that they imply *functional relations* between objects.
>
> Michotte (1963), p.4

1.4 An Explanation of Terminology

1.4.1 Representation of Meaning

This thesis is concerned with the representation of meaning, specifically that of spatial prepositions. Previous accounts have mainly been split between Classical notions of meaning representation and Prototype based (or Cognitive Linguistic) meaning representation. Both views will be discussed in this section.

I focus first on an explanation of the two terms in the previous sentence "representation" and "meaning". It is certainly important to present a definition of representation and also tackle the age-old question "What is meaning?".

First, let us examine "representation". For a psychologist, the study of word meaning raises two basic questions:

1. How do we store word meaning knowledge in the mind? (a representation question).

2. How are these meanings accessed in the process of producing and understanding discourse? (a processing question).

(adapted from Garnham, 1990)

This thesis is interested in question one, which is concerned with the representation of meaning in the mind.

Second we turn to the question "What is meaning?" Semantics and pragmatics are involved with a definition of meaning. In this thesis my main interest is with semantics, a subject which is studied within many fields, including philosophy, psychology, anthropology and linguistics. Clearly "meaning" has many meanings. An important distinction within the use of meaning is the distinction between "sense" or “intension” and "reference" or “extension”.

The intension of a word is its abstract specification or meaning and this determines how a word is related in meaning to other words. It specifies the properties that an object must have to be a member of that class. Extension is what the word stands for in the world (that is the objects picked out by the intension). Basically, it presents the class of entities defined by a particular term. For example, the word “purple” has an extension which is “the class of purple entities” and it also has an intension which is “the property of purpleness”.

1.4.2 Semantics

It is also important to define the term "semantics". One might separate out two kinds of semantics: lexical and structural. Structural semantics examines how the meanings of complex (composite) expressions depend on the meaning of their parts and the way that those parts are put together. On the other hand, lexical semantics is traditionally defined as the study of meaning , specifically of words (Lyons 1995). In this thesis I am interested in the meaning of words.

Gazdar (1979) proposed that the term semantics can be defined as the aspects of meaning that contribute to the truth-conditions of sentences. Basically, the truth-conditions are a specification of those circumstances in which the sentence would hold true. A truth-conditional theory is involved with "the meaning of an expression and is its contribution to the truth-conditions of the sentences containing it" (Lyons, 1995, p.40). Languages can be used to make descriptive (or propositional) statements which are true or false according to whether the propositions that they are expressing are true or false (truth conditional theory of semantics). Truth is important in the theories developed by logicians known as model-theoretic or truth-theoretic semantics. Such formal approaches to meaning do help refine what meaning might be however they do not help with the encoding-decoding problem.

1.4.3 The Present Approach

A semantic theory is the primary focus of this work. A theory must explain how words relate to the world in which we interact. The Functional approach presented in this thesis is concerned with the relationship between prepositions and the situations that they are used to portray. I am interested in how we mentally represent spatial prepositions. Certainly it is important to capture the way that words refer to things that are members of the same category yet are different in some way to non-members of the category (Harley 1995). Categories are what concepts are about. I now focus on two main views on the nature of concepts and how they may be represented in the mind.

1.5 What is Contained in the Mental Lexicon?

All words have a lexical entry and these constitute our mental lexicon and differing approaches have differing views on what it is that makes up this lexical entry. The main interest of this thesis is what fills the slot in the lexical entry for, for example, IN or OVER. The purpose here is not to present an exhaustive listing of representation issues. I focus on the history of two major views of meaning representation that have been used to account for spatial meaning: the Classical View associated with componential approaches and the Prototype View associated with Cognitive Linguistics. First, a general outline presenting the main tenets of these two views is given. Second, I present a discussion of some major approaches that have developed under the umbrella of these views.

1.5.1 The Classical View to Meaning

Classical approaches to meaning have been suggested by philosophers and now psychologists for centuries. The Classical approach can be seen as the traditional view of meaning representation.

According to this approach the lexical entry for, for example, BANANA would contain simply a list of properties that bananas must have in order to be bananas (fruit, inanimate, edible, yellow). The lexical entry for MAN could list 3 properties- the object must be human, male and adult. This entry contains only the bare bones of its encyclopaedic entry and the view assumes that words can be defined in terms of necessary and sufficient conditions. For example, for the sense of the word BOY the semantic components could be "male", "non-adult", "human" and these would form necessary and sufficient conditions for membership of the category BOY. Here we have the basic tenets of the approach.

In the Classical view the word BOY will have more or less the same meaning for everyone and this is certainly important in any approach analysing lexical entries. People will store the same necessary facts about things. This means that a word will not change its meaning every time you learn something new.

Several theories of meaning representation have eschewed this view in one form or another and I concentrate here on the work of Katz and Fodor (1963) and Collins and Quillian (1968) in order to gain some historical perspective. Basically this research advocated the use of componential analysis as a structuring tool.

1.5.1.1 Componential Analysis

Componential analysis makes precise the sense relations between lexemes (Lyons, 1995) and lexical decomposition is an alternative term for componential analysis. The claim would be that semantic components reveal themselves to us when we test analogies among words. You take a domain of interrelated word analogies and identify semantic components on the basis of these analogies. For example, taking MAN:WOMAN :: BOY:GIRL as an analogy we find that the difference in meaning between man and woman is the same as between boy and girl, namely gender and adulthood.

You can use + - notations to express this where a BOY is -adult and a GIRL is -male and a WOMAN is -male and also +adult and so on. Taxonomies take into account the fact that something cannot be both +male and -male at the same time. MALE(x) and FEMALE(x) form a binary taxonomy [MALE(x), FEMALE(x)] and this carries the information that some x can be male, or female but not both at the same time.

I now present the feature theory of Katz and Fodor (1963) and the network theory of Collins and Quillian (1968) both of which assume that words can be best defined by decomposition into necessary and sufficient conditions.

1.5.1.2 Katz/Fodor: A Classical Feature Theory

This theory can be seen within the framework of componential analysis. Katz and Fodor (1963) proposed that a dictionary entry (or lexical entry) took the form of a hierarchical tree. An example of such a tree is given in Figure 1.1. Each path corresponds to a different meaning of the word BACHELOR. The unenclosed items are grammatical markers, the elements that are shown in parentheses are the semantic markers. These decompose the meaning into the primitive elements or distinguishers which are shown within the brackets.

Chomsky (1965) went on to state that within this theory word meanings are described in a more accurate way by semantic markers which are <u>not</u> fully ordered in a hierarchy. These semantic markers have bivalent features, i.e., +feature vs. -feature. This theory was, according to Lyons (1995), the first "linguistically sophisticated attempt to give effect to the principle of compositionality" (Lyons, p.210) and illustrates the main characteristics that can be found in feature theories. Componential theories often involve selection restrictions and the Katz-Fodor theory is no exception.

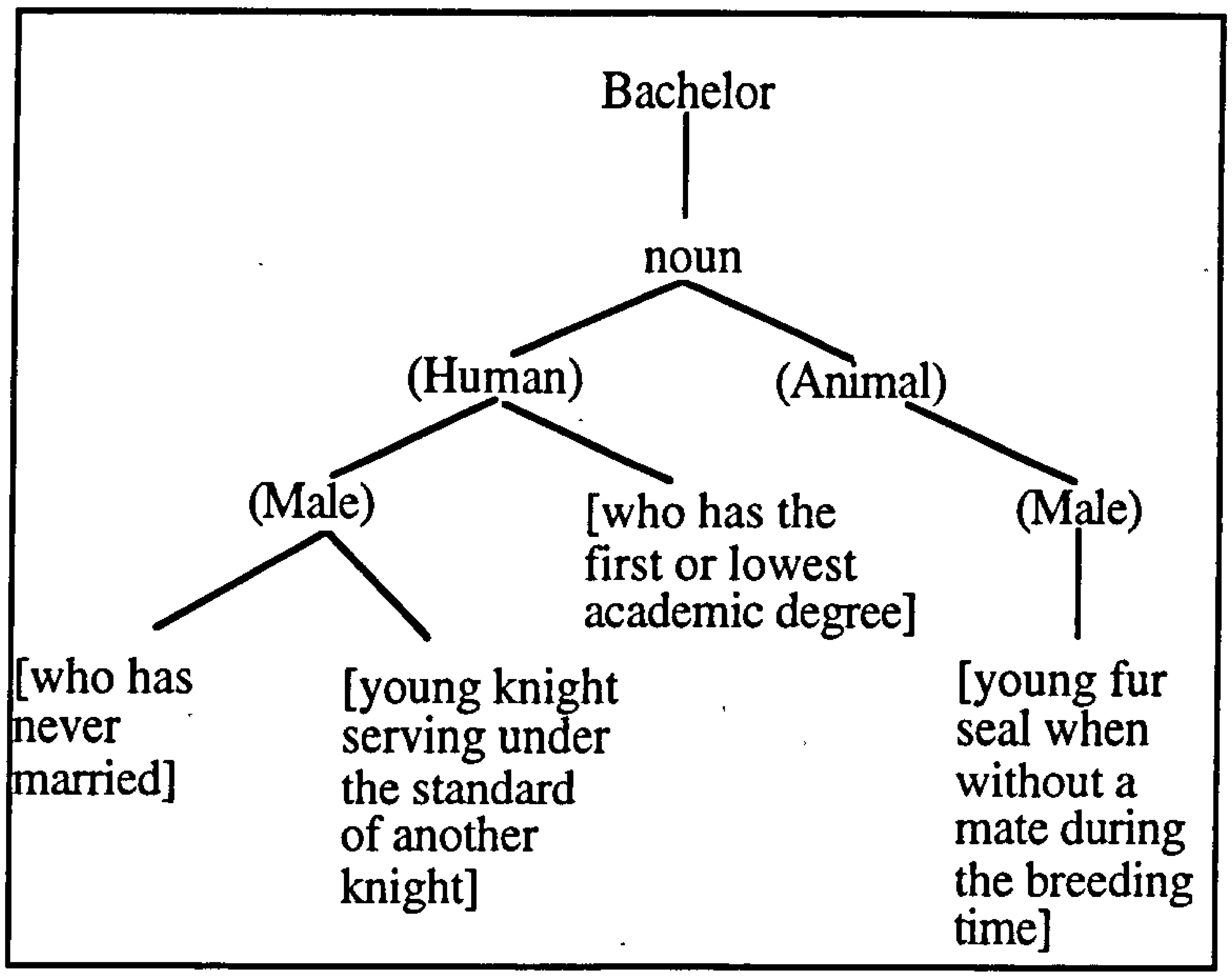


Figure 1.1 - Hierarchical Tree from Katz and Fodor (1963).

1.5.1.3 Collins and Quillian: A Classical Network Theory

This approach to meaning focuses on the notion that the meaning of a word is embedded within a network of other meanings.. It does seem intuitively appealing that concepts are often strongly related. An associative theory is one where all the concepts and general knowledge are interrelated through associations of varying strengths. However, associative links do not give a great deal of information and in semantic networks the links are not merely associations as they also have meaning. In 1968 Quillian used semantic networks to represent word meanings in his Teachable Language Comprehender (TLC). TLC could answer questions as it had a memory structure. It could represent knowledge and answer questions such as "Does a canary have skin?" The structure involved a hierarchically organised system in which related concepts were connected by associations. There was a hierarchical conceptual organisation which meant that superordinate concepts were at a higher level and were connected to subordinate concepts. Retrieving knowledge was fairly simple and was activated by a question.

This led onto the theory by Collins & Quillian (1969) in which concepts that correspond to word meanings are represented by nodes. These nodes are then joined by a network of links called ISA links (as in a canary "is a" bird). The links represent relations between concepts (see Figure 1.2 for an example of a network taken from Collins and Quillian, p.241).

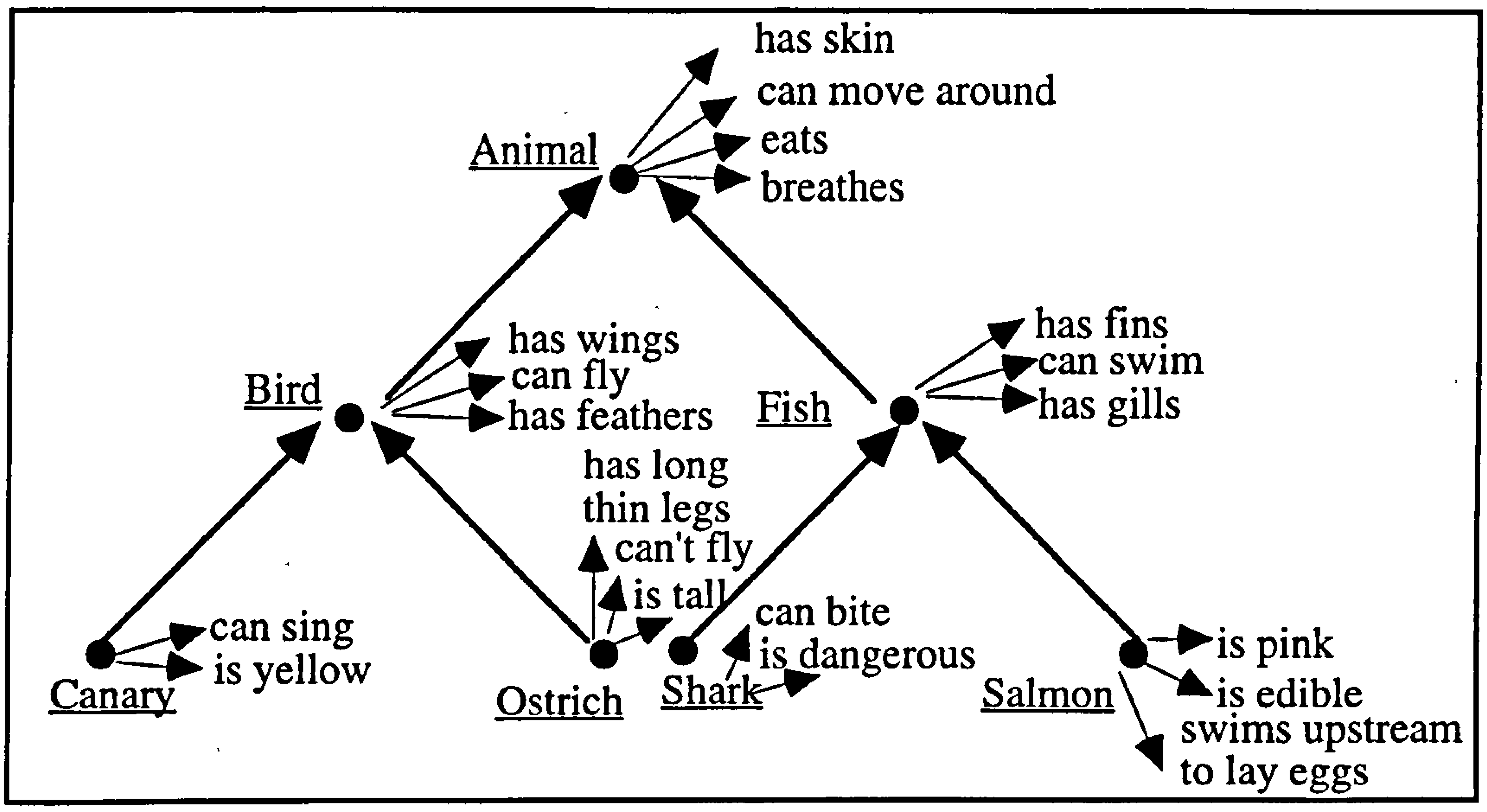


Figure 1.2 - A Hypothetical Three-Level Hierarchy.

The category name or superset of CANARY is BIRD which in turn is a member of the superset of ANIMAL. Collins and Quillian stated that the information held at the memory node for CANARY need not store information about birds in general since this information can be recovered from the hierarchy. In this way the system achieves cognitive economy. Based on this theory they predicted that a person should take longer to decide that “A canary can fly” than “A canary can sing”. Indeed there were certain implications for psychological research as there is a category size effect. Larger categories require more time for search than smaller ones. Collins and Quillian (1969) experimentally give evidence for this, response time increases from "A canary is a canary" to "A canary is a bird" to "A canary is an animal". A similar effect was found for the properties of the sets. Response times increased from “A canary can sing” to “A canary can fly” to “A canary has skin”. It was suggested that this happens because it takes a certain amount of time to travel along a link and as these processes are additive. It takes longer to reach a higher level link such as ANIMAL from CANARY that it does to reach the superset of ANIMAL from BIRD. The early data certainly supported this theory.

The Semantic network Collins & Quillian (1969) directly resulted in the spreading activation model of Collins & Loftus (1975). This retained the associative network of the original theory but took out the strict hierarchical structure which led to problems.

1.5.1.4. Evaluation of the Early Feature and Network Theories

These theories do have an intuitive appeal. They advocate minimal specification of lexical entries and are therefore very economical. However the decompositional theories discussed here do have their limitations. For example, in some cases to account for all senses of a word we do need to look beyond semantic components. GIRL can actually refer to adult females in certain situations and the semantic components do not account for this fact. Conrad (1972) argued that the differences in retrieval time did not reflect differences in hierarchical storage. Conrad collected frequency norms, asking people to write down all the things that they could bring to mind about the word CANARY, and showed that these properties are experienced with different frequency. Also researchers have noted that it is extremely difficult to come up with a list of effective semantic features using necessary and sufficient conditions (McNamara and Sternberg, 1983).

The theories do not say anything about how the words actually relate to the world. How words relate to other words is not enough, we need to know how they relate to the world and the state that the world is in at that time. For example as Johnson-Laird (1988) points out semantic networks are "as circular as dictionaries" (Johnson-Laird, p.52). If a speaker makes a statement such as "the dog is ON the sofa" the listener, about to lower onto the sofa, understands how the world should be if what the speaker is saying is true. If one has a theory that relates words to the world then one automatically takes care of how words relate to words.

Many previous approaches to the semantics of spatial language have also used decompositional notions as their structuring tools and these are presented in Chapter 3. Such work is within the Classical view and the positive and negative aspects of the approach, within the spatial realm, are reviewed at the end of Chapter 4.

1.5.2 The Prototype View

Dissatisfaction with the Classical view led researchers to question the idea that there need be a set of necessary and sufficient conditions for category membership. Discussion of prototype theory evolution will provide a historical background for the work of Lakoff (1987), Brugman (1981) and others discussed in Chapter 4. These Cognitive Linguistic approaches to spatial language use prototype notions as a structuring tool and reject the main tenets of the Classical view.

1.5.2.1 Rosch and Prototypes

The major challenge to classical theories came with Eleanor Rosch's 1973 paper on prototypes where she stated that prototypes are used to define membership of a category. This work proved to be revolutionary and helped begin a shift from Classical to Prototype based views within psychology. Putnam (1975) succinctly notes the general concerns over classical approaches at this time. He stated that the meaning of TIGER can be decomposed into semantic primitives such as Four-Legged, Animate, Striped and so on. Putnam notes that none of the properties are essential for an animal to be recognised as a TIGER and that the properties of, for example, Animate and Four-legged are criteria rather than singly necessary and jointly sufficient conditions.

The issue of categorisation was certainly brought into the limelight by Rosch (1973, 1975) and she states that the meaning of a lexical item is best conceived of using prototypicality. This involves graded membership based on family resemblance rather than the all or none phenomenon found in decompositional work. So, the best example of a concept, for example, BIRD is the prototypical bird. The prototype member is often a composite rather than an actual member of the category. Rosch (1973) asked subjects to make representativeness ratings of a range of words from certain categories. Agreement between subjects was high, especially when they were ranking the best examples of a category. To illustrate, the mean "exemplariness" ranks are given for the category FRUIT and the category VEGETABLE in Table 1.1.

Rosch states that these findings show that questions of centrality and peripherality of category membership are meaningful to the subjects. Rosch (1973) then hypothesised that reaction times would be faster when subjects responded "true" to true statements of the form "an x is a y" when x was a central member (a good example) of y as compared to when x was a peripheral member (not very good example) of y.

FRUIT		VEGETABLE	
Apple	1.3	Carrot	1.1
Plum	2.3	Asparagus	1.3
Pineapple	2.3	Celery	1.7
Strawberry	2.3	Onion	2.7
Fig	4.7	Parsley	3.8
Olive	6.2	Pickle	4.4

Table 1.1 - Exemplariness Ranks from Rosch (1973).

For VEGETABLE the best example of the category was found to be Carrot and the best false example was Spinach. The peripheral member from the previously done ratings was Onion and the false example was Mushroom. Reaction time for true best examples was 1011.67 msecs and for the peripheral members it was 1071.45 msecs. Central true sentences took less time to answer correctly ($t(23) = 6.54$, $p < 0.01$). Rosch interpreted these findings to mean that categories have an internal prototype structure and that this concerned mental representation. In 1978 Rosch gave evidence that the more a category item has attributes in common with the rest of the category (family resemblance) the more likely it will be seen as a representative member of that category.

1.5.2.2 The Cognitive Linguistic Approach and Prototypes

Typicality effects have been used as strong evidence by many researchers that prototype effects represent a theory of the mental representation of categories. However, Rosch herself, in the late 1970s stated that prototypes did not necessarily reflect mental representation rather that they were involved in some way with category membership.

In chapter 4 we see that Cognitive Linguistic approaches utilise the notions of prototypes and reject necessary and sufficient conditions. Lakoff (1987) notes the problems with misinterpreting Rosch's findings and suggests that these prototype effects result from "cognitive models" that are used (see Chapter 4). Lakoff (1987) and Brugman (1981) both present a full specification analysis of spatial language using prototypes as central and to a certain extent fall into the trap of using prototypes in the STRUCTURE = INTERPRETATION manner that Lakoff himself warns about.

1.6 Evaluation of Classical and Prototype Based Theories

1.6.1 Abandonment of Classical Theory

Prototype theory resulted in many researchers abandoning the notions of necessary and sufficient conditions in favour of graded category membership. This has typically meant, in the case of locatives, a focus on full specification. Cognitive linguistic approaches focus on the fact that some featural information found in concepts may be more prototypical than others (Cuyckens 1993). As will be seen in Chapter 4 there are certain philosophical elements of a Cognitive Linguistic approach that are more appealing than the Classical. Such notions are incorporated into the functional theory presented in Chapter 6. However, I feel that prototype effects do not result in better structuring tools than the minimal semantic primitives approach used in classical theory. As a conclusion to this introductory chapter I will focus on the idea that certain elements of Classical theory may have been thrown out for the wrong reasons.

1.6.2 Margolis: Reassessing the Shift from Classical to Prototype Theory

Margolis (1994) suggests primarily that both these theories lack psychological implications. He suggests that the difference between Classical and Prototype theory is as follows:

> (1) The Classical Theory
> All instances of a category share a set of properties singly necessary and jointly sufficient for membership within the category.

> (2) Prototype Theory
> Category membership is a matter of having some sufficiently many properties that members of the category tend to have.
>
> Margolis (1994), p.77

Margolis notes that many have decided that Classical theory is incorrect because it is so difficult to specify the necessary and sufficient conditions for category membership. In general language users cannot come up with necessary and sufficient conditions, or even general conditions for use (Putnam, 1975); but this does not mean that they do not exist. Despite various objections to the classical approach that will be discussed in Chapters 3 and 4 we should be wary of throwing the baby out with the bath water. Indeed it is proposed that the minimal specification for, for example, IN can be given using concepts of a functional nature.

There is also the argument that unlike Prototype theory the Classical cannot account for fuzziness. Prototype theory allows for degrees of membership and the argument is that classical theory involves an all or none phenomenon: you are either a member or you are not. Members of categories are seen as having the same properties but this does not mean that there cannot be degrees of membership. Margolis explains this succinctly:

> At the very least, there is a relevant and clear sense in which classical theory does admit degrees of membership, namely, through the potential fuzziness of the properties required for membership. Consider a simple example, *black cat.* In one sense, the extension of the category *black cat* is perfectly determinate: something is a black cat just in case it is black and a cat (has the properties *black* and *cat*). At the same time, it does not follow that for every object it is either a black cat or not (full stop). *Black cat* may admit of degrees so long as either *black* or *cat* does, and I doubt that there is much dispute of the former. The same goes for any complex concept - including lexicals - however its semantics is to be projected from its constituents. Hence, fuzziness does not in itself argue against classical theory.
>
> Margolis (1994), p.84

It is also important to note that intuitions that a category is fuzzy could simply reflect how language users have come to know what is what (an epistemological issue).

I now turn to a consideration of the robust and reliable typicality effects found in prototype research. Basically, after rating for exemplars has been carried out, it is found that subjects respond faster to "typical" members of a category over the "atypical" members. Classical theory does not make any predictions about this. However there is evidence that typicality effects are found for categories where the subjects actually know the necessary and sufficient conditions of category membership.

Armstrong, Gleitman and Gleitman (1983) examined, amongst others, the concept of ODD NUMBER. This concept can be defined precisely as "an integer not divisible by two without remainder" (Armstrong et al, p.274). The prototype experimental paradigm should predict that there will be no differences in response time to 3 or 9 as examples of an odd number. First, it was found that the subjects actually rated some odd numbers as being a better example of odd numbers, for example, the numbers 3 and 7 were rated better odd numbers than 447 and 91. The results found for this well defined category look a great deal like the results found for categories that are said to be fuzzy. Second, it was found that "good exemplars" for ODD NUMBER had a lower verification time than bad exemplars. For example, the well defined exemplars 7 and 13 were verified in 1088 msecs whilst the bad exemplars 15 and 23 were verified in 1132 msecs. Typicality effects were found for categories with well defined necessary and sufficient conditions and this suggests that typicality evidence is unequivocal.

The comments by Margolis (1994) certainly suggest that there are reasons why one should not disregard Classical notions in favour of Prototype notions. It is not suggested that classical theories are the answer, rather that elements from this view can be saved. Prototype notions are not employed in the functional analysis presented within this thesis, however, certain influences from the prototype influenced cognitive linguistic approach are apparent.

1.7 Summary of the Chapters

In this chapter the general theoretical background to the previous spatial approaches have been introduced as has the issue that I wish to address within this thesis: the functional nature of spatial prepositions.

Chapter 2 of the thesis consists of a discussion concerning the nature of spatial prepositions. It explains why prepositions are a valid area for semantic analysis and the importance of such research on a more global level. This chapter also reviews some of the literature concerning children's knowledge and acquisition of spatial relations.

Chapter 3 involves a discussion of what can be loosely termed the "Classical" accounts of spatial prepositions. This chapter gives an account of the main body of previous work done in the area and highlights the many problems of such approaches. The spatial investigations of Leech (1969), Bennett (1975), Cooper (1968) and Miller and Johnson-Laird (1976) are discussed.

Chapter 4 focuses on the Cognitive Linguistic approaches to the semantics of spatial language. The philosophy of this approach is discussed and the polysemical, prototype based accounts of Lakoff (1987), Brugman (1981) and Brugman and Lakoff (1988) are presented. I also briefly examine the work of Cuyckens (1993). At the end of the chapter I discuss the areas that should be saved from both the Classical and Cognitive Linguistic approaches.

Chapter 5 investigates the previous approaches that in one way or another extol the functional approach. These accounts recognise in one way or another the importance of functionality in defining spatial prepositions. Accounts by Herskovits (1986), Vandeloise (1991), Miller and Johnson-Laird (1976), Cienki (1989), Garrod and Sanford (1989) and Coventry (1992) will be discussed.

Chapter 6 is concerned with a full discussion of what has been termed a functional geometry. The origins of this work can be traced to Garrod and Sanford (1989) and their views on mental models are presented. The functional definitions and functional controls (which involve principles of fContainment, fSupport and fSuperiority) are introduced and fully explained. Importance is placed on interaction with the environment and the functions that objects have. The importance of a cognitive geometry for space which focuses on functionality is discussed with reference to the work of Talmy (1988) and Cohn et al (1996).

Chapter 7 presents the experimental results concerning the spatial prepositions IN, ON and OVER. These investigations involve direct experimentation with static scenes. Various factors suggested to affect functional control were manipulated. Confidence ratings of IN, ON, OVER and ABOVE were examined.

Chapter 8 presents the experimental results concerning the spatial prepositions IN, ON and OVER. These investigations involve direct experimentation with dynamic scenes. The functional controls are suggested to be inherently dynamic and notions of control were directly manipulated to examine the effect on confidence ratings.

Chapter 9 presents the experimental results found using indirect methods. This involved examining whether the suggested notions of location control are actually in operation. No direct testing of prepositional confidence occurred. Results from such experiments were correlated with the relevant static preposition scenes to examine the relationship between confidence of preposition and presence of suggested location control.

Chapter 10 presents the conclusions formed after conducting this body of research. The main aims of the thesis are discussed and the main findings are summarised. Methodological considerations are discussed and suggestions for future research and improved methodologies are given.

Chapter 2

An Overview of Spatial Prepositions

2.1 Introduction

People never seem to have taken prepositions seriously [2]

In this chapter the semantic area of spatial prepositions and spatial organisation is discussed. It has not been unusual for prepositions to be considered of little importance. The spatial prepositions are discussed with regard to their history and their importance in human cognition. The preposition is also defined in this chapter and the different types of spatial prepositions and forms of use are discussed. I suggest that children's development and understanding of spatial language is related to the functionality of the spatial terms and that language acquisition is based on interaction with the environment. The language acquisition data yields some important information that can be interpreted as further support for the theory presented within the thesis. Finally I recognise that a knowledge and understanding of space is vital for human cognition. Knowledge of space and the potential of the objects around us is used in order to effectively navigate space. Indeed our use of spatial language provides us with a window through which the general workings of language can be viewed.

2.2 The Spatial Preposition

2.2.1 The Many Senses of a Preposition

Prepositions are similar to other constructions and word classes, for example adverbs, participles, conjunctions and adjectives (Quirk et al, 1985). Basically, a preposition expresses a meaning relation between two entities in space or time (Crystal, 1995), for example "the ball IN the bowl" (indicating space) and "Joyce will be back IN an hour" (indicating time).

In this thesis I am interested in the use of prepositions to indicate space. Prepositions as a group provide a great deal of grammatical information; the Concise English Dictionary (1990) lists 21 different senses or uses of the preposition IN. Prepositions can also

[2] Jackendoff, R. (1973). The base rules for prepositional phrases, p.345-356. In Anderson, S. R. & Kiparsky, P. (Eds.). *A Festschrift for Morris Halle*, New York: Rinehart & Winston Inc.

express temporal and abstract meaning in a non-spatial manner. Spatial prepositions can also be referred to as spatial locatives as they are used to locate objects in space.

Lindkvist (1950) presented the first comprehensive account of modern English prepositional usage, and though it provides only an extensive listing without comment on mental representation, it provides an insight into the many and varied uses of apparently "simple" prepositions. Lindkvist stated that IN indicated seven general, local senses and these are listed below:

1. Enclosure within a body.

2. Enclosure within a surface, expanse or area.

3. The quality or nature of an object.

4. Location within or along a line.

5. Relative position.

6. Enclosure within a body, surface or area thought of as being used to serve a certain purpose.

7. Motion and direction to the interior of a body or surface.

He also recognised that IN can involve part enclosure and gives examples such as:

His hands IN his pockets.

A carnation IN his buttonhole.

A magnificent azalea IN a pot.

A foot IN the stirrup.

Wax candles IN glass chandeliers.

A hook IN the ceiling.

Although Lindkvist's listing does not represent a semantic analysis, rather the work of a skilled lexicographer, actual research into the mental representation of spatial language often does not encompass all the facets spelled out by Lindkvist. The approach presented in this thesis argues that a minimal lexical entry can be provided to account for these seven "senses" or "uses" of IN. It is not necessary to resort to prototype semantics and recognition of full polysemy.

2.2.2 Locating Objects in Space

Spatial or locative prepositions are involved with locating objects in space and how objects interact with one another. When locating an object during communication there are some important elements that play a fundamental role (Svorou, 1993). Language users locate objects with respect to other objects, for example "the banana is IN the bowl". There is an object we wish to locate and an another object we use in order to help us locate it. These objects are referred to in many different ways throughout the literature investigating space. This terminology replaces the need to use the terms subject (or head noun phrase) and object (or noun phrase) and is now listed:

1. Referent (x) and Relatum (y) (Miller and Johnson-Laird, 1976).

2. Located entity and Reference entity (Herskovits, 1986).

3. Trajector (TR) and Landmark (LM) (Lakoff, 1987; Vandeloise, 1991).

4. Spatial Entity being localised (SpE) and Localiser (L-r) (Cienki, 1989).

5. Figure and Ground (Talmy, 1983).

6. Theme and Reference object (Jackendoff, 1983).

Throughout this thesis I adopt the chosen style of Miller and Johnson-Laird (1976). The object to be located (x) will be represented by what I shall call the referent and the reference object (y) will be represented by the relatum.

The expression of the spatial relation between two objects in space does not relate the two objects in a direct manner. What is happening is that the relatum object is defining a region where the other object, the referent is to be found. So in the phrase, typical of the work to be examined in this thesis, "IN the bowl" defines an area in terms of the relatum bowl and we see that the referent (the ball) can be found in this area.

2.3 The Preposition Uncovered

In this thesis I am focusing on the spatial prepositions IN, ON, OVER and ABOVE and at this juncture it would be helpful to discuss the forms and types of prepositions in use in the English language.

2.3.1 Forms of Prepositions

The simple form of spatial or locative expression consists of a spatial (locative) prepositional phrase combined with noun modifiers, for example:

The ball IN the bowl

where the order is NP + prep. +NP. The ball is the subject of the preposition and the bowl the object of the preposition.

The expression could also contain an existential quantifier, for example:

There is a ball IN the bowl.

The referent does not only refer to objects it can also refer to actions and events and so can take the form of a clause such as "I was singing" rather than a noun phrase, for example:

I was singing ON a stage.

Spatial expressions can also be structured around a copulative verb, for example:

The ball is IN the bowl.

The simple form of NP + prep. + NP structured around a copulative verb is the form focused on during the direct experiments carried out as part of this research.

2.3.2 Types of Prepositions

Herskovits (1986) makes a distinction between static and dynamic prepositions. She states that IN and ON are primarily static whilst TO and FROM are primarily dynamic. This thesis will show that dynamics, in a more global sense, contribute important information to the language user for the traditionally static prepositions.

The spatial prepositions ON, IN and AT are referred to as basic topological prepositions. However, there are also a set of prepositions termed the projective prepositions. Such prepositions can involve deictic and intrinsic uses as they rely on different points of view. These projectives include TO THE LEFT OF and IN FRONT OF which express relative position in the horizontal plane. The projectives that express position in the vertical plane include OVER and ABOVE (both of which are examined in this thesis). Basically, the projectives are used to define directions concerning an object. The location of the other object can then specified in relation to these directions (Herskovits, 1986).

Prepositions are also used metaphorically, for example:

I was IN deep water.

Matt felt UNDER the weather.

Jackie is ON drugs.

It is also important to note that prepositions can also be used to denote time, for example:

His birthday is ON Monday.

I will get there AT three o'clock.

2.4 A Brief History of the Preposition

The discussion of grammar in the western world can be traced back as far as the ancient Greeks. The first grammatical recognition of prepositions is found in the work of the Alexandrian Grammarian Dionysius Thrax (100 B. C.) (Crystal, 1995). Indeed, Sanskrit grammarians in the Indian tradition also recognised what can roughly be translated as prepositions (Lyons, 1971). The preposition has been with us for thousands of years and provides important information for the English language user. Other languages use prepositions but often different parts of language perform the spatial task. However, there is a common underlying need to describe space. Lindkvist (1950) notes that there had been great stability of prepositional usage during the previous 450 years. His monograph shows that most of the prepositional uses that he covers were also occurring at the beginning of the sixteenth Century. Unlike many other words and constructions the language we use to describe space has remained more or less the same and this exemplifies the importance of this word class. Certainly, IN and ON represent some of the most frequently used words in the English language (Crangle & Suppes, 1989)

2.5 Focus on English

The metalanguage used in this thesis is standard English. It is suggested that the functional geometric account proposed may present functional universals that can be adapted and could help explain spatial language on a more global level. Certainly the range of use for prepositions differs between languages. What is suggested is that functional primitives are in operation within these different ranges. Indeed many uses of spatial prepositions can be traced back to cultural and historical incidents and, it is suggested, their present use does not reflect the underlying functional controls in operation. For example, the use of ON the bus rather than IN the bus originated because

London buses used to have open tops. One would sit ON the open top of the bus and IN the lower, enclosed deck (Lindkvist, 1950). The work of Vandeloise (1991) is considered. This work involves a functional account of French spatial prepositions. Although there are certain differences in the use of IN and ON as compared to DANS and SUR respectively there are also strong similarities. Functional factors do appear to be of vital importance.

2.6 Acquisition of Spatial Prepositions

This thesis suggests that the semantics of spatial prepositions are best understood from within a framework of functionality. Therefore, it would be expected that a child's development of spatial language would mirror these functional factors. It is clear that children know about spatial relations before they actually begin to use them. They use their first spatial prepositions at 2 or 2;5. However, well before this age they show that they know that some objects are containers, others supporters and also a knowledge of normal orientation (like the fact that a bottle normally stands upright or the correct way up for a bowl or a plate). The first prepositions they produce are IN and ON from the age of 2;0 or 2;6. However, it should be noted that the although children of this age can produce different prepositions this does not necessarily mean that they understand their use.

Adults use spatial prepositions to describe the relationships between and among objects that are in the world. A child must learn to use and understand these terms (which are generally concerned with the relations between referents rather than the referents themselves). If not then they will not become competent communicators and receivers of information. Being able to understand space, and navigating space is important to many everyday activities; the giving and understanding of instructions, music, mathematics, using maps and so on. Certainly, "it is clear that inefficient use or misuse of spatial terms may handicap a child's progress in a number of areas" (Cox and Ryder-Richardson, 1985, p.612).

The important question is do children use the knowledge that they possess about <u>containing</u>, <u>touching</u> and <u>supporting</u> to form their first hypotheses about spatial meaning? Several studies have shown that children deal with prepositions by applying a few general strategies concerning this knowledge (Clark and Clark, 1973).

I take as the starting point the idea that spatial prepositions are functional and are closely linked with our physical interaction with the world. Thus it would be expected that the most functional prepositions (IN, ON, OVER) would appear first in a child's language. Prepositions that do not heavily rely on a functional account include ABOVE and BELOW.

Clark and Clark (1973) note that if a child of 1;6 is shown a box lying on a table and then given a small toy doll to play with we can be fairly sure that she will put the toy doll IN the box (rather than ON it). If instead she is given a toy crib and a toy cat she will put the cat IN the crib rather than UNDER or BESIDE it. Similarly if given a toy table and toy cat she will put the cat ON the table. It appears that in each situation the child bases her actions on one of two rules about the spatial relations holding between objects and <u>containers</u> or <u>surfaces</u>:

> Rule 1: If B (the stationary object) is a container, A (the movable object) goes inside it.
>
> Rule 2: If B (the stationary object) has a supporting surface, A (the movable object) goes on it.
>
> (adapted from Clark and Clark, 1973)

These rules may be used as a result of limited semantic knowledge and form a non-linguistic strategy (Clark and Clark, 1973). So, toy animals are to be put IN or ON a tunnel, box, truck or crib. Rule 1 takes precedence over Rule 2 since <u>containers</u> always seem to be treated as <u>containers</u> rather than <u>surfaces</u> even when there is an option. So, if these rules are right then they should play a role in children's first hypotheses about spatial prepositions. Clark (1973) examined how children between 1;6 and 5;0 dealt with instructions such as the following. These instructions concerned IN, ON and UNDER.

7 (a) Put the mouse IN/ON the box.

7 (b) Put the mouse IN/UNDER the crib.

7 (c) Put the mouse ON/UNDER the table.

Results showed that children of 1;6 could understand the use of IN as used in examples 7 (a) and 7 (b). However, they were unable to understand the use of UNDER or ON. For example 7 (c), where there is a supporter present, the youngest children appeared to understand ON but not UNDER. Clark (1973) felt that this indicated that the very young children were basing their hypotheses about word meaning on Rules 1 and 2 and as such it made it seem that they always understood IN, that they understood ON with surfaces but not containers and that they did not understand UNDER at all. Clark suggests that ON is harder than IN to acquire because the child has to learn not to apply rule 1 as the use of ON only needs rule 2 (Clark and Clark, 1977). This study shows that children's knowledge about objects and how they interact with one another provides vital information for spatial language acquisition. Comprehension is normally complete by the age of 4, but even after this point children continue to have some difficulty with spatial prepositions (Cox and Ryder-Richardson, 1985). However, the importance of these studies by Clark and Clark is reflected in the fact that children do use knowledge about containing, supporting, and touching whilst developing full use of spatial language. As will be seen in later chapters these notions are vital in a functional account of spatial prepositions. It is also interesting to note that Coventry (1992), in a study of children aged between 3 and 5, found that the sense of OVER predicated by functional factors seems to emerge earliest. There are other "senses" of OVER but these develop later. He also notes that the less functional ABOVE appears later than the functional OVER.

2.7 The Importance of Spatial Language

Everyday we talk about situations and locate them in space (Svorou, 1993). To locate situations and entities in a spatial manner we use expressions such as "BEHIND the sofa", "IN FRONT OF the house" and "IN the bread bin" in order to communicate and interact with others.

It becomes readily apparent that spatial organisation dominates much of our language use and that spatial prepositions are key elements in our language for space. This domain has been investigated many times in the name of spatial cognition. Why has this been so? The spatial domain is ideal as it is a closed set of words (known as a closed-class) and it is also a relatively small area. Also, spatial prepositions have a simple semantic structure. However, within this small area the semantics are surprisingly complex and it is not hard to find circumstances of usage that belie simple logical or geometrical analysis. It has been estimated that there are about 80 to 100 spatial prepositions used by English speakers and so it should, therefore, be of no surprise that there is a limited way in which they can express spatial relationships (Jackendoff, 1992). One may imagine that IN can be termed as "when something is inside something else". Perhaps even that ON can be termed as "when something is on top of something else". The many and varied uses of both IN and ON immediately negate the possibility of either definition. Certainly if one examines Lindkvist's extensive listings for IN and ON it can be immediately realised that there is a much more complex situation under the surface.

2.8 The Geometry Without Angles

It is generally agreed that the representation in Figure 2.1 can be described as "The apple (x) is IN the bowl (y)". However, spatially this is not the case; the apple is not within the spatial confines of the bowl. To imagine such confines one can draw an imaginary line along the rim of the bowl (Herskovits (1986), Vandeloise (1979)).

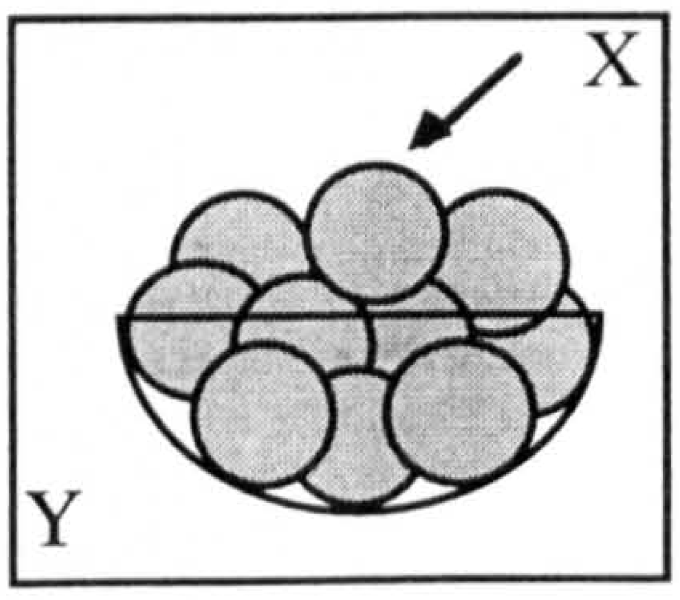


Figure 2.1 - The Apple IN the Bowl.

The many previous accounts of the language used to describe space would describe Figure 2.1 as either unexplained or in the form of a selection restriction. However, it is clear that we can map the sentence "the apple is IN the bowl" onto the world and that it makes sense. As mentioned in Chapter 1 the Functional Geometric theory proposed and experimentally investigated within this body of work presents a functionally based representation of spatial prepositions which is fully discussed in Chapter 6. Such an interpretation then allows cases such as Figure 2.1 to form part of a cohesive theory.

In this thesis spatial prepositions are analysed within a functional framework which I believe recognises and solves many problems found in the previous approaches. I now turn to a discussion of some of the previous analyses that have been proposed to account for the use of spatial language.

Chapter 3

Previous Accounts: The Classical Approach

3.1 Introduction

> "When I use a word", Humpty Dumpty said in a rather scornful tone, "it means just what I choose it to mean - neither more nor less"[3]

This chapter presents accounts of spatial organisation which fall mainly into the "Classical" category. This categorisation is to some extent artificial but is used in order to provide an accessible framework. In the present chapter I provide a definition of the Classical viewpoint then go on to present the semantic accounts of Leech (1969), Bennett (1975) and Cooper (1972). An account such as that of Miller and Johnson-Laird (1976) can be seen as Classical as they do treat locatives as expressing simple spatial relations. However, they also take into account functional factors which are important for a valid semantic theory of spatial language and their work will be discussed further in Chapter 5. Problems concerning accountability of all prepositional cases using these Classical analyses are discussed within this chapter. The problems of simple relations accounts were succinctly listed by Herskovits (1985, 1986) and these are discussed at the end of the chapter.

3.2 The Classical Viewpoint

The Classical viewpoint favours a division between semantics and pragmatics (Coventry, 1992). It typically takes a componential approach to meaning represented by first order logic formulae of simple relations. These formulae state that all instances of a category share a set of properties that are singly necessary and jointly sufficient for membership within the particular category. An example of a simple relation could be given by the following notation:

x ON y: x located surface y.

If this was applied to the following sentence:

The book is ON the table

[3] Carroll, L. (1872). Through the Looking-Glass.

then the book would be represented by x, the table by y and x would have to be on the surface of y.

Basically this simple relation is an example of a core meaning. Such core meanings are often accompanied by other factors. These can include pragmatic information and in some cases functional information. The theory put forward within this thesis claims that any "core meaning" must contain notions of functionality rather than ignoring such notions or having them tagged on peripherally.

In this view reason can be seen as abstract and disembodied as used by a machine. It basically involves the manipulation of abstract symbols and these symbols get their meaning from correspondence in the external world (Lakoff 1987). This traditional view has been held for thousands of years.

The work of Leech (1969), Bennett (1972) and Cooper (1968) can be termed as Classical and are representative of prepositional analyses which rely on what I will call "non-functional cores".

3.3 The Semantic Description of Geoffrey Leech

The work of Leech (1969) can be seen as a minimal specification approach in the classical tradition. His analysis is componential and this involves the assumption that expressions can be contrasted on different dimensions of meaning. These factors are called variously semantic markers, components or semantic features and examples are +HUM/-HUM, +MAT/-MAT, +MALE/-MALE. Such features can be used to define words, for example, woman=+HUM -MALE +MAT and dog=-HUM+MAT. Leech also incorporates the notions of a structural analysis (this involves predication, the cover term for assertions). He states that both a structural and componential analysis are required for a semantic theory. The notations and associated systems of "place" and "dimensionality" proposed by Leech (1969) are now examined.

Leech discusses how language determines locations using "position and dimensionality", "relative position", "extremities and parts of locations", "compass points" and "orientation". Basic to all locative meaning is the system of "place" (see Table 3.1). In all the following definitions and formulae x refers to the referent or object and y refers to the relatum or location.

<u>"Place"</u>

<u>(x) ---> PLA (y) "(x) at/on/in place (y)"</u>

<u>logical properties: asymmetric, irreflexive, transitive, many-one</u>

<u>Table 3.1</u> - The System of Place (Leech, 1969).

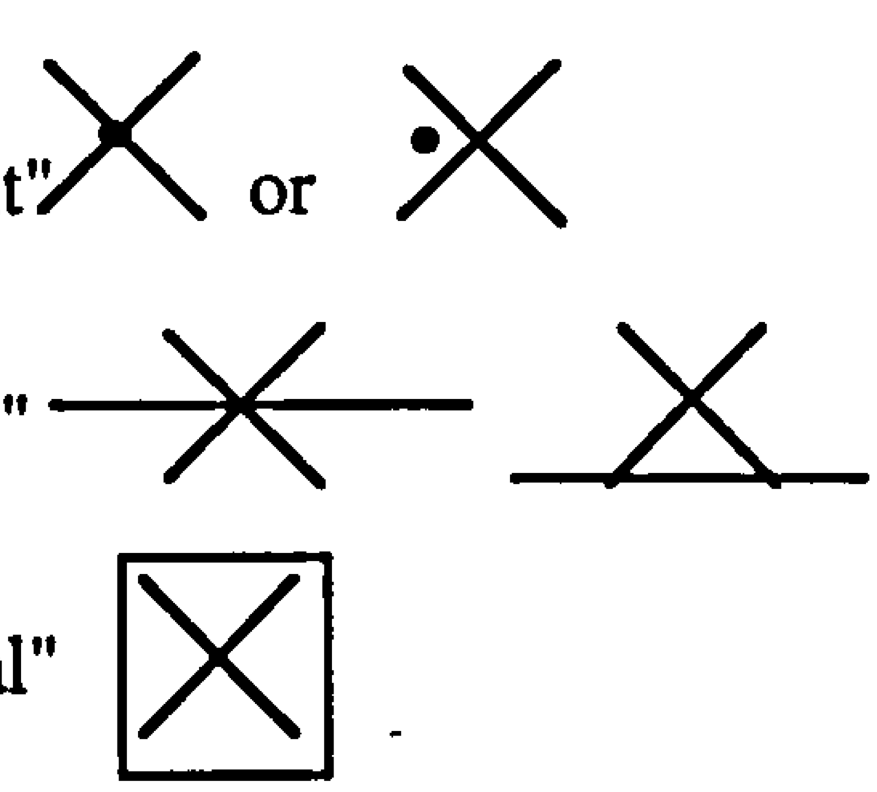
Associated with the system of place is the system of dimensionality. This is used to describe properties of AT, ON and IN (see Table 3.2).

"Dimensionality"

1 DIME "at - no dimension relevant" or

2 DIME "on - one/two dimensional"

3 DIME "in - two/three dimensional"



<u>Table 3.2</u> - The System of Dimensionality (Leech, 1969).

X represents the object or referent. The location or relatum is represented by the black dot, the lines (1 and 2 Dimensions) and by the box (an enclosed 2 or 3 Dimensional space).

Leech does note that the members of this system do not reflect the actual physical character of the location: "These categories have obviously more to do with the human apparatus of visual perception than with the objective physical properties of objects as interpreted, for example, in Euclidean geometry" (p.162). However, this valid point is not taken into consideration in his definitions of spatial prepositions. AT, ON and IN are defined using place and dimensionality as follows:

AT: --->PLA[1 DIME].
ON: --->PLA[2 DIME].
IN: --->PLA[3 DIME].

3.3.1 Leech: The Preposition IN

IN expresses the concept of "enclosure" or "containment" as applied to either two-dimensional or three-dimensional locations which can be areas or volumes. Therefore the final definition for IN can be expressed as:

IN: x in y: x is "enclosed" or "contained" either in a 2D or 3D place y.

Containment is a necessary requisite for IN and this is indeed recognised by Leech. However, it is implicit in this definition that the referent(x) must be smaller than the relatum(y) which is not true for all representations that warrant the use of the spatial preposition IN (for example "The tennis racket was IN her hand"). Neither does it account for cases where there is not total enclosure. This leaves many cases such as "The bulb IN the socket" (Figure 3.1) and "The flowers IN the vase" (Figure 3.2) unexplained:

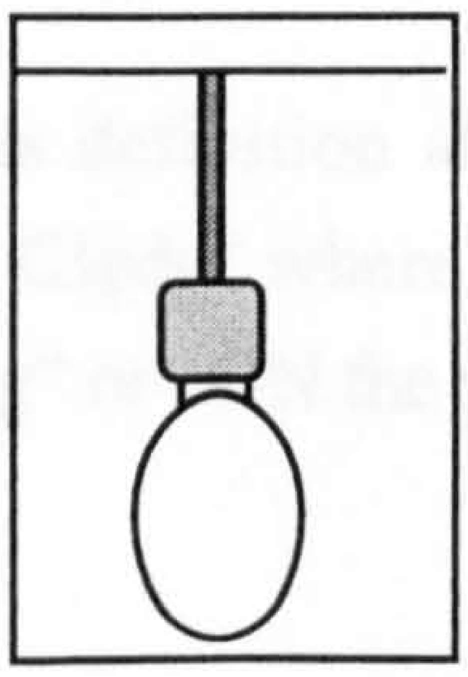


Figure 3.1 - The bulb IN the Socket.

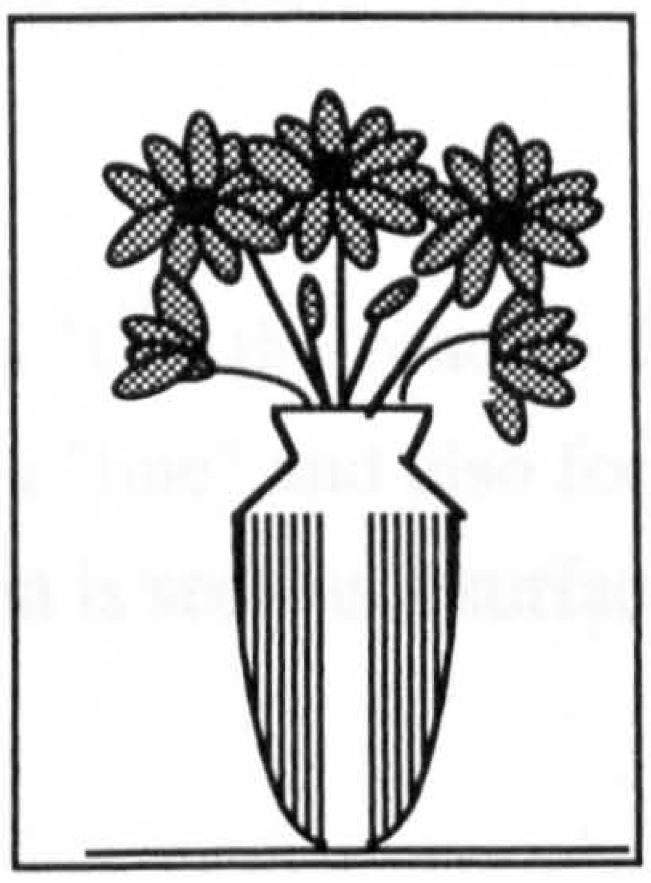


Figure 3.2 - The Flowers IN the Vase.

There are also examples where this definition for IN allows one to use it for cases that would be more normally seen as UNDER (see Figure 3.3). Here the apple is enclosed in a three dimensional place and fulfils its' geometric conditions for "in-ness". The definition is too vague to take account of all the factors that account for our choice of locative.

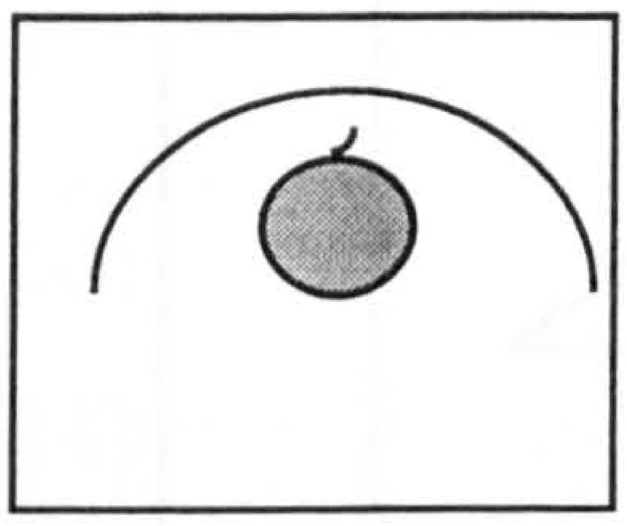


Figure 3.3 - The Apple is UNDER the Bowl.

It is quickly apparent that the core meaning offered by Leech does not account for all uses of the locative IN.

3.3.2 Leech: The Preposition ON

Leech also proposed a definition for ON which expresses the concept of "contiguity" or "juxtaposition" with a line or surface location. The definition given for ON can be expressed as:

ON: x is "contiguous" or "juxtaposed" with the place y, where y is conceived of as either one- dimensional (a line) or two-dimensional (a surface).

Admittedly this definition allows for such cases as "ON the road to Edinburgh" or "ON the River Clyde" where the location is seen as a "line" and also for cases such as "ON the ceiling" or "ON the page" where the location is seen as a surface.

However, if the referent (x) must be contiguous with the relatum (y) then cases such as "The book (x) ON the table (y)" (see Figure 3.4) and "The light ON the ceiling" (see Figure 3.5) are left unexplained. In such representations the spatial relation expressed is false. Leech (1969) suggests that spatial meanings left unexplained by his definitions are either idiomatic uses or should simply be ignored. This is obviously unsatisfactory.

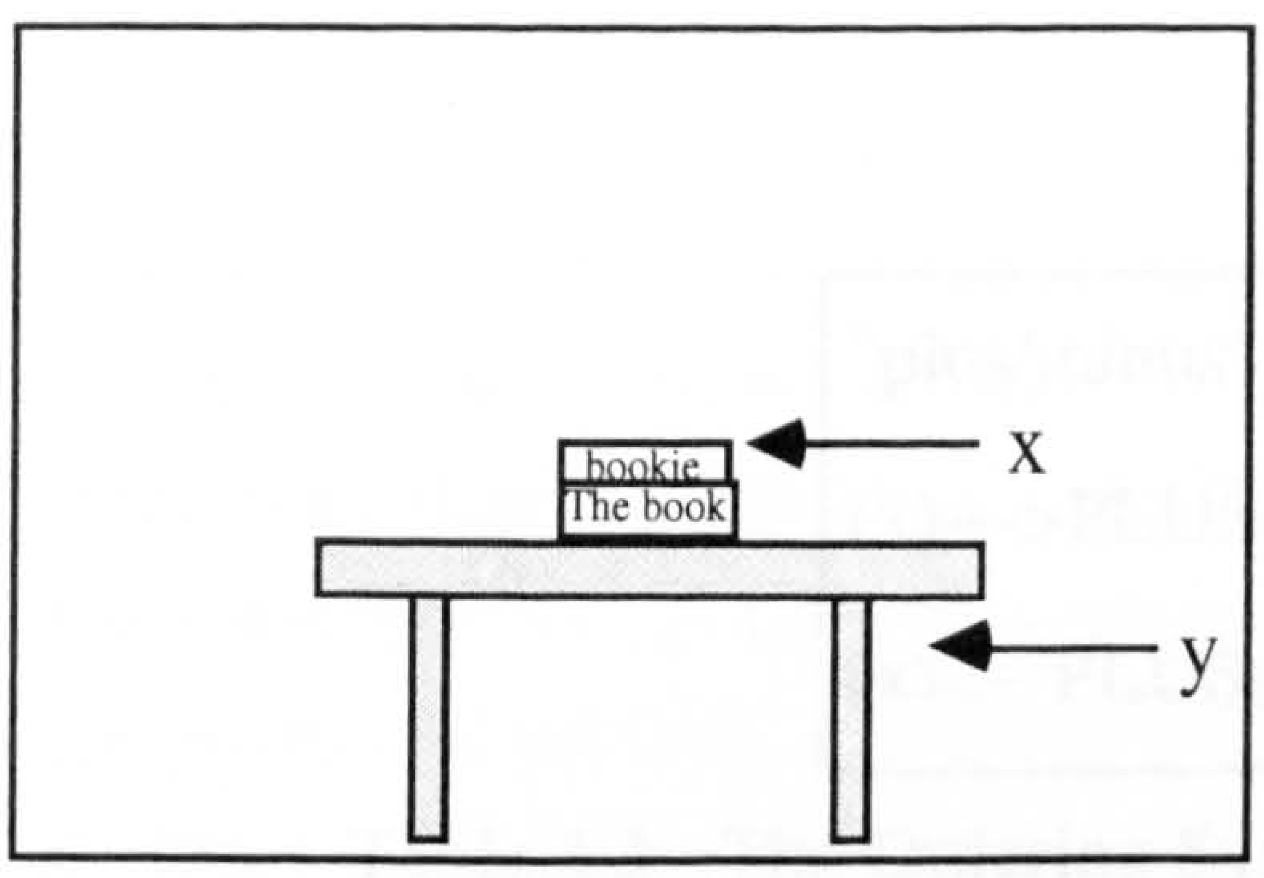


Figure 3.4 - The Book ON the Table.

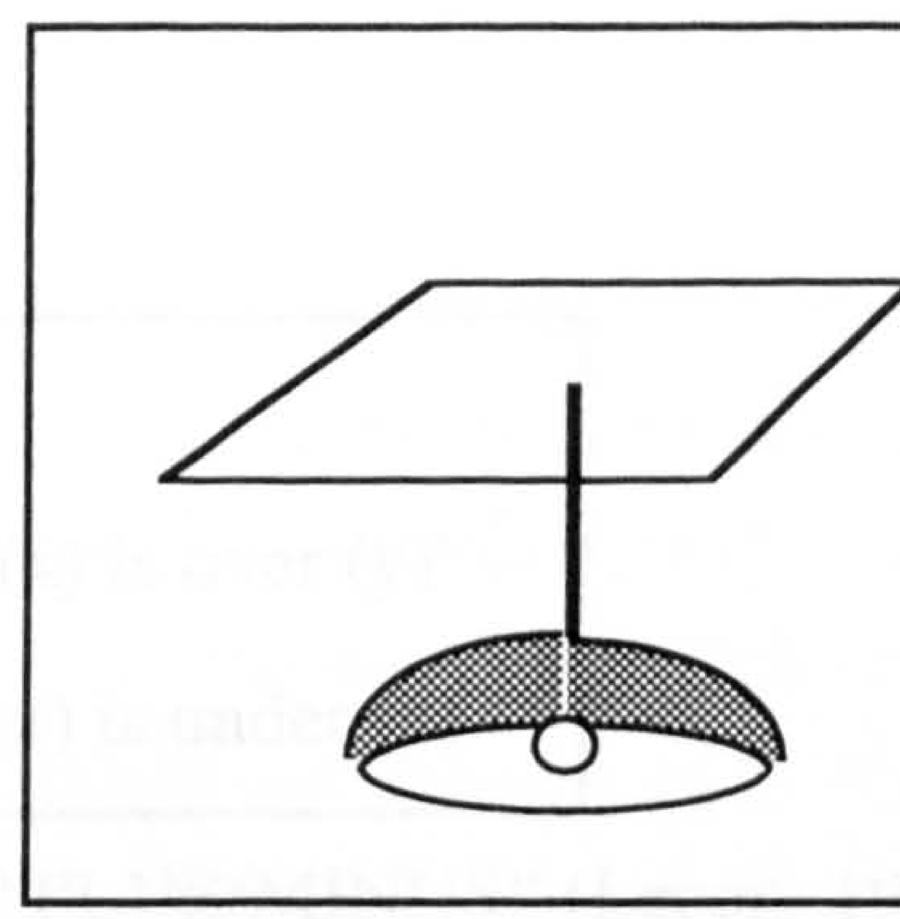


Figure 3.5 - The Light ON the Ceiling.

It is also apparent that there are object representations that comply with this definition of ON which are clearly not seen as ON. Two objects can be contiguous without the referent x being seen as on the relatum y. For example, in the case of Figure 3.6 we could not say that Book A was ON Book B. These books, stacked upright on a shelf, are sitting side by side but A is not ON B. Many other factors are involved and as we shall see in later chapters these are mainly of a functional nature.

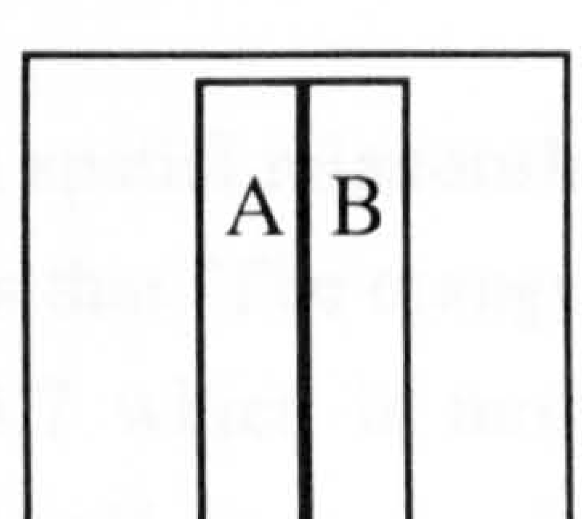


Figure 3.6 - Book A and Book B.

3.3.3 Leech: Definitions for OVER and UNDER

Leech (1969) states that the prepositions OVER and UNDER refer to the relative position of two objects on the vertical axis. The system of verticality (+VER) is an important concept in Leech's definitions of OVER and UNDER as is the ordering system "PLUS/MINUS" which is neutral to the three axes (see Table 3.3). It also takes into account the transitivity of each relation and also the converse nature of these relations.

"plus/minus"	
(x)--->PLUS(y)	'(x) is over (y)'
(x)<--'PLUS(y)	'(x) is under (y)'

Table 3.3 - The Ordering System "PLUS/MINUS" (Leech, 1969).

X is OVER y is represented by the following definition:

OVER(x)--->PLUS(y) +VER.

X is UNDER y is represented by the following definition:

UNDER(x)<---PLUS(y) + VER.

The notion for OVER relies on a spatial relationship. It is seen on the +Vertical axis and such a definition would mean that "The orange is OVER the bowl" should be the constant definition of Figure 3.7 which is more commonly represented by the statement "The orange is IN the bowl".

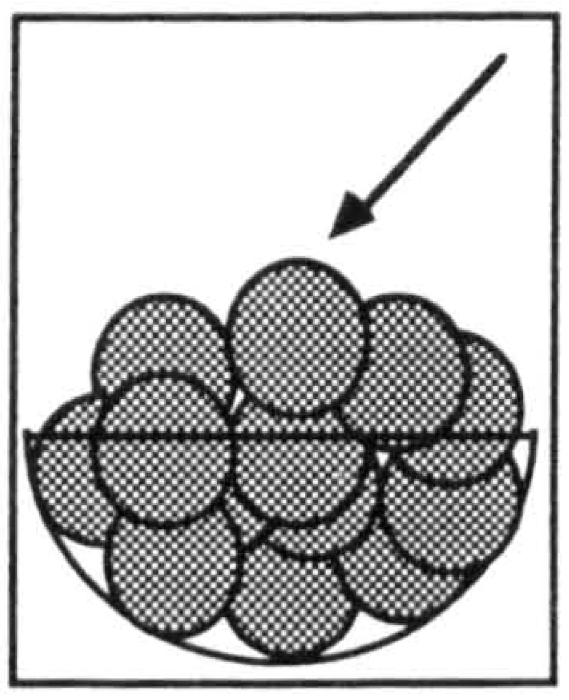


Figure 3.7 - The Orange is IN the Bowl.

Leech comments that there are slight differences between OVER/UNDER and ABOVE/BELOW. The first pair tend to indicate a direct vertical relationship which can be seen as "right above" and "right below" whereas ABOVE and BELOW mean little more than "higher than" and "lower than". Basically Leech correctly implies that there is a functional relationship involved in the use of UNDER or OVER that is not present in ABOVE and BELOW. The functional account of OVER is presented in Chapter 6. Leech explains these differences with the following examples:

The kitchen is BELOW the bathroom.

The kitchen is UNDER the bathroom.

In the first example we may simply mean that the bathroom is on a lower floor but in the second example we are making it clear that the bathroom occupies roughly the equivalent position on a lower floor.

3.4 Bennett: Stratificational Semantics

Bennett (1975) does not even attempt a fully comprehensive account of prepositional semantics and leaves open the question of whether or not the "spatial" uses of a preposition can be accounted for in a single definition. He presents a componential approach to the meaning of words. Bennett states that the prepositions IN and ON form part of locative sentences and that such sentences specify where something is located. Bennett's proposed componential definitions for the eleven prepositions whose meaning are locative are as follows:

ABOVE: “locative higher”.

AFTER: “locative posterior time”.

(A)ROUND: “locative surround”.

AT: “locative”.

BEFORE: “locative anterior”.

BEHIND: “locative posterior place”.

BELOW: “locative lower”.

BEYOND: “locative path locative”.

BY1: “locative proximity”.

BY2: “locative goal time”.

DURING: “locative path extent time”.

IN: "locative interior" or "in y:locative (interior(y))".

IN BACK OF: “locative posterior place”.

IN FRONT OF: “locative anterior place”.

INSIDE: “locative interior of side”.

ON1: "locative surface".

ON2: “locative interior”.

ON3: “locative”.

OUTSIDE: “locative exterior of side”.

OVER: “locative superior”.

SINCE: “locative source time”.

UNDER: “locative inferior”.

The first and most obvious problem is that the focus here is between words and other words rather than with words and how they relate to the world. This sketch is very basic and his ideal meanings do not cover all possible uses of spatial prepositions.

3.4.1 Bennett: The Preposition ON

Bennett does note that contact is an important concept of ON and his definitions allow for both "The picture ON the wall" and "The book ON the table". However, in order to achieve this he gives three definitions of ON; “locative”, “locative interior” and “locative surface”.

Without actually mentioning the notion of “support” Bennett notes that we often mean "on top of" due to the need to take into account the force of gravity. This notion forms an integral part of the functional account that is proposed for ON in Chapter 6. Bennett does not actually use the term “support” but notes that although the fly can be ON the table leg (Figure 3.8), the book cannot (Figure 3.9).

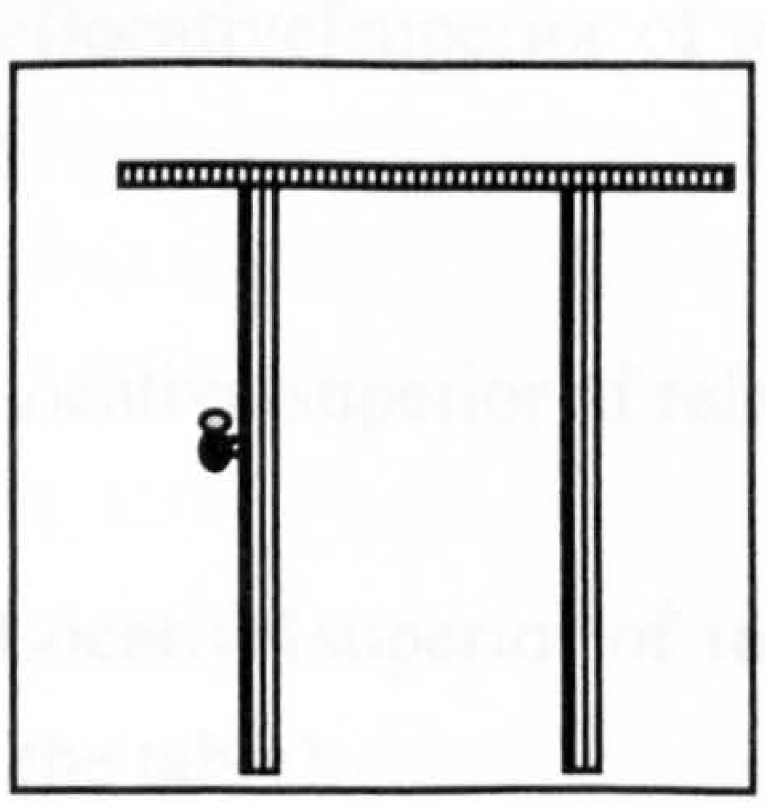


Figure 3.8 - The Fly ON the Table Leg.

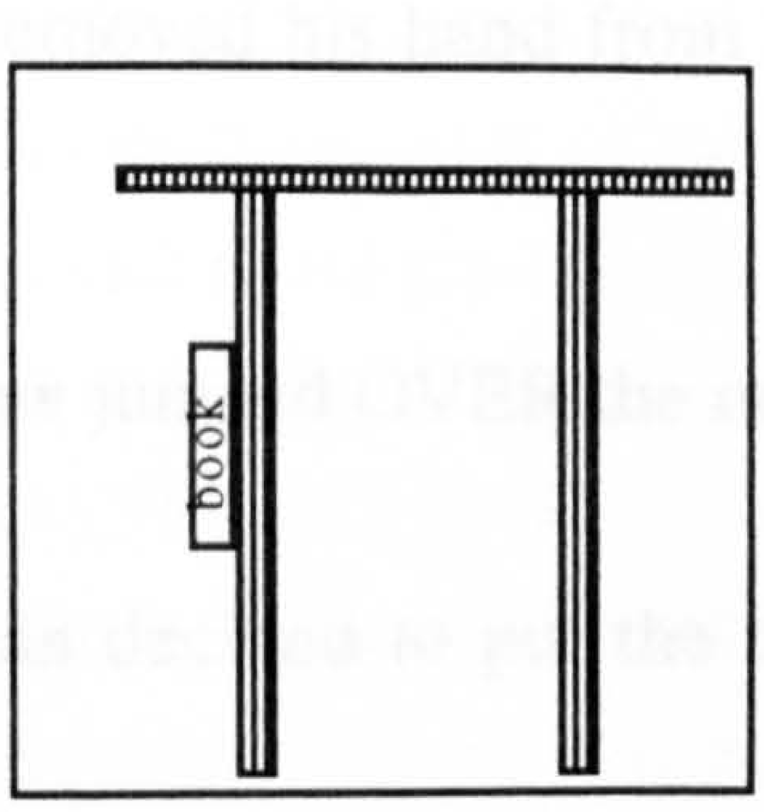


Figure 3.9- The Book ON the Table Leg?

The book cannot stay in this situation as there is no gravitational support; it must be attached in some way. The fly, owing to certain properties of its feet can easily support itself in this way. However, if this attachment of book to table, say by obvious glue or tape, is made clear perhaps one would be more likely to say "The book is ON the table leg" rather than "The book is attached to the leg of the table".

3.4.2 Bennett: The Preposition IN

The definition for IN is simply given as “locative interior”. This is very basic and has the problem of not being able to account for examples previously given in this chapter. This includes spatial configurations where the referent is larger than the relatum as well as cases where the referent is not even partially included in the relatum.

3.4.3 Bennett: The Preposition OVER

Bennett, with regard to OVER, does recognise the importance of examining all expressions of the locative. This is one criterion that must be met in the quest for a viable minimal specification of spatial prepositions. The semantic representations have been adapted from Bennett (1975) and examples for each representation are given in brackets:

[locative [superior of relatum] place] (The helicopter OVER the target).

[Source[locative[superior of relatum] place]] (He removed his hand from OVER the candle).

[Path[Locative[superior of relatum] place]] (The cow jumped OVER the moon).

[Goal[Locative[superior of relatum] place]] (Gillian decided to put the table-cover OVER the table).

[Locative[Path[Locative[superior of relatum] place]] place] (The church is OVER the hill).

[Source[Locative[Path[Locative[superior of relatum] place]] place]] (The crowd appeared from OVER the hill).

These examples of OVER help to explain the complexity of the preposition and the challenge that it presents to any minimally oriented approach.

Bennett works from within the classical approach but makes no claim to have found a minimal specification to cover all the uses of IN, ON and OVER. Indeed, it must be recognised that much of this work was carried out in reaction to the kind of dictionary type approach given by Lindkvist (1950) whose work was briefly discussed in Chapter 2.

3.5 Cooper: A Semantic Analysis

Gloria Cooper (1968) presents an analysis of thirty three English locative prepositions. She states that a preposition is analysed in two stages:

1. Function concepts pick out the relevant characteristics (those which are semantically salient) of objects to be related.

2. A relation concept is specified describing the relation between the function values.

This two stage analysis results in a relation marker in the form of R (f(x), g(y)). R is the relation marker, f and g are the function markers and x and y are the objects to be related. The semantic markers are formal symbols standing in for a concept. For example, C(X,Y) is a marker which stands for X is CONTIGUOUS with Y. C is a two-place relation which holds between X and Y when they are in contact, very close, adjacent or in juxtaposition (Cooper, 1968). Prepositions are assigned simple relational meanings and Cooper (1968), as do some other "Classical" accounts, states preconditions (Herskovits, 1986) or selection restrictions.

3.5.1 Cooper: The Preposition IN

Cooper proposes the following definition for the locative IN:

IN: x in y: x is located internal to y, with the constraint that x is smaller than y.

The precondition for this preposition is that x must be smaller than y. This allows for the following selection of examples, as given by Cooper:

The elephant IN the zoo.

The flowers IN my room.

The drawer IN my desk.

The crack IN the wall.

A bee IN my bonnet.

For example, if we take the sentence "The jumper is IN the drawer" a simple compositional rule would be applied: The jumper will be located internal to y, and the jumper will be smaller than the drawer. This kind of meaning representation involves a first order logic formula that represents the necessary and sufficient conditions for "The jumper is IN the drawer" to be true.

Although the examples given can be explained by Cooper's notation it is immediately clear that many uses of the spatial preposition IN have been not explained by this minimal specification. The referent x does not have to be smaller than the relatum y.

This definition, in common with those proposed by Bennett and Leech, does not cover all uses of IN.

There are many spatial configurations that are not explained, for example:

The truncheon IN her hand.

The caveman had a club IN his hand.

In both these configurations the referent x is larger than the relatum y. The notation also states that the referent (x) must be "located internal" to the relatum (y). Again, this does not allow for many uses. In many cases the referent is only located partly internal to the relatum:

The spoon IN the mug.

The key IN the door.

The bulb IN the socket.

The pagemark IN the book.

3.5.2 Cooper: The Preposition ON

Cooper also proposes a minimal definition for the locative ON as follows:

ON: x on y: A surface of x is contiguous with a surface of y, with the constraint that y supports x.

The precondition that y must support x is an important one as it recognises a non-geometric factor. Support is seen as a physical notion. This notion of support is presented not as part of the core meaning but rather as a precondition. This notation allows for the following examples, given by Cooper:

The nose ON his face.

The desk ON the floor.

The book ON the table.

The fly ON the ceiling.

The picture ON the wall.

The car ON the street.

The blood ON his hands.

The paint ON the wall.

However, this notation does not account for situations where there is no contiguity yet the referent is still described as ON the relatum (as in Figure 3.4).

3.5.3 Cooper: The Preposition OVER

The spatial preposition OVER is certainly more complex than either IN or ON. Cooper (1968) puts forward two notations for this preposition. The first notation can be represented as follows:

X OVER1 Y: X is located internal to the space Z, a bottom boundary of which is contiguous with the top of Y, with the constraint that X and Y are separate.

Cooper states that this notation is a synonym of ABOVE and it can account for the following examples:

The plane OVER the city.

The shelf OVER the desk.

The moon OVER Manhattan.

The mist OVER the water.

The second notation suggested by Cooper, X OVER2 Y, is not synonymous with ABOVE and has the selective semantic restriction SR, as follows:

SR < x flexible solid or liquid >, the back of x is contiguous with at least the top of y.

This restriction incorporates a sense of covering and allows for the following examples:

The blanket OVER the bed.

The frosting OVER the cake.

The water OVER the floor.

There is no recognition of functionality and it is important to note that Cooper considers each use of OVER as an independent lexical item and employs numerical subscripts to distinguish these homonyms (Hawkins, 1984).

3.5.4 Summary of Cooper

In summary the notations described by Cooper within the Classical framework do not account for the uses of IN, ON and OVER which are primarily focused on in this thesis. I now turn to a "Classical" account which does provide a more comprehensive and psychologically valid account of these locatives.

3.6 The Analysis of Miller and Johnson-Laird

The account presented by Miller and Johnson-Laird (1976) does to some degree account for functionality and accordingly these functional notions are discussed in Chapter 5. However, it is important to note that their notations do not recognise functionality as central and can be seen as simple relations within a classical framework.

3.6.1 Miller and Johnson-Laird: The Preposition IN

The notation provided for IN is as follows:

IN(x,y): A referent x is 'in' a relatum y if: (i) [PART(x,z) & INCL(z,y)].

The term PART stands for "partially" and the term INCL stands for "included spatially in". In an examination of this locative Miller and Johnson-Laird recognise that the referent (x) can be larger than the relatum (y) and that there may be cases when there is only part inclusion rather than total inclusion. Recognition of these factors is essential for a valid account of spatial prepositions. However, this definition does not provide an account of cases where the referent (x) is not even partly included within the relatum (y) (see Figure 3.7) or where the use of IN would be unacceptable to the language user (see Figure 3.3).

3.6.2 Miller and Johnson-Laird: The Preposition ON

The assertion for ON is as follows:

ON(x,y): A referent x is 'on' a relatum y if: (i) [INCL(x, REGION(surf(y))] & SUPRT(y,x): otherwise go to (ii) PATH (y) & BY (x,y).

In this definition the term INCL stands for "included spatially in", SUPRT stands for "support", REGION stands for "the region of interaction with the surface" and *surf* stands for "has the total surface". The inclusion of PATH and BY means that we can interpret uses of ON that involve edges by seeing the relatum as a path. This means that the following cases can be represented by this definition:

The cabin ON the lake.

The house ON Alma Road.

Miller and Johnson-Laird also attempt to deal with so-called "transitive" uses of ON. A transitive use of ON can be visually explained by Figure 3.10. In this example the book x is not actually contiguous with the table y yet can still be referred to as "ON the table".

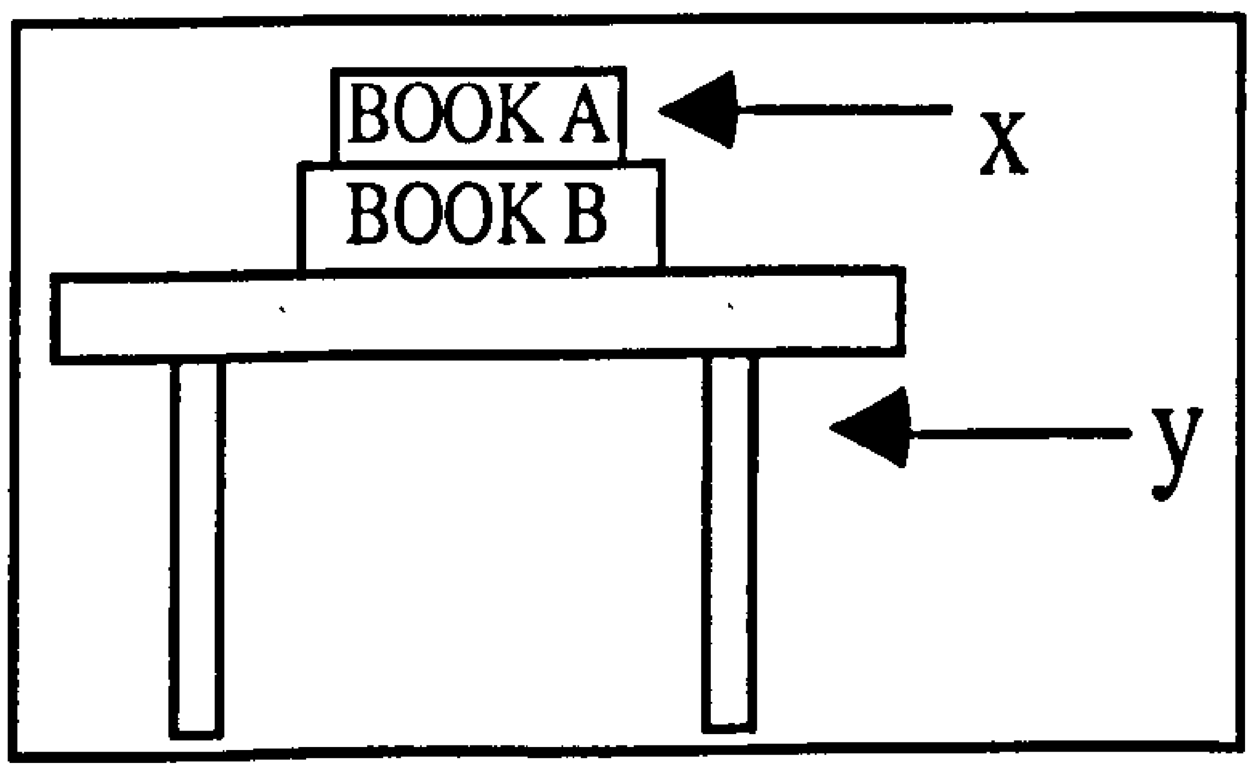


Figure 3.10 - Book A is ON the Table.

They note that one can say "the table ON the floor" even if there is a rug in between the table and the floor. Mention of "ON the rug" can be ignored due to the transitivity of the support relation. Miller and Johnson-Laird do note that there is a limitation on this apparent transitivity: Although the book in Figure 3.10 may be "ON the table" one cannot say that the book is "ON the floor". They state that there is a sub-domain of search for the preposition ON that must be within the REGION of interaction with the relatum surface. Using their own example Miller and Johnson-Laird comment on this transitivity:

> We cannot say the lamp (on the table on the rug on the floor) is on the floor because when we search in the region of the floor we will not encounter it. Hence the limited transitivity of "on" as used to describe a pile of objects.
>
> Miller and Johnson-Laird (1976), p.387

There are problems with this view of a transitive ON. It fails to account adequately for the following examples given by Herskovits (1986) (see Figure 3.11 and Figure 3.12). In both Figures the lid is within the same domain of search or region of interaction yet one would only say "the lid ON the table" of Figure 3.12. Indeed, Book A from Figure 3.10 is seen as "ON the table" although it is no further away from the table than the lid in Figure 3.11. It quickly becomes apparent that there must be more than just limited transitivity involved in our use of the preposition ON.

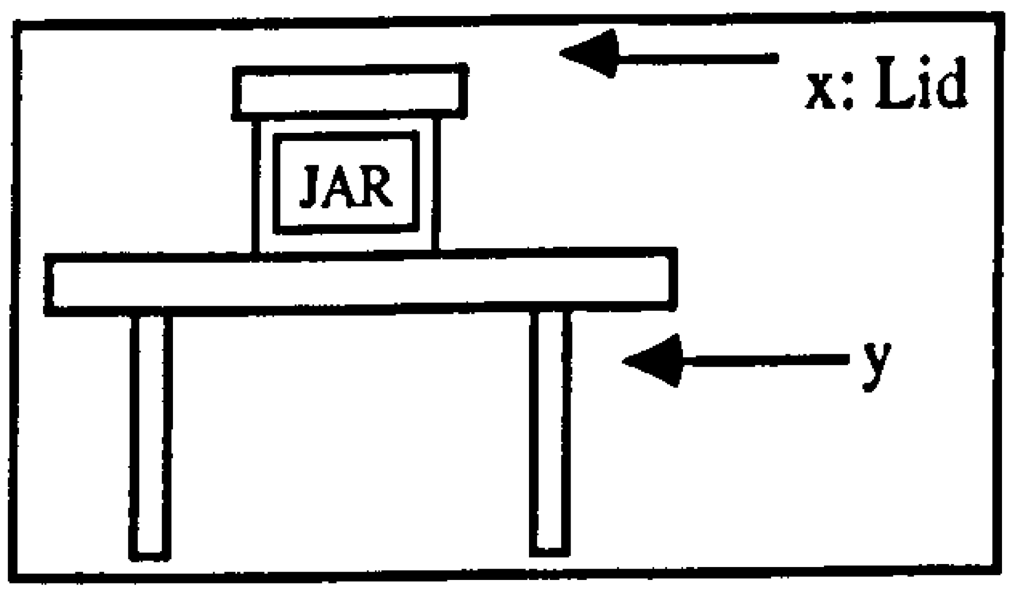


Figure 3.11 - The Lid is ON the Table?

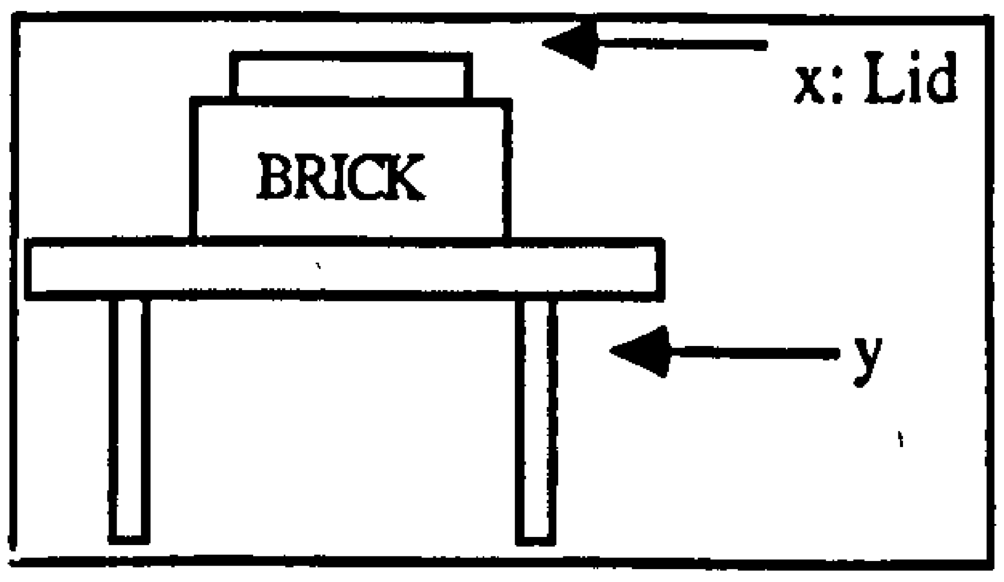


Figure 3.12 - The Lid is ON the Table.

3.6.3 Miller and Johnson-Laird: The Preposition OVER

Miller and Johnson-Laird (1976) briefly discuss the locative OVER and also make some brief comments about the vertical dimension that applies to this preposition. They recognise that "it is probably gravity that makes the vertical dimension unique"(p.397). As we shall see notions of gravitational force are important in the functional account of OVER. Their suggested notation for OVER is given as follows:

OVER(x,y): A referent x is 'over' a relatum y if x is vertically above y and Betw (x,y,earth).

However, this notation does not account for cases where there is contact, such as "The cloth OVER the table" or "Put your jumper on OVER that top".

3.7 Evaluation of the Classical Approach and Simple Relations

3.7.1 A Minimally Based Approach

The approaches discussed in this chapter fail to account for linguistically acceptable uses of spatial prepositions. The simple relations accounts fail to account for many cases of IN, ON and OVER. It is certainly not satisfactory to write off such cases as "idiomatic" as language users certainly do not feel such cases to be odd or strange in their use. Certainly, the minimal approach using core meanings is intuitively appealing. However, the core meanings must account for more than just "geometric" information. The function of objects provides us with vital information about prepositional use. We interact with the world as we see it and not as physicists or mathematicians would wish us to see it.

The following chapter presents approaches that fall within the Cognitive Linguistic field. The negative and positive aspects of both Classical and Cognitive Linguistic approaches are then discussed at the end of Chapter 4. At this juncture I note that the so-called Classical approaches discussed involve a minimal specification of lexical entries, the need to find necessary and sufficient conditions and a rather objective, abstract view of the world. The functional approach presented in this thesis favours minimal specification and I feel that this does not necessarily mean adopting a Classical or Objective (Lakoff, 1987) view of the world.

3.7.2 Problems with Simple Geometric Relations

Finally it is important to recognise the various problems found with the use of simple geometric relations as definitions of spatial use. It is hoped that this chapter has highlighted the problems and I now present a summary, adapted from Herskovits (1988), of the insufficiencies of simple geometric relations.

Firstly, it should be noted that simple geometric relations refer to figures, points and surfaces associated with objects and not to the actual objects. So, in the sentence "The hotel is ON the road to Edinburgh" the hotel is seen as a geometrical point and the road is seen as a line. Also geometric conceptualisations exist where the whole is used to represent a part of the object (synecdoche). Herskovits presents the example shown in Figure 3.13 where the base of the house is actually the only part that is ABOVE the building. The entire house and building are used to represent the base.

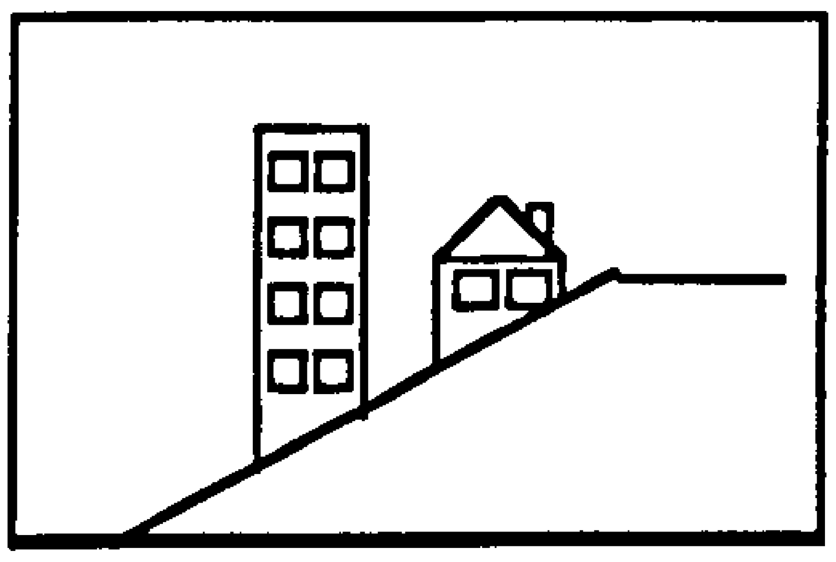


Figure 3.13 - The House ABOVE the building.

Another failure of the approaches discussed in this chapter is the fact that the geometric relations provided are insufficient and do not hold true. Indeed, the geometries provided do not adequately describe use of spatial relations (Crangle and Suppes, 1989). For example, an account such as that of Leech (1969) presents simple geometric relations which do not hold true. Figure 3.4 shown earlier in the chapter can be expressed as "The book ON the table" even though there is no contiguity and only indirect support. Similarly, Figure 3.7 can be described as "The orange IN the bowl" even though the orange is not within the geometric confines of the bowl.

The simple relations presented do not fair well with respect to certain context dependencies that occur in prepositional use. Herskovits (1985, 1986, 1988) uses the following as an illustrative example:

> *Jim is at the supermarket*
>
> The appropriateness of this sentence does not depend solely on Jim's position with respect to the supermarket, because if both speaker and addressee are in the supermarket the sentence is inappropriate - one would then be likely to say instead:
>
> *Jim is in the supermarket*
>
> Herskovits (1988), p. 279

Simple geometrical relations are unable to explain the difference between the use of IN and AT in these examples. Herskovits (1988) also recognises the unexplained restrictions that occur with geometrical relations. Geometric relations hold true for the use of UNDER to describe Figure 3.1 and the use of IN to describe Figure 3.3, however, the language user would not choose these respective prepositions to describe the configurations.

The main tenets of the Classical view have been presented in this chapter and the problems with simple relations evaluated. I now turn to a consideration of semantic analyses using the Cognitive Linguistic approach.

Chapter 4

Previous Accounts: Cognitive Linguistic Approaches

4.1 Introduction

This chapter presents Cognitive Linguistic accounts of spatial language that use a polysemical or prototype approach. In Chapter 1 the basic tenets of a prototype semantics approach were discussed. In this chapter I provide a definition of Cognitive Linguistic approaches and discuss the prototype notions used within them. Certainly the work of Herskovits (1986), Vandeloise (1991) and Cienki (1989) cannot be ignored as Cognitive Linguistic approaches incorporating prototype notions. These analyses of spatial language will be briefly discussed in the present chapter. However, this work will be dealt with more fully in Chapter 5 when focus is placed on functional recognition.

The closely related work of Brugman (1981), Lakoff (1987) and Brugman and Lakoff (1988) is explained and their approach is then evaluated. I also discuss the analysis of the Dutch preposition IN presented by Cuyckens (1991, 1993). An evaluation and criticism of these approaches is also presented. Various aspects of both the Classical and Prototype based theories are considered as useful in the present functional approach; these are discussed at the end of this chapter.

4.2 Lakoff and Brugman: A Cognitive Linguistic Approach to OVER

4.2.1 The Basic Tenets of the Approach

Brugman's 1981 thesis presents a polysemical, extensive analysis of the spatial preposition OVER. Later work by Lakoff (1987) and also Brugman and Lakoff (1988) further defines this prototype oriented approach. Basically, this work analyses the senses of the polysemically treated item OVER. These senses are proposed to form a radially structured lexical network with the central sense being prototypical (Brugman and Lakoff, 1988). Their meaning chain analysis of OVER focuses directly on the nature of prototype effects and this approach to semantics opts for a full specification of word meaning: polysemy is recognised fully and prototype notions are employed. The relevant issues that have just been raised in this brief biopic will be fully discussed. First, I discuss the shift from Classical to Prototype based theories and present some important philosophical considerations.

4.2.2 The Transition from Classical to Prototype

The Cognitive Linguistic approach to the semantics of spatial prepositions can be seen as a departure from the more traditional Classical approaches, as discussed in Chapter 1. The traditional view is linked to the now familiar Classical theory which states that categories are defined in terms of the common properties of their members. Such an approach states that we can decompose words into semantic primitives. Word meaning is seen basically as an autonomous linguistic phenomenon that involves necessary and sufficient conditions for defining a category.

However, there has been a large shift within cognitive science from Classical to Prototype based accounts. General reasons for this shift were shown and questioned in Chapter 1. However, at this juncture I am interested in the philosophical reasons for a shift as given in a spirited argument by Lakoff (1987).

4.2.3 Objectivism Versus Experientialism

Lakoff (1987) argues that Classical or Objectivist views wrongly eschew the idea that language use involves the mechanical manipulation of abstract symbols. He states that such a view implies that the mind is similar to an abstract machine. He also attacks the Classical accounts on the grounds that pragmatics are not included in any analysis (these spatial semantic accounts did not take into account the pragmatics of the situation as it was felt that this was a separate issue and not relevant to the semantics of the preposition in question). Indeed, extralinguistic knowledge is all but ignored. He also condemns these approaches because their characterisation of concepts does not involve a recognition of the interaction between the human body and the environment. Lakoff points out the fact that Classical theory was not even seen as a "theory" as it was just wholeheartedly accepted, without question, by scholars throughout history.

Wittgenstein (1953) recognised a problem with the Classical view, now recognised by supporters of prototype semantics, and a famous passage from his *Philosophical Investigations* succinctly notes these concerns:

> Consider for example the proceedings that we call "games". I mean board-games, card-games, ball-games, Olympic games, and so on. What is common to them all? Don't say: "there must be something common or they would not be called "games" - but look and see whether there is anything common to all - For if you look at them you will not see something that is common to all, but similarities, relationships, and a whole series of them at that. To repeat: don't think, but look!
>
> Wittgenstein (1953) p.31-2

Wittgenstein stated that the necessary and sufficient conditions cannot represent all the things that many word meanings denote. He thought that these similarities would be better characterised as "family resemblances". Certainly these views prepared researchers for the prototype evidence given by Rosch (discussed in Chapter 1).

Lakoff (1987) presents an Experientialist view which comes under the umbrella of Cognitive Linguistics. By understanding the experientialist approach taken by Lakoff we can better understand his treatment of spatial relations and discover the philosophical considerations that are sympathetic to a functional view.

Lakoff argues that there is a case for prototypes and that decomposition into semantic features does not occur (see Kintsch, 1974). In the experiential view, language is not seen as a separate phenomenon and linguistic information is not seen as modular. So this view, unlike the Classical, does not recognise a difference between semantics and pragmatics. The Cognitive Linguistic approach does not accept that there must be necessary and sufficient conditions met for category membership.

Experiential realism states that thought is <u>embodied</u>. This means that the structures that are used to put together our conceptual systems grow from our own bodily experience and make sense in terms of it. Basically, the use of concepts is closely tied to our processing capacities and interaction with the world around us. Thought is seen to be imaginative; unlike Classical theory it is not seen as just a mirroring of our external reality (Lakoff, 1987).

These considerations of experiential realism use prototype theory as the method for representing meaning and there is also an emphasis on extensive polysemy. Models are used to represent the meaning of spatial prepositions. I now turn to a discussion of the prototype notions employed, polysemy and the use of cognitive models.

4.2.4 Polysemy

The notion of polysemy is central to the work presented in this chapter. Polysemy can be described as a single lexical item with distinct but related senses attached to it. As John Lyons (1969) neatly explains, polysemical words are those that are not regarded as being different enough to warrant being described as distinct words. A good way to discuss polysemy is to compare it to homonymy. If two words are described as homonyms then they are regarded as being unrelated. This means that they may be spelled differently or that they have completely different histories (epistemologies). It is generally regarded that the related meanings found in polysemy are being related in a historical manner. Another important fact about a polysemous word is that it is taken as a single lexical item.

The use of "polysemy" by Brugman and Lakoff is slightly, but crucially, different to the definition just given. The preposition OVER belongs to several lexical categories and therefore cannot be termed as a single lexical item. Instead of recognising this familiar idea of polysemy Brugman (1981) recognises what she calls a "functional shift" and notes that "making a case for OVER as an example of polysemy is a complex endeavour" (p.1). This recognition of more than one lexical item means that this work advocates a fully specified lexical account and Brugman describes OVER as a polyseme "which is in essence a category of categories" (p. 5).

Brugman (1981) notes that if there is a historical relation between two "related" senses then it is important to know how the derived sense got derived in the first place. So there is a claim that a concept should be understood with reference to its development, in this case via experientialist notions. Also the approaches taken by Brugman and Lakoff reject the "core sense" approach to polysemy. This is where a core meaning is given and then a full specification is given of idiomatic or restricted uses. The work of Annette Herskovits (1985, 1986, 1988) is such an approach and her work represents a middle point between the Classical and the Cognitive Linguistic as she presents a Cognitive Linguistic account which proposes idealised core meanings and then specifies use types for these ideal meanings. Similarly Vandeloise (1991) presents a full specification approach recognising the importance of functionality. He presents usage rules for French spatial prepositions which ideally consist of a single rule or core. Similarities and regularities in the use of a preposition are also presented and these are basically family resemblance concepts. Another full specification, core meaning approach is given by Cienki (1989). He examines prepositions in English, Polish and Russian using use types and conditions. The work of Herskovits, Vandeloise and Cienki all, to some extent or another, recognise the importance of functionality and will be discussed fully in Chapter 5.

4.2.5 Prototype Notions

Brugman (1981) pre-supposes that polysemes have "primary" senses from which "non-primary" ones are extended. The extension from a central or primary sense is a basic factor in prototype semantics. Brugman states that her work relates to the pioneering work of Rosch (discussed in Chapter 1). In alignment with Rosch, Brugman suggests that the central member of a category is the "best example" of the category, in other words it has the largest number of characteristics associated with the category. Rosch (1977) also states that there is another type of prototype categorisation in operation. This is one where no single central member has all the features associated with the category. In this type there are several members that are clustered around the centre, each of them possess the characteristic features but none has them all. So some of the non-central members may bear little resemblance to each other. An object can exist on the edge of two categories if it contains elements of both.

Brugman (1981) notes that the work of Coleman and Kay (1981) extended these physical object findings to an investigation of linguistic categories. They examined the verb LIE and suggested that this semantic category exhibits three elements by which individual instances can be judged to see if they belong to the category. These elements are as follows:

1. the falsity of the statement.

2. the speakers' belief that the statement is false.

3. the speaker's intent to deceive the addressee.

These may have differing levels of importance, so one element might be more important than another in determining category membership.

The description that Brugman gives relies heavily on prototype semantics and not the necessary and sufficient conditions found in the classical or minimal approach. She attempts to define elements which determine the degree to which an object configuration or scene can be described as OVER and as such her work reflects more closely on Rosch than Coleman and Kay. Basically, Coleman and Kay examined appropriateness based on the situation described, so if LIE was ungrammatical it was not seen as a member of the category. Brugman states that she is primarily examining the grammatical uses of OVER and therefore the central members of the category. Deviations from the prototype are not progressions from grammaticality to ungrammaticality they are deviations from one sense of a polyseme into other senses (Brugman, 1981). However, LIE is a category that only has one level or sense.

In a discussion of prototype theory Lakoff (1987) notes that there is no evidence that prototypes are directly, mentally represented. Basically, "goodness of example" ratings should not be seen as a direct reflection of category membership. Lakoff (1987) uses an example from the Aboriginal language of Dyribal to show that some categories do not seem easily explained by prototypes. In Dyribal the category BALAN classifies objects which include women, dogs, the sun and stars, most birds and anything to do with fire or water. Lakoff notes that it would be very hard to say that there is a prototype or best example and suggests that there are central members, for example "woman" in BALAN which are then linked to other members. So "woman" could be linked to "fire" which is linked to the "sun" and so on. Idealised models are suggested to characterise the links. It should be noted that even though Lakoff says we should not fall into the trap of using prototypes as a reflection of category membership he goes on to rely heavily on prototype notions in the analysis and representation of OVER.

This approach utilises prototype ideas in an analysis of OVER and there are two levels of prototype structure. The following is adapted from Brugman and Lakoff (1988):

1. Each sense of OVER is a complex topological structure (semantic content). At this level prototypicality concerns the degree of fit of some real world relations to an individual sense of the word.

2. All the senses form a radial category (structure in the lexicon). The central sense is the prototypical sense of OVER.

What exactly is this prototype represented on Level 2? In order to answer this question one needs to understand their use of prototype notions as previously discussed. It is also necessary to discuss the use of idealised models and radial categories in the meaning chain analysis.

4.2.6 Idealised Cognitive Models and Radial Categories

Lakoff (1987) states that we should beware of misinterpreting prototype effects. He advocates using cognitive models which attempt to understand what kind of prototype effects actually exist. He proposes that Idealised Cognitive Models (ICMs) are needed in order to give a theoretical underpinning to prototype theory and argues that they are used to organise knowledge. Such models have over-simplified background assumptions and can include the beliefs or myths of a culture (Lakoff, 1987).

A radial category structure is a type of ICM. Basically, for a preposition a central prototypical sense is recognised which may be very specific. Polysemy is accepted and this occurs when the preposition is related closely to the prototype instance, but is in fact distinct from it. These related meanings are organised radially around the prototype sense in a centre-periphery schema. Sub-categories are linked to the centre by various links. Figure 4.1 shows a hypothetical graphical representation of such a radial organisation.

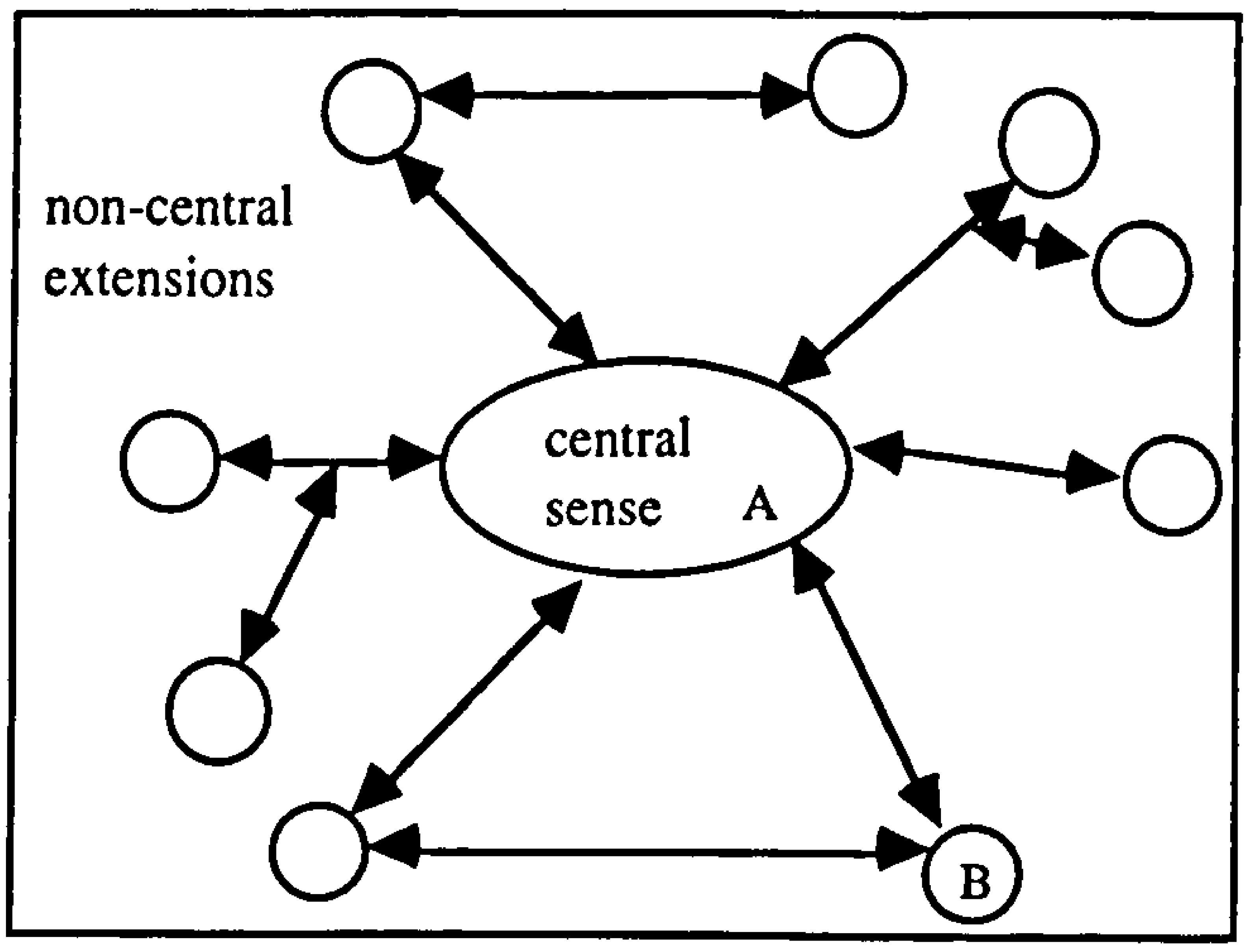


Figure 4.1 - A Hypothetical Radial Category.

Basically the prototype can be seen as part of the centre periphery schema such that "given category B with radial structure and A at its centre, then A is a *best example* of B" (Lakoff, 1987, p.289). The hypothetical radial structure shows a meaning chain with sense A at the centre and B as part of the linked model.

These notions of polysemy, prototypes and radial categories contribute to the analysis of OVER to which I now turn.

4.3 The Analysis of OVER

4.3.1 Variables Described by Brugman

In her 1981 thesis Brugman presents the possible variables that arise in configurations described by the preposition OVER. "Trajector" is used to represent "referent" and "landmark" is used to represent "relatum":

1. The size and shape of the trajector. The trajector can be viewed as a single point, a line or a plane with respect to the landmark.

2. Plexity of the trajector. The trajector can be a single object or can be a collection of objects, a "multiplexity".

3. The size and shape of the landmark. Again, this is a relative concept.

4. The horizontal-vertical orientation of the landmark. This refers to the orientation in space of the landmark being referred to in the expression. For example, a fence would be of vertical orientation and a garden would be of a horizontal orientation.

5. A verticality relation between the trajector and the landmark.

6. A trajectory that exists or is implicit between the trajector and landmark or a point for point correspondence between the two.

7. The boundaries of the landmark.

8. A presence or absence of a physical contact between the landmark and the trajector.

None of these variables are necessary and sufficient for category membership. Basically, most of these variables will be present but it is not necessary for all to be present. Brugman (1981) analysed OVER using these basic variables.

4.3.2 Brugman and Lakoff: A Topological Approach

The work of Brugman (1981) is refined in a paper by Brugman and Lakoff (1988). In this paper an analysis of OVER is presented and it is to this that I now turn. They give the following examples of OVER in order to highlight the complexity of the preposition:

The painting is OVER the mantel.

The plane is flying OVER the hill.

Sam is walking OVER the hill.

The wall fell OVER.

Sam turned the page OVER.

She spread the table cloth OVER the table.

The guards were posted all OVER the hill.

The play is OVER.

Do it OVER, but don't OVERdo it.

Look OVER my correction and don't OVERlook any of them.

You made OVER a hundred errors.

These senses include examples where OVER is not being used in a locative sense and Brugman and Lakoff (1988) also attempt to explain the representation of metaphorical senses of OVER. Focus here will be on their semantic analysis of the "spatial" uses of OVER.

4.3.3 The Central Sense

Brugman and Lakoff (1988) suggest a central sense for the preposition OVER. This is termed the "Above-Across Sense". This sense is viewed as the prototypical sense of OVER from which all other senses radiate. Basically, in this full specification account the senses of OVER are seen to form a chain and the central sense is at the centre. A pictorial representation of this central sense is shown in Figure 4.2.

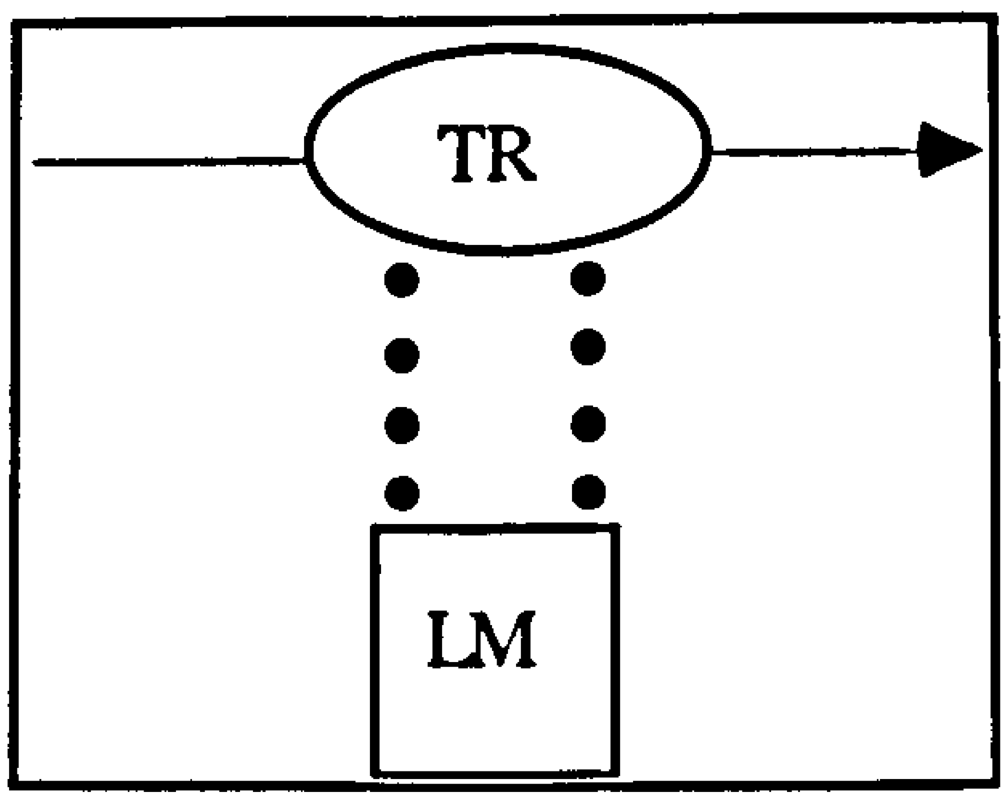


Figure 4. 2 - The Central Sense of OVER (Brugman and Lakoff, 1988).

The example sentence that can be applied to this schema is "The plane flew OVER". In which case the trajector (TR or referent) would be the plane and it is oriented relative to the unspecified landmark (LM or relatum) shown in Figure 4.2. The arrow indicates the PATH the plane is moving along and the dotted line represents the boundaries of the landmark. According to Brugman and Lakoff (1988) this central sense is neutral with respect to contact. They then list special cases of this central sense schema which involve the addition of extra information. These include cases such as those shown in Figure 4.3 and Figure 4.4.

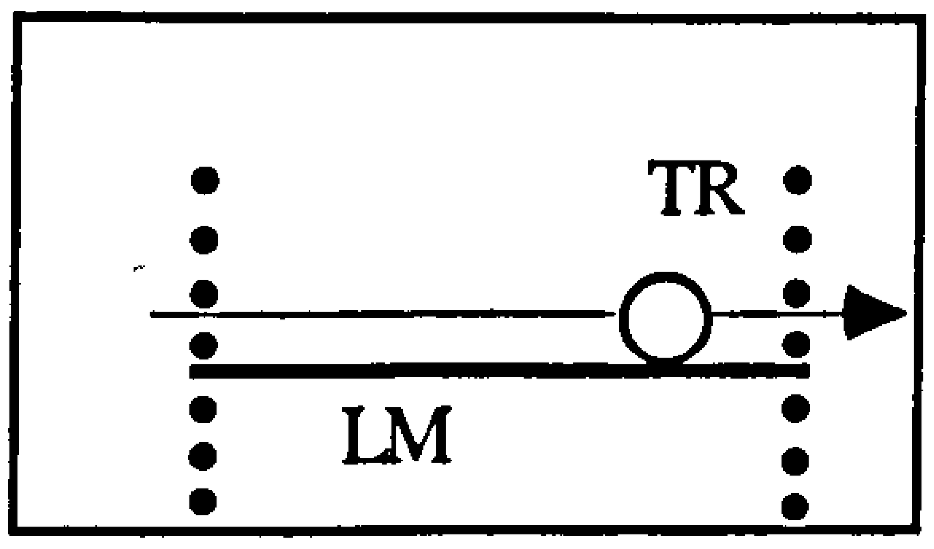


Figure 4.3
Sam Drove OVER the Bridge.

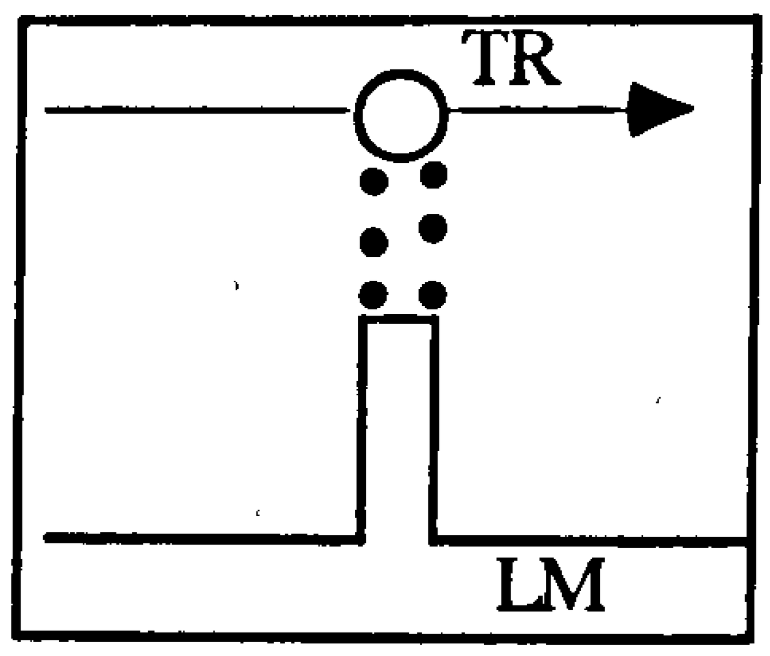


Figure 4.4
The Bird Flew OVER the Wall.

4.3.4 Other Senses of OVER

Brugman and Lakoff (1988) also suggest a stative sense with no PATH which they call the ABOVE sense; this is shown in Figure 4.5. It is taken to have roughly the same meaning as ABOVE. However, as will be made clear by the experimental work in this thesis, the locative ABOVE does not need to be directly over the relatum or landmark. Take for example the expression "Findlay lives ABOVE Joyce". If Joyce's flat is represented by the LM in Figure 4.6 then Findlay's flat could be either TR1, TR2 or TR3. One can imagine the use of ABOVE as being better represented by Figure 4.6.

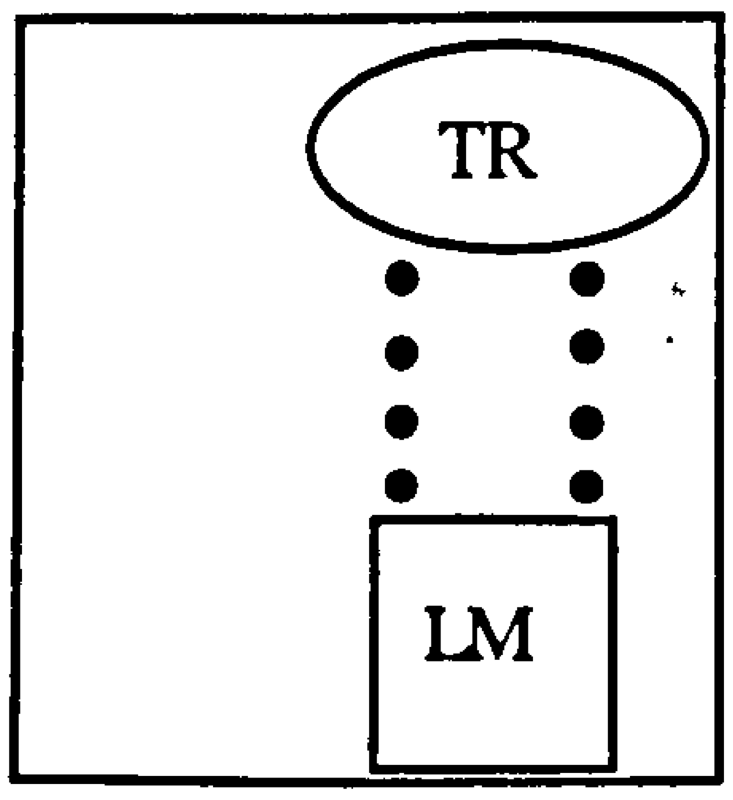


Figure 4.5 - The ABOVE Sense (Brugman and Lakoff, 1988).

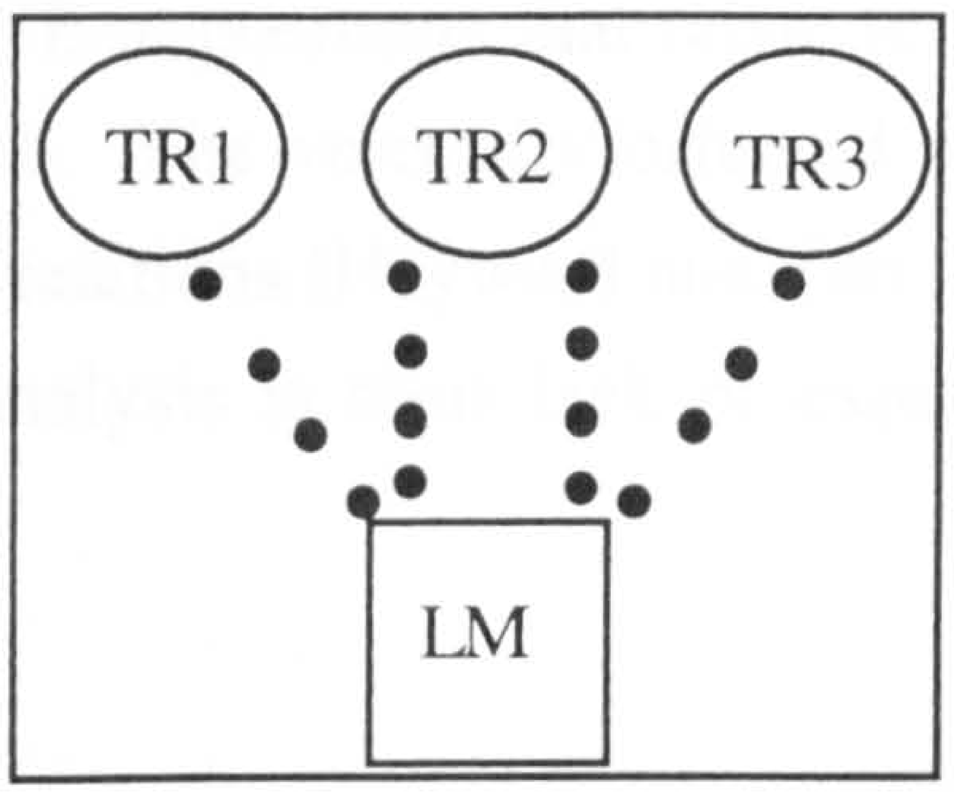


Figure 4.6 - Suggested Representation for ABOVE.

This range of use for ABOVE has also been independently highlighted by Hayward and Tarr (1995). In one condition the relatum was a computer and the referent was a circle. A grid with 48 squares was used and the computer remained at all times at the centre of this grid. The circle was shown in 48 displays, each time occupying a different part of the grid. Choice of either ABOVE or BELOW was examined in this condition. For each display subjects had to make an rating on a Lickert type scale from 1 (least applicable) to 7 (most applicable) for the use of either ABOVE or BELOW to describe the location of the circle in relation to the computer. The results found are shown in Figure 4.7 (Hayward and Tarr, p.57).

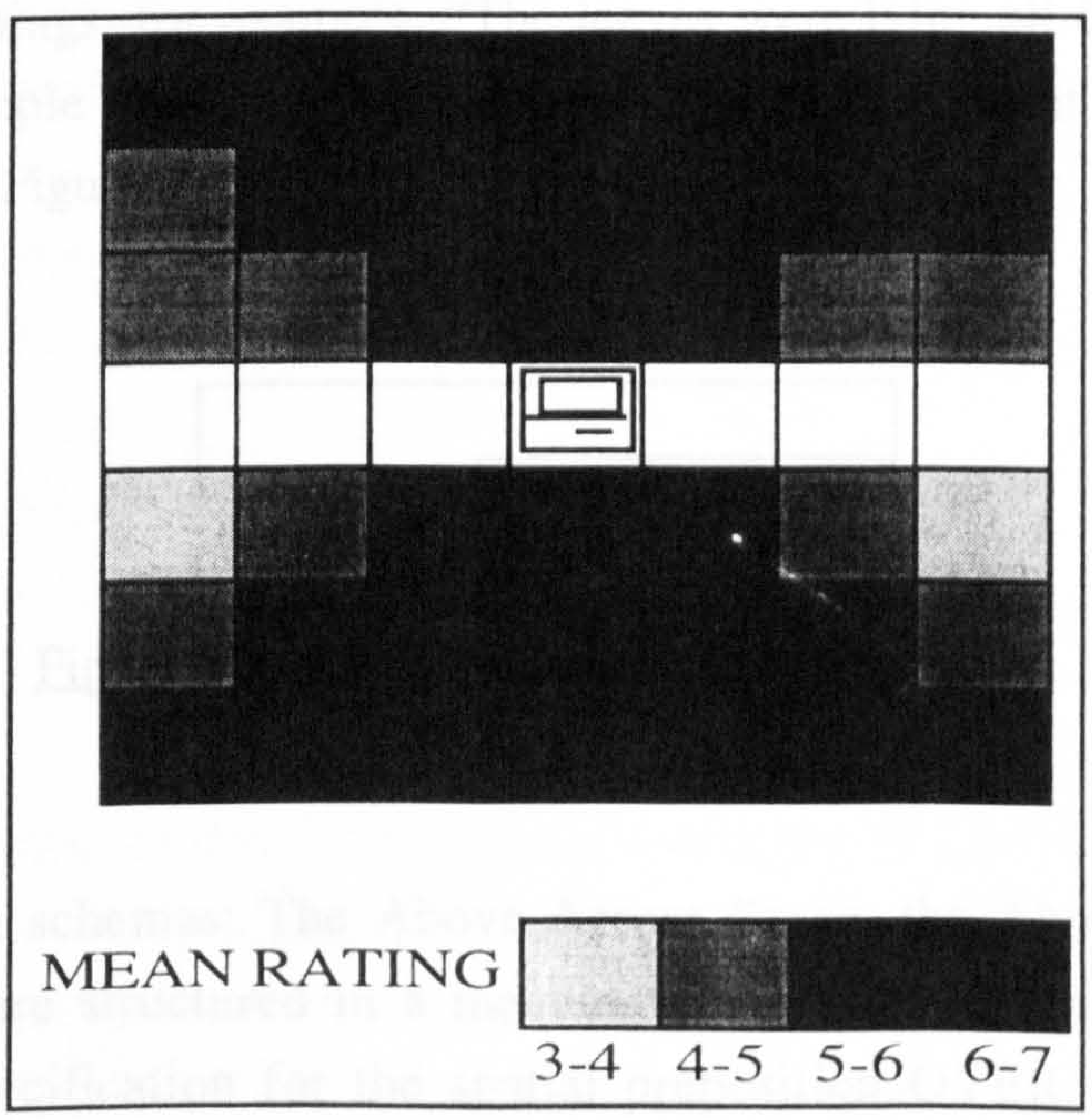


Figure 4.7 - Average Ratings for ABOVE and BELOW
Adapted from Hayward and Tarr (1995).

These results provide further, experimental, evidence that ABOVE does not just mean that the referent is directly over the relatum. Indeed, subjects gave high applicability ratings for the use of ABOVE in positions that relate to the hypothetical schema for ABOVE given in Figure 4.6. The vertically oriented preposition ABOVE applies over a wide range of spatial relations (Hayward and Tarr, 1995). A direct criticism of the Brugman and Lakoff analysis is their lack of experimental evidence for their claims.

Turning back to their analysis of OVER Brugman and Lakoff (1988) suggest a group of schemas called "The Covering Senses". Instances of this schema include the cases where contact is specified and there is a final result, for example, "The city clouded OVER" (see Figure 4.8).

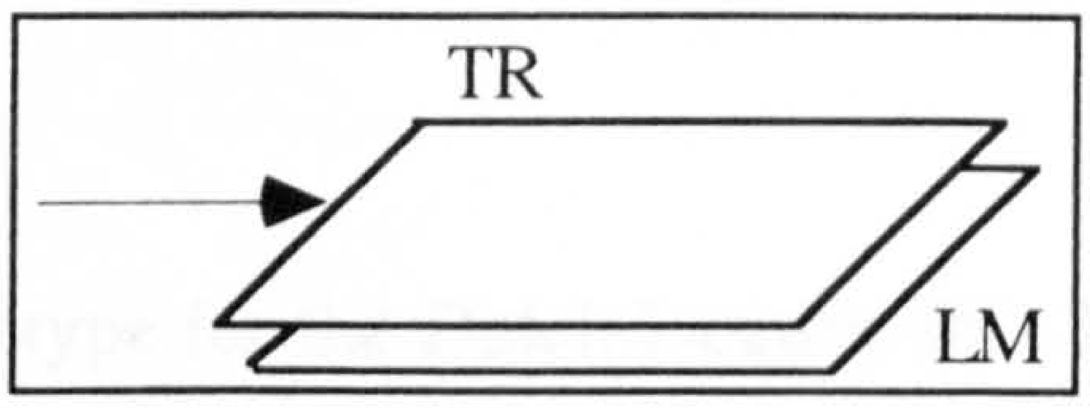


Figure 4.8 - Example 1 of the Covering Sense.

Another instance of the covering schema involves a referent or trajector made up of lots of separate things, for example, "The leaves were lying all OVER the forest". The schema example given by Brugman and Lakoff to account for such a use of OVER is given in Figure 4.9.

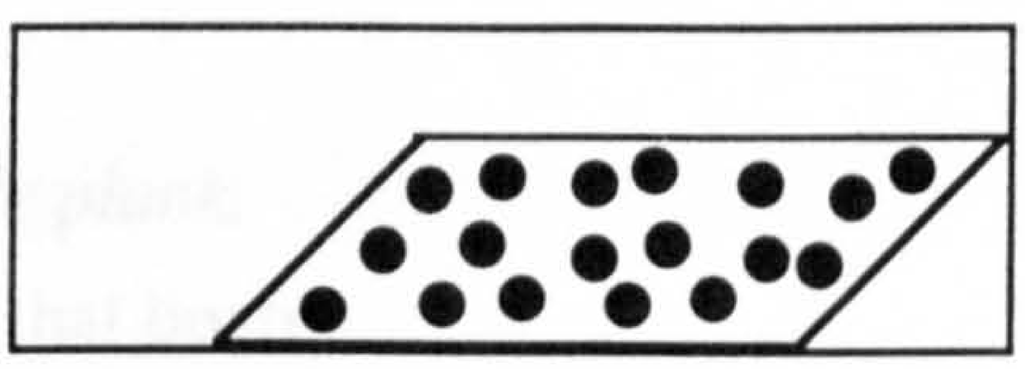


Figure 4.9 - Example 2 of the Covering Sense.

These three main schemas: The Above-Across Sense, the Above Sense and the Covering Sense are structured in a meaning chain network and are involved in providing full specification for the spatial preposition OVER. I turn now to a discussion of the Cognitive analysis provided by Cuyckens and then present some objections to these full specification approaches.

4.4 Cuyckens: The Dutch Spatial Preposition IN

4.4.1 The Cognitive Linguistic View

Cuyckens (1991, 1993) also provides a cognitive linguistic interpretation of spatial language. Here I focus briefly on his analysis of the Dutch spatial preposition IN. Similar to Brugman and Lakoff he rejects classical notions entirely in favour of a full specification approach. He supports the view that language is inextricably tied with interaction with the world, that there are family resemblance relationships in operation and that there must be a recognition that some cognitive concepts are more prototypical than others.

4.4.2 Analysis of IN

Cuyckens isolates a prototype for the Dutch locative IN. The following selection of examples are given by Cuyckens (1993). The examples are shown in Dutch and English.

De vaas staat IN de kast.
The Vase IN the cupboard.

Hij woont IN Duitsland.
He lives IN Germany.

Let op voor de nagels IN de plank.
Watch out for the nails IN that board.

Cuyckens (1993) argues that IN expresses a relation of COINCIDENCE and the notion of "medium" which is associated with the relatum. This is described in terms of family resemblance concepts rather than necessary and sufficient conditions. Basically he reinterprets previous notions of "enclosure", "containment" and "inclusion" as a COINCIDENCE relation between x and y. Further information for the use of IN is gained from the family resemblance structure of "medium" (see Figure 4.10). This network of overlapping featural configurations (Cuyckens, 1993) also involves a chaining of related configurations.

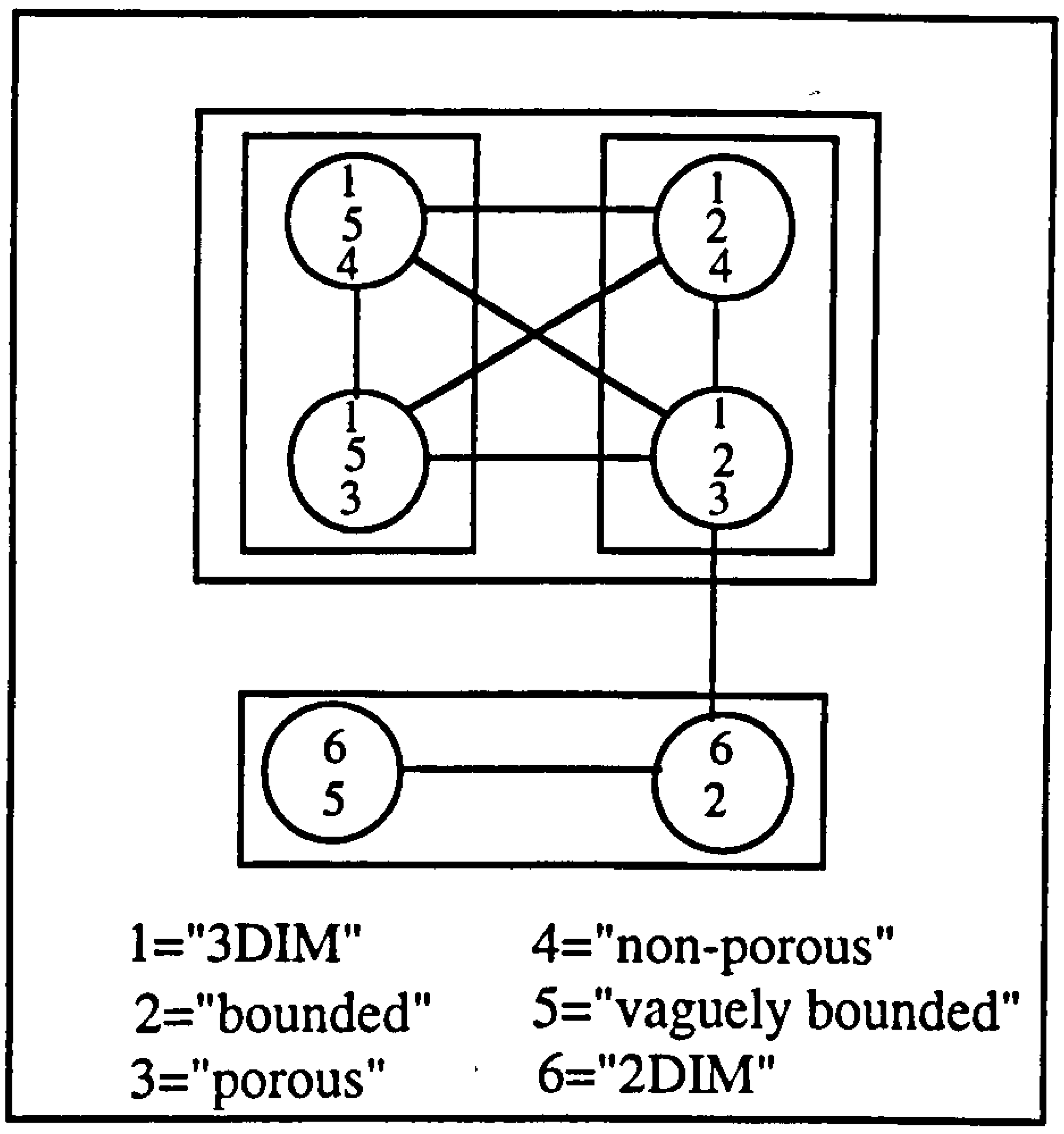


Figure 4.10 - Pictorial Representation of "Medium" Adapted from Cuyckens (1993).

Cuyckens is basically arguing that we need to use COINCIDENCE as this expresses the coincidence between the referent and the relatum. This is also the case for ON and he suggests that it is actually the properties of the relatum (captured by the family resemblance structure of "medium") that then makes the language user select ON as the appropriate preposition. He suggests that such an analysis allows more than just 3 dimensional objects to be included as relatums.

4.5 Assessment of the Cognitive Linguistic Approach

The approaches to spatial semantics presented within this chapter advocate the use of full specification of the lexical entry. This means that we do not achieve the goal of cognitive economy as each sense needs to be specified in the mental lexicon. Everything is lexicalised and this means there is uncertainty about where the specification should stop.

Another valid criticism concerns selection of the central sense; the "above-across sense": Why should this be the central sense? Brugman and Lakoff (1988) present no evidence from language users to suggest that this would be the case. Indeed the use of a prototype as central sense, even when part of an ICM, does imply representation using such a notion and there is no conclusive evidence to show that prototypes are used in our mental representations of space (Chapter 1 discusses the unequivocal typicality results found by Armstrong, Gleitman and Gleitman (1983)). It is also important to point out that this central sense is spatial in nature and, as we will see, there is little or no evidence to suggest that the primary sense would be spatial.

It is also difficult to know which criteria should be used to define the level of abstraction in these full specification approaches. These analyses are in a sense speculative as they do not use direct experimentation in order to gain psychological validity. Basically, without experimentation it seems to be nearly impossible to tell if the core meaning or indeed central sense is semantically adequate and psychologically possible. Also, as highlighted by Hayward and Tarr (1995), and more explicitly by the present experimental work in the following chapters, there is a need for direct experimentation with language users before deciding on <u>any</u> senses for OVER or ABOVE.

4.6 Philosophical Considerations Relating to a Functional Account

The Classical approach to meaning was abandoned in favour of more prototype based approaches. There were many problems inherent with what Lakoff (1987) refers to as the objectivist approaches to meaning. We must separate out the fact that such approaches promoted the notion of minimal specification and necessary and sufficient conditions from the more negative aspects. The present approach argues that a minimal specification approach, utilising some of the tenets of a cognitive linguistic approach, is preferred. One does not have to embrace the Classical theory and all its philosophical implications by taking such a minimal approach. It is argued that the previous minimally based accounts have only been misguided in their lack of finding the correct minimal specification for the spatial prepositions analysed.

One negative aspect of a Classical Approach is that linguistic expression is seen as having a direct relation to the state of affairs in the real or possible worlds. It is important to recognise that a mental representation is invoked which mediates between the real and discourse world (Garrod and Sanford, 1989, Taylor, 1993). The objective (Classical) approaches did not recognise how closely tied we are to our bodily experiences. It is important to incorporate into the present theory the way we experience space, objects in space and the forces that act on the objects in space as these give us the basic structures through which we conceptualise even more abstract domains (Taylor, 1993). Spatial prepositions form the lexical items that function to symbolise our conceptualisation of spatial relations. The demise of Classical views led to an abandonment of the abstract, language as symbols notions that are recognised as untenable. Of course it also meant that, unfairly, the notions of minimal specification were thrown out as well. On the negative side, the Cognitive Linguistic approaches introduced the notion of full polysemy recognition and thus full specification of the lexical entry.

It is hoped that the general arguments presented by Margolis (1994) (see Chapter 1) and the specific arguments presented here show that there are many problems to be found by adopting a prototype based approach. Certainly some of the criticism given to Classically based theories has been unwarranted and the search for minimal specifications (the recognition of as few senses as possible) should not be abandoned. I also argue that greater emphasis needs to be placed on functional/physical relations. I turn now to a discussion of approaches that have in one way or another recognised the importance of functional notions. It is argued that the employ of such notions will lead to a psychologically valid account of the semantics of spatial prepositions.

Chapter 5

The Essence of Functionality

5.1 Introduction

It is clear that the semantic accounts suggesting purely logical or geometrical representations of space are not sufficient. This chapter discusses various approaches to spatial prepositions which recognise in one form or another the importance of functionality. However, these accounts do not fulfil the aim of having a relatively simple relation which accounts for a wide range of applications (Garrod and Sanford 1989). Other information such as use types, pragmatics and context are brought into play as separate factors.

This selection of functionally based or influenced accounts incorporate many of the facets of the Cognitive Linguistic approach discussed in the last chapter. I focus on the work of Herskovits (1986), Cienki (1989) and Vandeloise (1991). Miller and Johnson-Laird (1976) present a mainly geometric approach (see Chapter 3). However, there is a recognition of functional factors and these are discussed here. Herskovits (1986) presents geometric ideal meanings which involve sense shifts to different use types. Her near-pragmatic principles and general views recognise that a geometric approach is not sufficient in itself. Vandeloise (1991) presents an examination of the meaning and use of French spatial prepositions using a functional basis. He presents a framework of functional notions that, he claims, can fully explain the semantics of locatives. Although fully recognising the importance of functional relations, he fails to provide a cohesive or intuitively appealing account. Similarly, Cienki (1989) suggests core meanings but relies on a full specification of lexical entries in order to explain prepositional use.

Finally, the theoretical paper which provides the basis of the present work is introduced. Garrod and Sanford (1989) provide the framework and beginnings of the present functional model. Continuing in this framework is the comparative work of Coventry (1992) which is briefly discussed.

5.2 Functional Recognition: Miller and Johnson-Laird

The work of Miller and Johnson-Laird (1976) was presented as a simple relations account in Chapter 3. However, this approach is further examined here as it does, to some extent, recognise the importance of functional factors. Certainly they comment on the fact that language is related to the external world and how we interact within it. It is recognised that functional information is involved in the formation of meaning. The authors also recognise some of the problems inherent in the approaches of Bennett (1972), Cooper (1968) and Leech (1969).

In their notation for ON, Miller and Johnson-Laird recognise the important functional notion of "support". Indeed, Aurnague (1995) notes that if the French spatial preposition SUR (ON) was only represented in terms of contact then language users would be unable to discriminate between

1. The wallpaper is ON the wall

and

2. The cupboard is AGAINST the wall.

In sentence 1 the fact that the wall is supporting the wall paper is integral to the use of the locative ON. In sentence 2, the cupboard is not being functionally supported by the wall and only contact is operating. It is easy to see that the importance of functional notions cannot be ignored.

Also REGION, a functional concept, is recognised by Miller and Johnson-Laird as part of the meaning of a number of spatial prepositions. This notion of REGION was discussed in Chapter 3 with reference to the preposition ON. It represents the range within which an object can normally interact with other objects.

5.3 Herskovits: Geometric Idealised Meanings

5.3.1 General Assumptions

The comprehensive work of Annette Herskovits involves an analysis of the semantics of locative expressions, with the aim of constructing an operational computer model of spatial comprehension. Herskovits (1986) recognises that the world is not neatly organised by rules of point, line and plane and that "spatial objects related often do not actually exist in the world" (Herskovits, p.2). She also acknowledges that language is not a rigid, but rather a flexible, often context-dependent phenomenon, and that we do not rely on purely linguistic notions. These Cognitive Linguistic considerations are vital if one wishes to adequately discuss spatial language and such considerations are incorporated into the functional geometric approach to be presented in the thesis. Herskovits (1986) recognises that "interactional properties" are important in understanding and using language. I will now discuss the main tenets of Herskovits' approach and the problems found within it.

5.3.2 Inadequacy of Simple Relations

It cannot be assumed that simple geometric relations are adequate to explain the use of spatial expressions. Indeed, Herskovits lists several points exemplifying the fact that "classical" or purely geometric accounts yield "wrong or insufficient" predictions (these inaccuracies were fully discussed in Chapter 3). She notes that the simple geometric relations often do not hold. For example, a referent can be outwith the confines of the relatum and still be considered by the language user as "IN the relatum" (see Figure 5.1).

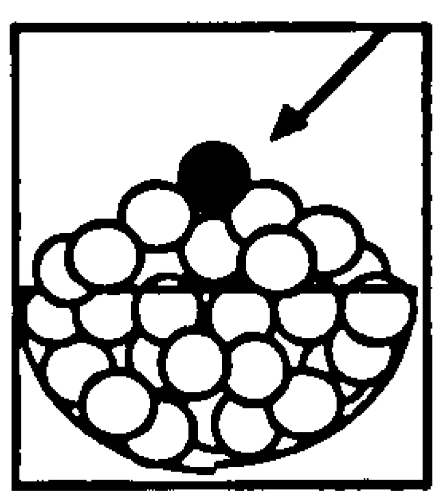


Figure 5.1 - The Ball is IN the bowl.

As discussed in chapter 3 there are unexpected context-dependencies, unexplained restrictions, divergences from the simple relations and additional constraints that are not taken into account by purely logical and geometric accounts. To call these factors and issues "idiomatic" would be a little like sweeping the dust under the carpet when what is needed is a powerful vacuum cleaner. Herskovits recognises this fact and, indeed, one of the questions formed by this thesis is: "Can we provide the semantic Hoover?"

5.3.3 Ideal Meanings: Sense Shifts and Pragmatic Principles

Herskovits (1986) proposes ideal meanings which are accompanied by two kinds of deviations:

1. Sense shifts (which result in polysemy).

2. Pragmatic or near-pragmatic principles (relevance, salience, tolerance and typicality).

According to Herskovits, simple relations should only be seen as a "geometric ideal". These geometric ideals resemble prototypes of the prepositions. Deviations from these ideal meanings are called sense shifts. The near-pragmatic principles are used to predict acceptable shifts from the ideal meaning. Important factors combine with such sense shifts and these include tolerance phenomena where the ideal meaning is allowed to be almost true. The near-pragmatic principle of salience is concerned with a kind of foregrounding of objects that are salient in the expression. For example in the expression "The girl sat UNDER the tree" only a part of the tree is salient, as the girl is not sitting under the whole of the tree (which would of course include its roots). The principle of relevance is concerned with what the language user wants to imply or express. Basically, Herskovits argues that a language user may use IN or ON depending on whether containment or contact is most relevant. Another important source of information can be found by using object knowledge. This concerns information about shape, size, gravitational properties, characteristic orientation and the interactional property of function. This information provides constraints for the interpretation of a spatial preposition using a particular use type (see Figure 5.2).

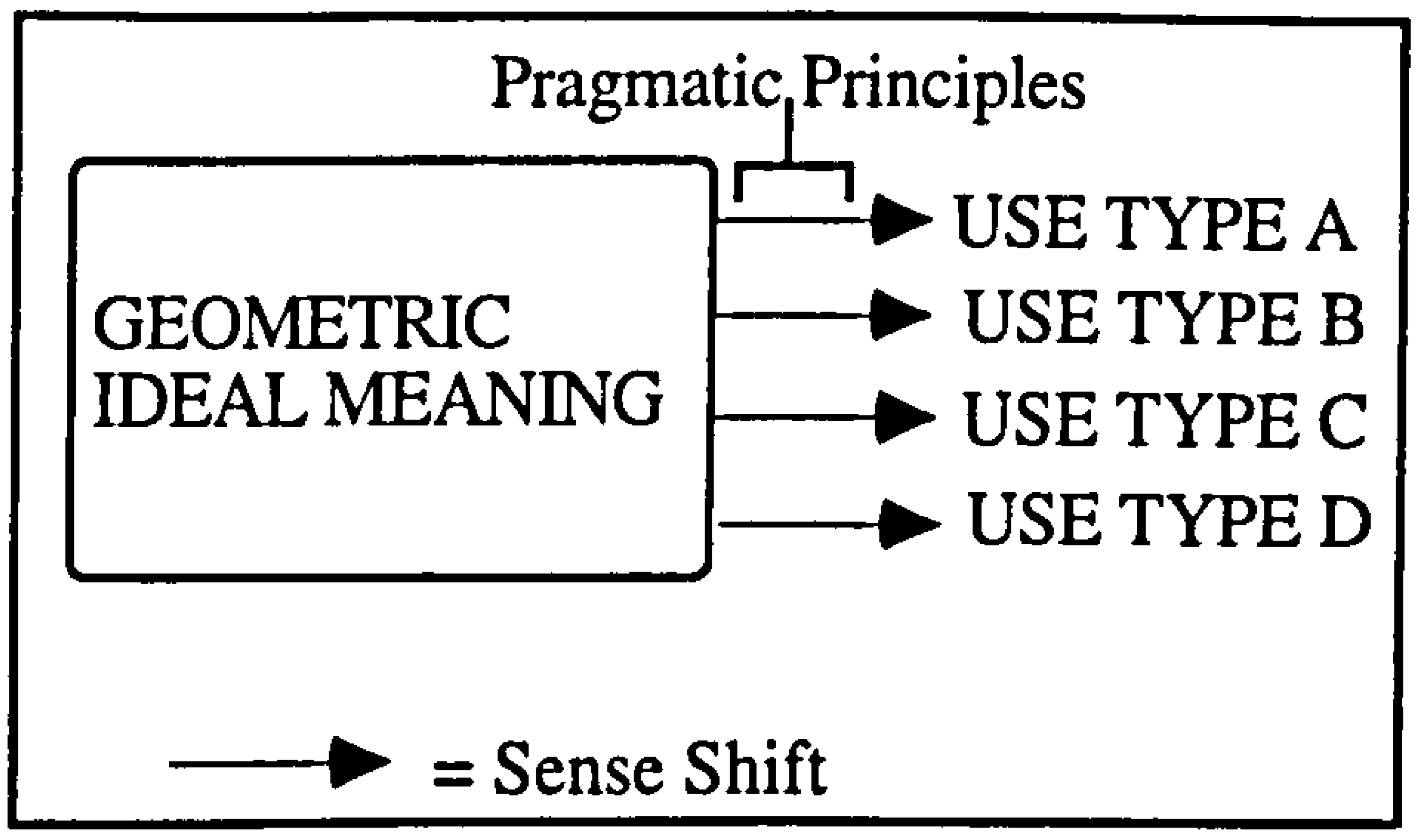


Figure 5.2 - Hypothetical Representation of Herskovits' Approach.

5.3.4 The Ideal Meanings for IN and ON

The ideal meaning is simply that, an ideal, and sense shifts occur in conjunction with the pragmatic principles to result in different use types. Herskovits claims that these sense shifted use types are independently learned and are derived from the ideal meaning. Herskovits (1986) concedes that spatial objects contained in prepositional sentences often do not exist in the world but are mental constructions. However, she proceeds to work within a geometrical framework. The geometric ideal meaning proposed for IN is as follows:

IN: inclusion of a geometric construct in a one-, two- or three- dimensional construct.

Herskovits' argument that all instances of use of a spatial preposition centre around or derive from the ideal meaning will be discussed to exemplify her work. Herskovits (1986) gives the following examples:

The water IN the vase.

The crack IN the vase.

The crack IN the surface.

The bird IN the tree.

The chair IN the corner.

The nail IN the box.

The muscles IN his leg.

The pear IN the bowl.

The block IN the box.

The block IN the rectangular area.

The gap IN the border.

The bird IN the field.

All these sentences convey the idea of inclusion or surrounding and involve differing use types. The use types suggested by Herskovits for IN are:

1. Spatial entity in container.

2. Gap/object "embedded" in physical object.

3. Spatial entity in area.

4. Physical object "in the air".

5. Physical object in the outline of another, or a group of objects.

6. Spatial entity in part of space or environment.

7. Accident/object part of physical or geometric object.

8. Person in clothing.

9. Physical object in a roadway.

10. Person in institution.

11. Participant in institution.

Deviations from the ideal meaning of IN result in sense shifts to these suggested use types. Pragmatic principles and object knowledge are also utilised in this shift. Th example sentence "The pear IN the bowl" involves the use type "spatial entity in container" and there is also an application of tolerance if the pear is actually outwith the confines of the bowl. The example sentence "The muscles IN his leg" involves a sense shift to the use type "accident/object part of physical or geometric object".

I now turn to Herskovits' analysis of the locative ON. She acknowledges that her ideal meaning for ON is the least clean-cut and proceeds to present the following idealised meaning of ON:

ON: for a geometric construct X to be contiguous with a line or a surface Y. If Y is the surface of an object Oy, and X is the space occupied by another object Ox, for Oy to support Ox.

This relation for ON sits at the centre of all uses of this preposition and Herskovits (1986) feels that the definition represents "the central meaning intuition associated with ON" (p.50). She argues that ON is used to represent contiguity with a line or a surface which is one or two dimensional, for example:

The carpet ON the floor.

The village ON the road.

The house ON the lake.

A point ON a plane.

The shadow ON the wall.

Herskovits focuses on the notions of "contiguity" and "support" as important features of ON. Contiguity is exemplified by sentences (1) to (3). According to Herskovits, support is implied when we are dealing with objects that are three-dimensional. Support can be indirect but only when the intermediate objects are either thin or not salient. This is not an adequate explanation of this kind of transitive use of ON. Basically, Herskovits uses the near-pragmatic principle of salience to explain the (hopefully now familiar) use of ON in the expression "The book is ON the table" when there is actually another book in between the referent book and the relatum table.

The following examples, according to Herskovits, present cases where neither support or contiguity are present or central to the idea being expressed:

The carving ON the stone.

A table ON three legs.

The cafeteria ON the campus.

The man ON the bus.

The suggested use types for ON are given as follows:

1. Spatial entity supported by physical object.

2. Accident/object as part of physical object.

3. Physical object attached to another.

4. Physical object attached to another.

Physical object transported by a large vehicle.

Physical object contiguous with another.

Physical object contiguous with a wall.

Physical object as part of itself.

Physical object over another.

Spatial entity located on geographical location.

Physical object contiguous with a line.

Physical object contiguous with edge of geographical area.

I argue that functional support is present in the examples that are proposed to indicate neither support or contiguity. For example, functional support is important in the sentence "The table ON three legs". This case is probably contrastive but its use nevertheless highlights the functional notion of support. Herskovits states that the use of ON in "The man ON the bus" is explained by a sense shift to the use type "physical object transported by a large vehicle". She argues that this is because:

> The vehicle must have a relatively large surface or floor that supports the travellers. If the vehicle is small, surrounding becomes more salient, and ON becomes less acceptable
>
> Herskovits (1986), p.144

However, the use of ON in "The man ON the bus" is conventional and can be explained when this is taken into account. Conventions of the language are involved and they are usually caused by historical or cultural factors. In Britain when discussing transport we will say "ON the bus", "ON the train" and "ON the ship". However, if one asks a Dutch person to discuss transport in this manner they will describe themselves as going "WITH the bus", "WITH the train" and "WITH the ship". This is a case where Dutch and English language users divide up the spatial world in different ways. In Britain ON has probably become the norm because the top deck of buses were originally "open-top". Thus one would be "IN the lower deck" and "ON the top deck" (Lindkvist, 1950). Certainly a native Dutch speaker (in personal conversation) sees the logic of using ON when the history is described in such a way.

5.3.5 An Evaluation of Herskovits

This Cognitive Linguistic approach does attempt to explain all uses of spatial prepositions. However, this is achieved by using a geometrical ideal involving relations between points, lines, volumes and surfaces. It is argued that there is no evidence to suggest that this ideal meaning would be geometric. Functional factors are recognised but only through the recognition of polysemical sense shifts and the use of prototype notions.

This approach can be seen as similar to prototype theory where the definition fulfils an approximation or resemblance to the situations in which one would select ON. Herskovits uses her ideal geometric meaning as a "best example" of the definition of a spatial preposition. Other uses are tacked on and therefore we do not find a cohesive and simple proposal for the mental representation of spatial language. Certainly, if many use types are used, there may well be just as many lexical entries. This would defeat the purpose of even having an idealised meaning. It also opposes the intuitively appealing idea that we have some kind of notion that represents use. It should also be noted that in using prototype notions Herskovits has fallen into the trap highlighted by Lakoff (1987): Herskovits assumes that there is a prototype in the mental lexicon which structures the use types. Lakoff termed this the STRUCTURE = INTERPRETATION problem with prototype based theories.

Herskovits (1986) does note that unexplained restrictions do occur within the proposed definitions. Although there is a representative core meaning, she suggests that individual use types are learned independently of this core. Child language evidence, however, shows that children use IN early in language development (Clark, 1973, Van Geert, 1985, Tomasello, 1987). This use takes the form of both the representative core meaning and also Herskovits (1986) use types. Even the more "difficult" and "unrepresentative" uses of IN are used by the young language learner. Herskovits also fails to explain how these use types would be derived from the ideal meaning.

Herskovits (1986, 1988) does present an account which recognises the importance of interaction with the world and a comprehensive account of spatial language is given. However, as is now familiar, the approach taken in this thesis focuses on a minimal rather than full specification approach to the semantics of spatial prepositions. Finally, it should be noted that Herskovits presents no psychological evidence that language users actually operate on the basis of her ideal meanings and use types. The work of Herskovits is discussed further in conjunction with the functional views of Garrod and Sanford (1989) and Coventry (1992).

5.4 The Approach of Cienki

5.4.1 Assumptions

Cienki (1989) discusses the semantics of prepositions in English, Polish and also Russian. He presents an account focused on core meanings with related polysemy (full specification). This work also recognises the importance of functionality. Cienki notes that componential approaches assign meanings for spatial prepositions that are comprised of simple relations. The meanings suggested do not cover all uses of spatial prepositions and they do not solve the problem of production and comprehension.

Cienki (1989) notes that when one uses spatial prepositions it usually indicates more than just a simple location relation. Other constraints must be met. By this Cienki means functionality, how we interact with the world, and he states that "the functional relation between the two objects....plays a role in the applicability of (a) preposition" (Cienki, 1989, p.18). However, Cienki's hypothesis is that "the motivation for the use of a spatial preposition stems from a geometric schematisation of the spatial elements involved" (Cienki, 1989, p.26). In other words, if we can conceptualise something as a geometric thing like a point, then that is the motivation for use of the preposition.

Cienki (1989) terms the world as we actually perceive it the "projected world". This is our only basis for experience and is thus what language deals with. He recognises that there are problems with componential or classical accounts which involve necessary and sufficient conditions. However, he does recognise that this does not make lexical decomposition invalid; he states rather that the analyses should not use necessary and sufficient conditions. Jackendoff (1983) argues for three conditions in a preference rule system: Necessary conditions, Centrality conditions and Typicality conditions. Cienki uses these notions in his analysis of spatial prepositions.

Necessary conditions involve those conditions which are necessary. For example the concept "blue" must contain the necessary condition of COLOUR. Centrality conditions involve graded judgements and notions of prototypicality. Cienki (1989) uses Labov's famous 1973 experiment as an example. In this study, various containers of different shapes and sizes were presented to subjects and their task was to label them as either "vase", "bowl" or "cup" (see Figure 5.3 for illustration). Graded conditions are involved.

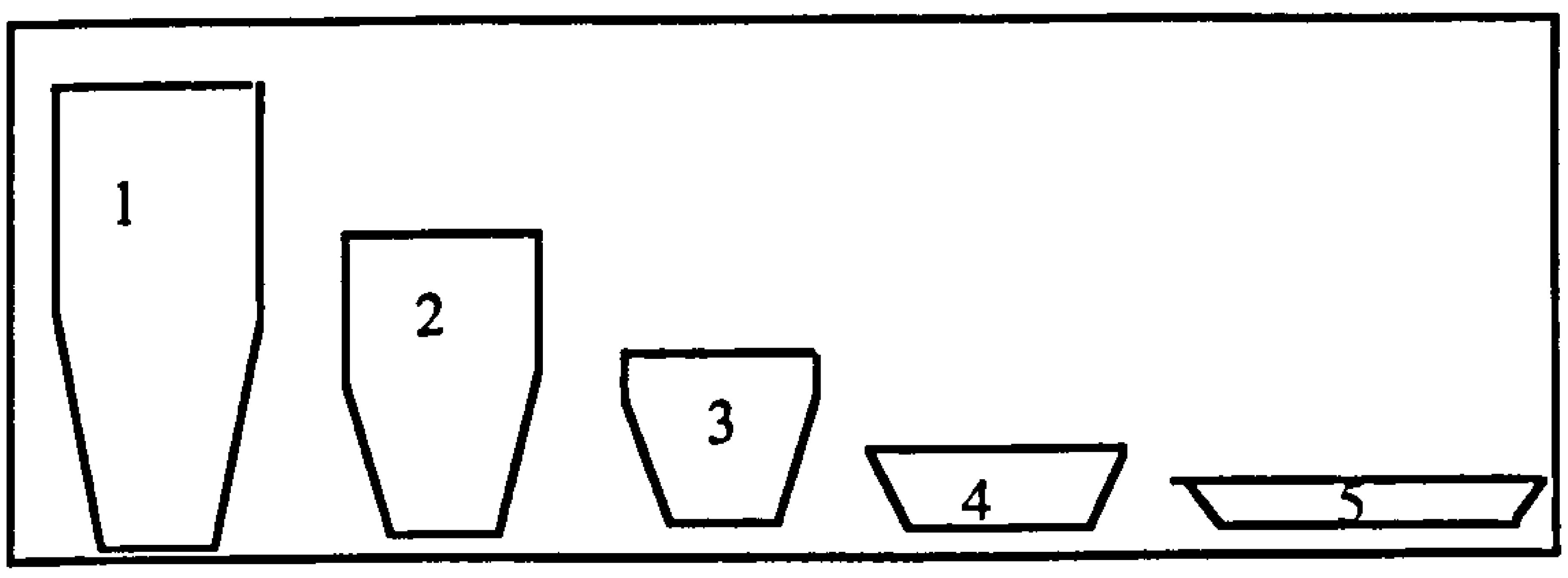


Figure 5.3 - Containers from Labov (1973).

The final condition, that of Typicality, is explained by Cienki with reference to Labov (1973). It was noted that when handles were added to the representations in Figure 5.3 subjects were more likely to judge that previously "vague" cases of cups, for example cases 2 and 4, were indeed cups. Having a handle is a Typicality condition on cups but not a condition for bowls or vases. Basically, these conditions are family resemblances and Cienki proceeds to present "core meanings" for spatial prepositions that involve these family resemblance notions.

Cienki certainly notes the importance of function but does so by basically discussing what Herskovits (1986) said about it. Using examples originally given by Herskovits (1986), he argues that it is the pragmatic preference rule that explains why one would not say "The lid is ON the table" but rather "The lid is ON the jar" for Figure 5.4. These configurations were discussed in relation to Herskovits' work in Chapter 3.

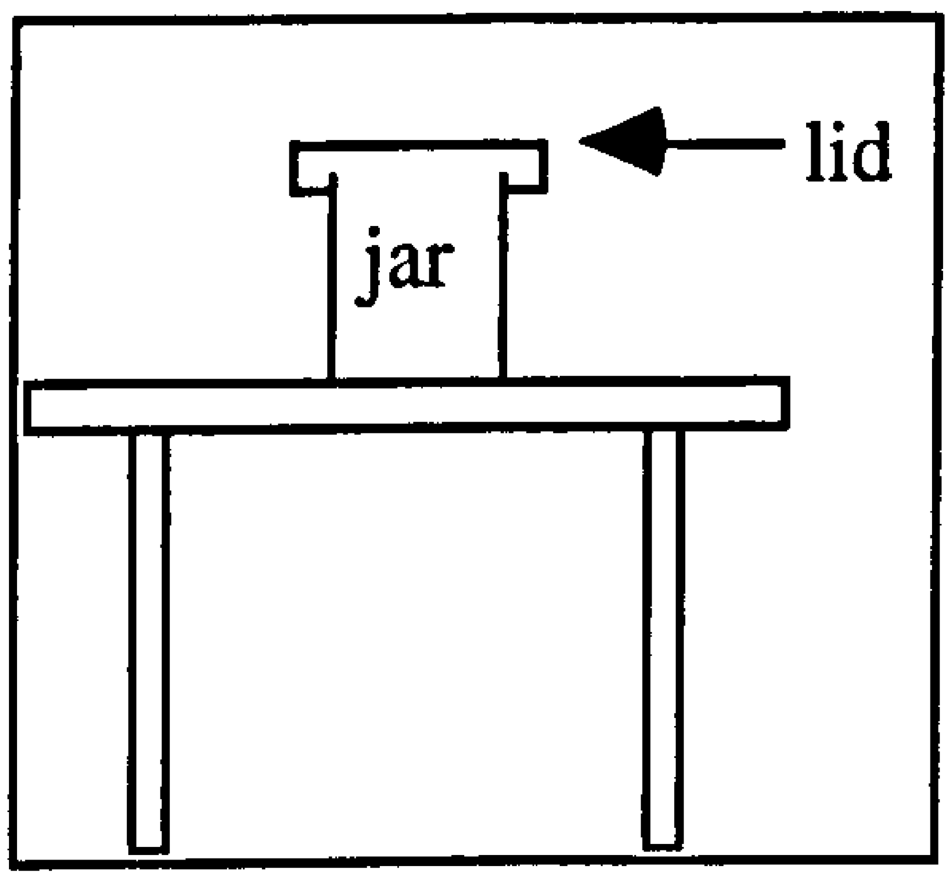


Figure 5.4 - The Lid is ON the Jar.

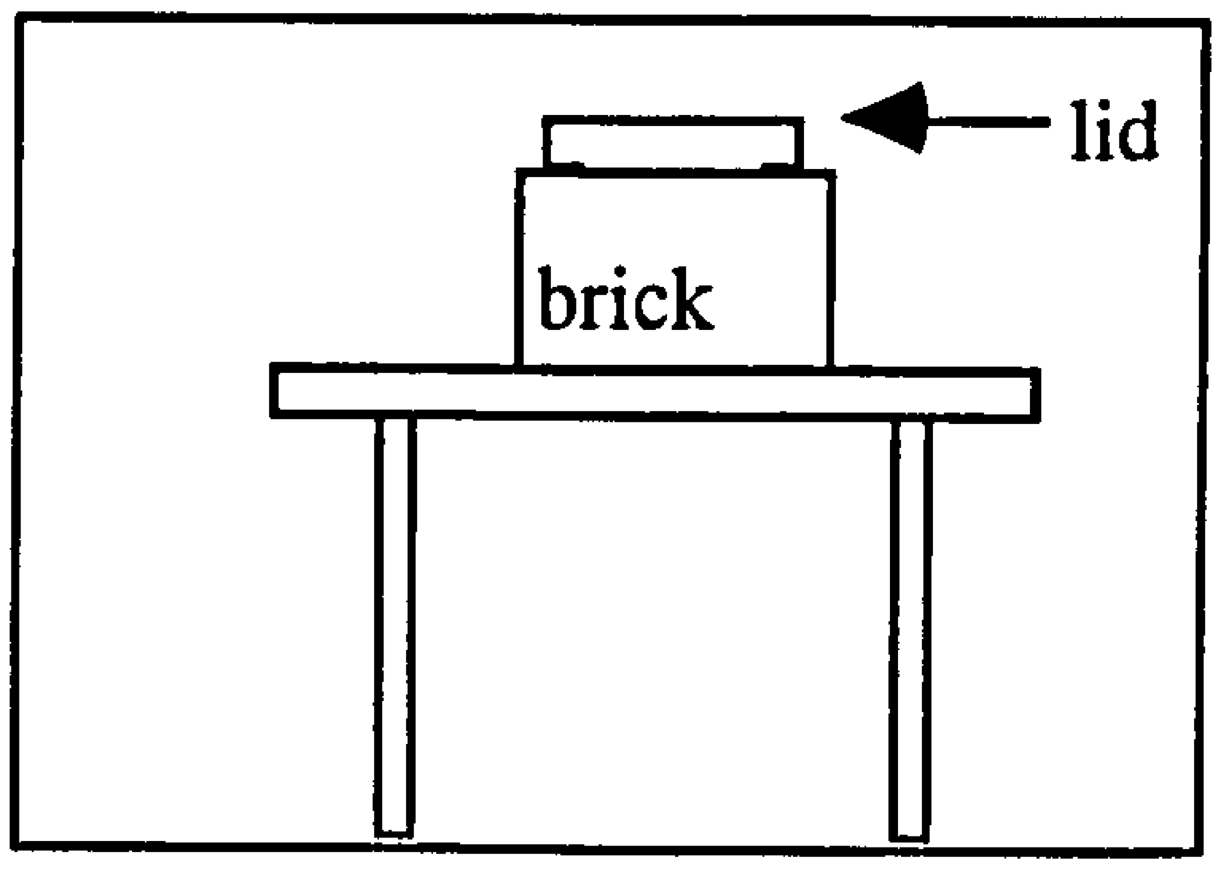


Figure 5.5 - The Lid is ON the Table.

In both cases the lid and the table are separated by the same distance but it is suggested that you would only say that the lid is ON the table for Figure 5.5. We must express the interaction according to the normal function and in this case lids are far more likely to be on jars so this typically is the expression that is preferred. I now present the core meanings in English for IN and ON given by Cienki. Each definition is further defined by the conditions that have been discussed.

5.4.2 Core Meanings

Cienki's core meaning for ON is as follows:

SpE(spatial entity) CONTACT WITH SURFACE OF L-r(localiser) (Typ)
L-r SUPPORT SpE (Typ).

In this core meaning the family resemblance Typicality condition is required.

Cienki's core meaning for IN is as follows:

[SpE INTERSECT INTERIOR OF L-r (Nec)].

"Nec" represents the Necessary condition and INTERSECT, understood in a mathematical sense, is meant to encompass previous notions such as "inclusion" given by Herskovits (1986) and "part of interior" given by Talmy (1983). The relation it points to is that the referent (SpE) and the relatum (L-r) share a common set of points. There is not always complete enclosure. Indeed there can be a lack of completely enclosing boundaries and this in the past has caused problems for those definitions that call for boundaries as necessary and sufficient conditions of use for IN. However, this definition also relies on family resemblance notions.

5.4.3 Evaluation of Cienki's Analysis

Cienki rightly notes many problems with simple relations accounts. However, his account relies heavily on the work of Herskovits (1986) and Jackendoff (1983). He states that we must discard the idea of necessary and sufficient conditions. However, it is argued in this thesis that this may not be a relevant step if one can postulate a minimally specified core meaning. Cienki does make some valid observations, most notably a recognition of the importance of functional factors. He does, however, rely on geometric notions as the basis of his descriptions. Finally, Cienki's core meanings do not explain how we represent all the diverse uses of locatives and in order to do this he has to rely on a full specification account which, as I have argued, is avoidable.

5.5 The Bridge from Geometrical Approaches

The accounts just discussed do recognise that purely logical and geometric approaches are not adequate for describing the spatial world. However, despite this recognition, none of these approaches presents a fully functional account of spatial prepositions. Miller and Johnson-Laird (1976) still rely heavily on the use of geometric notions although they recognise the importance of functionality. Their notations do not apply to all cases of spatial use. Herskovits (1986) presents a detailed account but still relies on geometrical ideals, using functional and pragmatic information, to explain prepositional use polysemically. Cienki (1989), in a similar analysis, relies on semantic conditions to further explain the use of his core meanings. I move now to a discussion of work that places functionality as central.

5.6 Vandeloise and Functionality

5.6.1 Beyond Geometry and Logic

Vandeloise (1991) presents a functional account, largely dependent on the functions that objects serve, investigating the semantics of French spatial expressions. His system is based on knowledge of the world. Indeed, Vandeloise argues that one cannot attempt to analyse spatial prepositions without recognising that we conceptualise, perceive and interact with the world. This approach fully recognises the philosophical considerations of a Cognitive Linguistic approach. He generally condemns geometric simple relations approaches as they do not take into account either the context or speaker.

Vandeloise defines functional as a utilitarian concept dependent on non-spatial factors. These factors are determined by the context and the circumstances of use of the prepositional terms. He recognises that the purely geometrical or logical accounts do not represent all the uses appropriate to IN. Such definitions only describe the most representative uses and often require the use of selection restrictions. For example, Cooper (1968) includes in her definition of IN the restriction that "referent (x) must be smaller than the relatum (y)". This can immediately be seen as false when we look at phrases such as:

The palm tree IN the plant pot.

The tennis racket IN her hand.

Logic certainly neglects the functional and flexible character of language. This means that a logical account reduces the semantic analysis to a description of the formal usage of spatial prepositions (Vandeloise, 1991).

5.6.2 Functional Primitives

Vandeloise (1991) recognises that it is vitally important to take into account qualities of language not covered by abstract logic. Language in reality involves the use of shared knowledge and contextual factors. This leads Vandeloise (1991) to a functional discussion in which he offers primitives or key functional/physical concepts that are involved in connecting the different uses of a single preposition. These general concepts or primitives are now discussed.

The primitive termed localisation involves an essential feature of spatial prepositions; situating objects that the speaker and listener hope to find. This functional primitive "is the determining factor in the distribution of the spatial uses of à"(Vandeloise, 1991,. p.157). The preposition à (roughly translated as AT) is involved in localising.

Vandeloise also points out the importance of naive physics concepts in spatial language use. This is the kind of physics employed every day by language users and it involves certain shared beliefs about the world (Hayes, 1985). These concepts include the bearer/burden relationship which is important in the description of *sur/sous* (which translate as ON and UNDER respectively). This involves the idea that if an object y carries or supports another object x then it is generally assumed that y is larger, closer to the ground and partially hidden by object x. Naive physics also play its role in the functional concept involved in the container/contained relation which describes the prepositions *dans/hors de* (which translate as IN and OUT OF respectively). Basically, the idea is that if an object y contains another object x it often hides the contained object x and has some influence on its shape and position; also the contained object x generally moves to the container y rather than the inverse.

This information can be recognised as pragmatic or world knowledge. There is no separation onto a distinct pragmatic level (Arnaugue, 1991) but rather a recognition that these are important factors within his functional account. We certainly use world knowledge and context when using language. For example, to typically understand the statement "Matthew is IN the car" we utilise pragmatic knowledge in order to ascertain that the expression is telling us that Matthew is 'IN the passenger space' of the car and we reject the notion that Matthew is 'IN the boot of the car' (adapted from Arnaugue, 1995).

Vandeloise (1991) recognises the importance of perception in a semantic analysis of spatial prepositions and posits a primitive concerned with accessibility to perception. It is widely accepted that we all possess the same type of perceptual ability and, thus, that we view space in the same way. The functional argument presented in this thesis recognises the importance of perception in this area.

The primitive of potential encounter involves the use we make of space. Vandeloise (1991) points out that "all our actions can be expressed in terms of encounter, whether it be with our socks, our food, or the love of our life" (p.16). This potential movement implies the same relations as real movement. This is tied in with his description of *avant/après* (translated as BEFORE and AFTER).

5.6.3 A Two-Level Description of Spatial Prepositions

To illustrate Vandeloise's approach, focus is placed on his analysis of the prepositions *sur/sous*. and this is followed by a brief discussion of the prepositions *dans/hors de*. In order to analyse these spatial prepositions using functional primitives (in this case the bearer/burden relation) Vandeloise uses two levels. First, he presents characteristics in the use of each preposition. For *sur/sous* these can be defined as follows:

1. *x est sur/sous y*: the referent is generally higher/lower than the relatum.

2. *x est sur y*: indirect contact is usually present between referent and relatum.

3. *x est sous y*: the relatum generally makes it difficult to see the referent.

4. *x est sur y*: the action of the relatum significantly opposes the force of gravity on the referent.

5. *x est sur/sous y*: the referent is generally smaller than the relatum.

These characteristics of *sur/sous* are involved in the bearer/burden relationship; they can be seen as traits of this family resemblance concept. Important relations are recognised such as the opposition to the force of gravity. However these concepts are organised in a family resemblance way and it is argued that the functional geometric approach presented is preferable.

Second, Vandeloise posits usage rules, preferably one for each preposition, and they basically govern usage of the prepositions. The usage rule for sur/sous is constructed in terms of the bearer/burden concept and is given as:

x est sur/sous y if its target is the second/first element of the bearer/burden relation and its landmark the first/second element of this relation.

I will now briefly discuss the prepositions *dans* (IN) and *hors de* (OUT OF) which are explained in terms of the functional, family resemblance relation of container/contained with three characteristics. Vandeloise suggests the following usage rule:

x est dans/hors de y if the landmark and the target are/are no longer the first and the second elements in the container/contained relation.

If the relatum (y) were a bowl and the target (x) a ball then this definition allows for the referent to be partially or completely outwith the imaginary spatial enclosure of the relatum (see Figure 5.6). Vandeloise states that this definition places the emphasis on the function of the preposition rather than on its geometry. Our everyday understanding of physics means that we know that frothy beer can be seen outwith the spatial rim of a beer glass and still be seen as IN (see Figure 5.7) and also that the ball is IN the bowl.

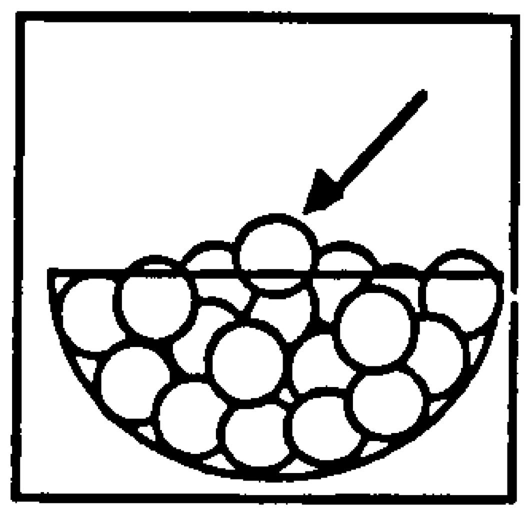


Figure 5.6 - Ball Partially Outside the Spatial Enclosure.

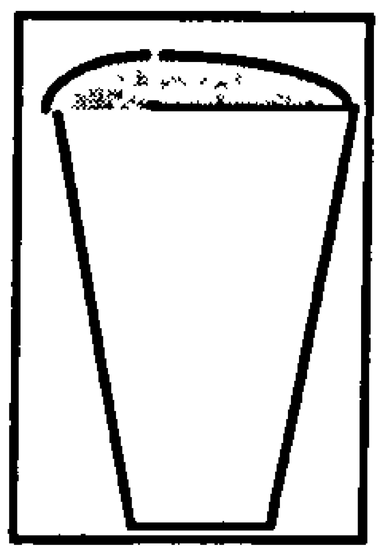


Figure 5.7 - Beer Froth Outside the Spatial Rim.

5.6.4 Evaluation of Vandeloise's Functional Account

Vandeloise (1991) presents a cognitive linguistic approach to the semantics of spatial prepositions. As noted in chapter 4, certain aspects of this approach, including interaction with the world, are important and these facets are included in Vandeloise's analysis.

He also notes that, although an object is usually three-dimensional, there are many one- and two-dimensional examples. What appears to be important, rather than the geometry of the situation (which is secondary), is the functionality. As long as the object can be perceived as a functional container, the number of geometric dimensions is irrelevant. Cuyckens (1993) notes that Vandeloise does not include geometric concepts at all in his analysis and he argues that this is misguided. He argues that dimensionality should not be ignored. The present functional account suggests definitions which include dimensionality but which also suggest, in the case of IN, a dimensionless alternative. I agree with Vandeloise's focus on functionality over geometry but realise that the geometry of a situation must be recognised and explained in some way. Vandeloise (1991) goes on to state that it is important that we recognise the flexibility and function of language rather than trying to see it as an abstract, logical and unchanging phenomenon.

However, although fully recognising the importance of functional relations he proceeds to analyse spatial prepositions with an emphasis on family resemblance concepts and full specification. The account, although an important monograph, involves the use of various lengthy concepts in order to arrive at a less than cohesive definition of spatial prepositions.

Finally, there are some general criticisms that apply to all the approaches discussed so far in this chapter. Hottenroth (1993) points out some of the problems with these polysemical "core meaning" prototype analyses. He asks how a core meaning, in Herskovits case, "ideal meaning", can be determined in a systematic and principled way. These core meaning, polysemical approaches raise further questions. How are the deviations from the core meaning coded in the lexicon? If they are not coded then on what principles are they operating?

5.7 Accounts Involving Functional Geometric Relations

The accounts discussed in the present chapter all recognise, in differing degrees, that purely geometric, simple relations accounts are insufficient for a credible account of spatial language. Accounts such as those by Miller and Johnson-Laird (1976), Herskovits (1986), Vandeloise (1991) and Cienki (1989) do recognise functionality; however their notations or ideal meanings are either insufficient to cover all uses of spatial prepositions or provide an ideal meaning which needs to be supplemented with use types, pragmatics and other extra information. Even if one could conceptualise spatial expressions as primarily geometric, these accounts still do not give a comprehensive account of the kind of geometries that would be required (Crangle and Suppes, 1989).

I now turn to investigations which argue that the geometry of spatial language is much less important in the analysis of spatial prepositions and also that there is a need for minimal specification of lexical entries. The birth of this view can be found in a paper by Garrod and Sanford (1989). I will also briefly discuss the minimal specification account presented by Coventry (1992).

5.8 Garrod and Sanford: The Origins of Functional Geometric Relations

5.8.1 Mental Models of Space

This paper proposes that the meaning of spatial language relies on mental models of space. Garrod and Sanford (1989) argue that such models capture the functional geometry of scenes to represent various control relations between the objects in the scene. Their work forms the launching point of the investigations carried out in this thesis. Discourse models are seen as interfaces between the language that we use and the external world. These models mediate between the language used and the world around us and Garrod and Sanford propose that utterances can only be given meanings in relation to such models (which can then be mapped onto the world to give various distinct interpretations). These mental models are more fully discussed in Chapter 6.

5.8.2 Problems with Geometry

Garrod and Sanford succinctly highlight the fact that geometry does not give an adequate account of spatial prepositions. The geometric relations shown in Figure 5.8 are all identical and all of these scenes should be described as "The apple is IN the bowl"; this is clearly not the case. Examples 1 and 2 geometrically warrant the description "The apple is IN the bowl", however, one would be more likely to say that the apple was UNDER the bowl in example 2. It is proposed by Garrod and Sanford that this is because there is no location control present in example 2. For IN, the location control is basically that if the container is moved the contained object will move with it in a correlated manner. This location control takes into account the functional geometry of the situation. The work to be presented in this thesis highlights another important point: the bowl is not fulfilling its purpose as a functional container as what is functionally important in example 2 is that the bowl is protecting and covering the apple. Example 3, although fulfilling the simple geometric requirements for IN, is more usually seen as "The apple OVER the bowl". Garrod and Sanford also cite cases where IN can be used yet geometric relations do not hold.

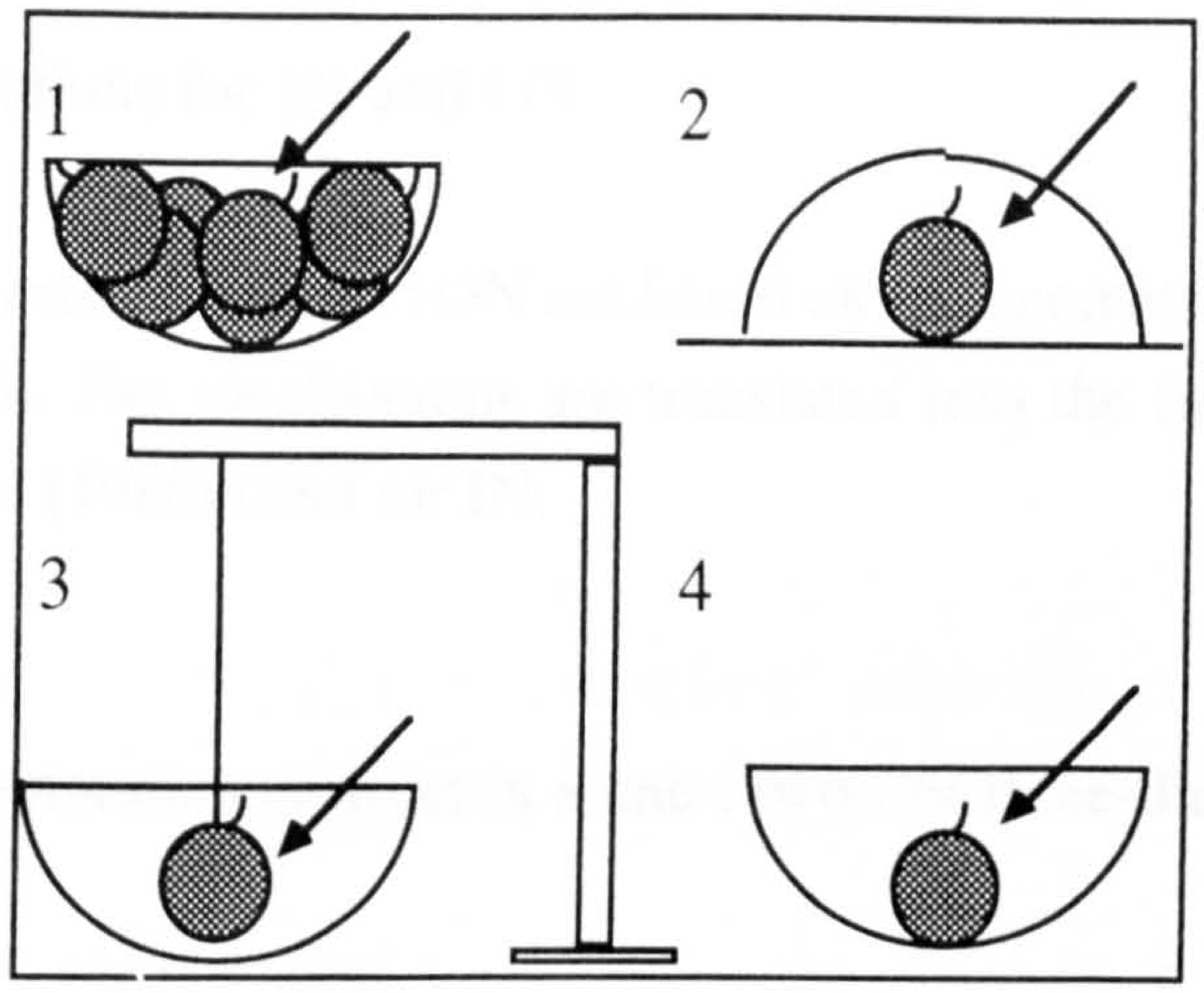


Figure 5.8 - Geometric Inadequacies.

They note that we could simply come to the conclusion, after seeing the many and varied uses of IN, that "it must be presumed that all such uses have to be learned and stored independently" (p.153, Garrod and Sanford, 1989). However, this view seems both wasteful of lexical space and also highly suspect. It does not take into account the intuition that IN expresses some straightforward concept of containment which is either present or absent. What actually appears to be important is the functional control present in the situation. The experimental work in this thesis investigates the functional controls that are involved in the use of the spatial prepositions IN, ON and OVER. Garrod and Sanford propose that functional geometric relations involving location control underlie the use of IN and ON and have two parts:

1. A purely spatial part.

2. A general interactional part.

Geometric notions are used for simple cases where spatial terms can be used, for example, when a ball is within the geometric confines of a bowl. It is suggested that transformations occur between purely spatial models and the interactional functional models.

5.8.3 Functional Notions for IN and ON

The definitions suggested for IN and ON are based on the geometric idealisations given by Herskovits (1986). Her idealisations are translated into the functional framework. So, taking Herskovits (1986) ideal for IN:

IN: inclusion of a geometric construct in a one-, two-, or three-dimensional geometric construct.

Garrod and Sanford proceed to redefine it as:

IN: inclusion of a geometric construct in a one-, two-, or three-dimensional functionally controlling space.

Control is asserted by the spatial preposition IN over entities in its control space dependent on a mental model of the situation. Therefore the meaning of IN does not change, as in full specification accounts, rather its notion of functional control. This functionally controlling space, suggests Garrod and Sanford, can also be seen to work with extended uses of IN:

John is IN a bad mood

Paddy is IN good health

These states directly control what the person can do, so John is in the sphere of influence of x.

Garrod and Sanford (1989) then turn to a discussion of ON which they argue can be characterised by a control relation where one object (the relatum) controls the location of another (the referent) by opposing the force of gravity. In other words, the supported object does not drop because of the supporting object. Contiguity alone is not enough, they need only to be roughly contiguous.

Herskovits ideal meaning for ON is:

ON: For a geometric construct X to be contiguous with a line or a surface Y. If Y is the surface of an object Oy, and X is the space occupied by another object Ox, for Oy to support Ox.

and this is redefined functionally as expressing rough contiguity and support from the force of gravity. A detailed account of the factors involved in the use of ON is not given.

5.8.4 Comment on Garrod and Sanford

The notations presented by Garrod and Sanford are based on the ideal meanings proposed by Herskovits (1986). Although her account does not result in what I feel is a semantically valid account (she suggests independently learned use types which would result in a large number of lexical entries) Garrod and Sanford (1986) do not give her full credit. The ideal meanings proposed by Herskovits and discussed by Garrod and Sanford are simply that, ideal. She does not state at any point that they cover all uses of spatial prepositions. Her sense shifts using near-pragmatic principles and object knowledge result in use types. These use types amply cover all the cases of the prepositions she discusses. I am interested in presenting an account where there is the bare minimum use of lexical entry, an account that one could envisage being programmed into a computer with a natural language front end.

Also Garrod and Sanford (1989) do not make explicit the importance of what I will call object function. It is important to recognise the function of objects. What is central is the function that objects have and whether they fulfil their function. This point is made succinctly by Coventry (1992) when he notes that hearts are best defined by their function, that is, as organs to pump blood.

Coventry (1992) criticises the work of Garrod and Sanford (1989) by arguing that it is not necessarily the case that the preposition IN will be used if a bowl is moved and the pear moves with it. Coventry gives the example shown in Figure 5.9.

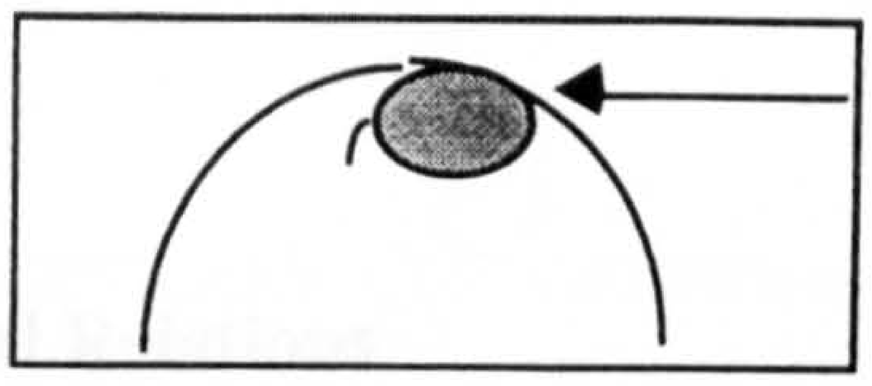


Figure 5.9 - The pear IN the bowl?

Coventry states that the pear is glued to the bowl. The pear will therefore move with the bowl, yet we would not use IN, rather UNDER. This appears to be rather harsh criticism as it is apparent that the bowl is not fulfilling its function as a container as the pear has been artificially stuck to the bowl. What is more functionally salient is the fact that there is support from the force of gravity provided by the glue sticking the pear to the bowl. It should also be noted that the Garrod and Sanford paper does not attempt to describe what the controlling space may be it only suggests that there is one.

The paper focuses also on the geometry, the spatial aspects, of a configuration. Mental models are suggested to represent the scene with spatial entities (points, lines, volumes, regions of space) associated with the objects in the scene. The model then represents significant spatial relations between those entities. So, spatial models represent the "functional geometry" of scenes. It must be pointed out that one would need to very clearly specify any geometry used.

Garrod and Sanford note that the term "geometric construct" could be replaced by the term "conceptualisation". This liberalises the dimensionality specifications and Vandeloise (1991) makes a very similar point when he notes that dimension is not of vital importance. He suggests that it is secondary in most cases and in some uses of spatial prepositions it is not required at all.

Finally, it is important to note that Garrod and Sanford realise that their account of functional geometry is a but a "sketch of the kind of psychological-semantic analysis which it is desirable to perform on locatives" (p.159). They show that geometric interpretations in the world are inadequate and direct us to the use of Functional Geometry.

5.9 Coventry and Functional Relations

5.9.1 A Minimally Specified Account

Coventry (1992) presents an account of the semantics of spatial prepositions that is closely based on the work of Garrod and Sanford (1989). Coventry does investigate how the spatial world and spatial language covary. Basically, he cites the preliminary study by Ferrier (1991) (see PREP1 studies in Chapters 7 and 8) and then proceeds to carry out a similar study using a different methodology (which will be discussed in Chapter 10). His functional relations are formulated from Herskovits (1986) in the Garrod and Sanford (1989) functional mould. However, focus for Coventry centres around the argument that minimally specified entries are psychologically viable. A series of experiments which examine whether use types (as suggested by Herskovits, 1986) are indeed separate senses were carried out. An experiment from Coventry (1992) is now presented as an example of this work.

5.9.2 Coventry: Sense Delineation

This experiment involved presenting subjects with sentences with blanks which were paired with pictures. The blank is where a preposition can be added (although subjects were free to enter any suitable phrase). Two simple sentences were paired with two corresponding simple pictures. These two simple pictures were also combined and the sentences presented together. IN, ON and AT were investigated. Figure 5.10 shows examples from the IN condition.

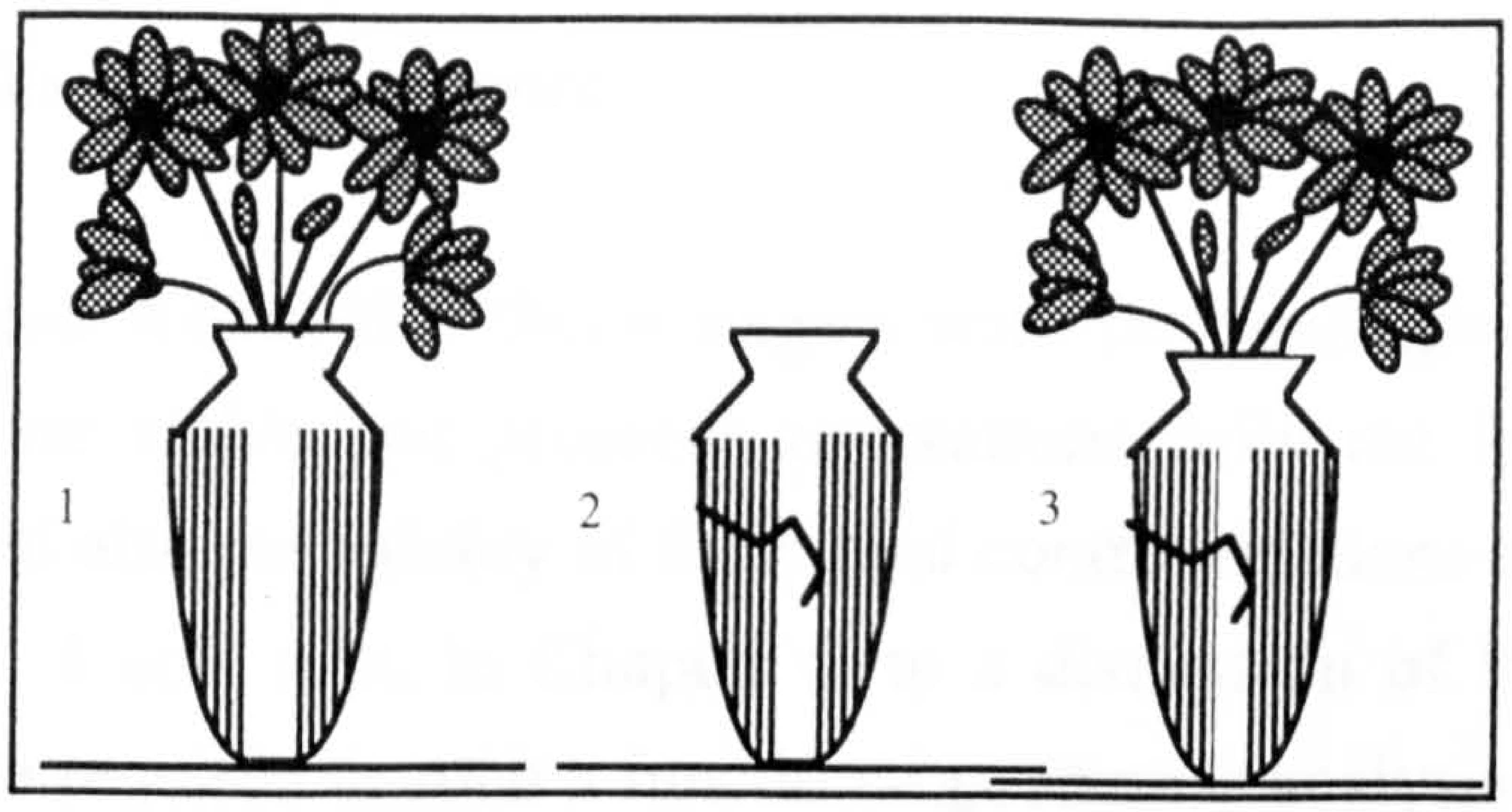


Figure 5.10 - Flower and Crack Variations from Coventry (1992).

Scene 1 was accompanied by the sentence "The flowers are ___ the vase". Scene 2 was accompanied by the sentence "The crack is ___ the vase". Scene 3, which involves a combination of both the flowers and the crack, was accompanied by both sentences. Coventry's aim was to find out whether subjects switched preposition, where possible, in this free association task when they were confronted with the combined picture. It was suggested that if they did switch it would be as a consequence of the preposition being used in two different ways (use types).

For the flowers and vase scene the Herskovits use type would be "spatial entity in container" and for the crack and vase scene the use type would be "gap/object embedded in physical object". In the combined example both use types are represented in the scene. If the use types are different senses then we can predict that IN will not be used in both sentences. Coventry predicted that if this was the case then subjects would use an alternative preposition for one of the sentences.

No significant difference was found between responses for the simple sentences and responses for the complex condition. Subjects use the same preposition, for the example in Figure 5.10 the choice was most likely to be IN, in the complex condition. Coventry suggests that the use types proposed by Herskovits (1986) for IN and ON need not be explicitly represented in the lexicon.

5.9.3 A Link to the Present Account

The work presented within this thesis begins with the assumption that minimally specified entries are viable and proceeds to examine fully the factors involved in location control and also the validity of functional control relations as the predictors of prepositional use. I now turn, in Chapter 6, to a discussion of the kind of mental models that will be required in such a functional geometric analysis and present a full exposition of the functional control relations involved in the prepositions IN, ON and OVER. I thus hope to provide the "psychologically motivated semantics of locative prepositions" (p.160) hoped for by Garrod and Sanford (1989).

Chapter 6

Functional Geometry: A Geometry Without Angles

6.1 Introduction

This chapter introduces the theory of functional geometry. The importance of functional factors will be discussed; functional definitions and control relations fully explained. As must now be familiar, the previous work in the area of spatial language is split roughly into Classical approaches and Cognitive Linguistic (including polysemical and prototype) approaches. In this chapter I briefly summarise the problems that have been found within these frameworks and the aspects of Classical and Cognitive Linguistic approaches that I wish to salvage. I then discuss the kind of geometry that would be required in order for these previous accounts to work (Crangle and Suppes, 1989, Suppes, 1991). This leads into an introduction of the functional geometric account proposed in this thesis. I introduce force dynamics (Talmy, 1988) and qualitative spatial reasoning (Cohn, 1995) both of which help to provide a "cognitive geometric" framework for our theory. The functional geometric mental models suggested by Garrod and Sanford (1989) are discussed. Their theoretical paper gives the present work its main foundation and starting point. Functional definitions and their functional controls are then presented. The arguments for these functional controls give rise to hypotheses which are examined experimentally in the next three chapters.

6.2 Previous Accounts Considered

6.2.1 Classical Accounts Examined

Previous chapters of this thesis have shown that a cohesive and psychologically acceptable account of the semantics of our language for space has proved elusive. Classical or objective accounts, such as those by Cooper (1968), Leech (1969), Bennett (1972) and Miller and Johnson-Laird (1976) present componential approaches that require necessary and sufficient conditions for use. These are simple relation accounts where the preposition is associated with a representation that can be decomposed into spatial primitives. None of these simple relations can adequately account for the wide range of prepositional uses.

To summarise, some of the uses of spatial prepositions that are not explained by these simple relations are stated. Basically, some approaches do account for a few of these cases but none account for all. These includes cases when:

1. x is partly included by y (the flowers IN the vase).

2. x is not geometrically included by y (the ball IN the bowl).

3. x is larger than y (the tennis racket IN the hand).

4. x is not in the expected geometric relation to y (the lightbulb IN the socket).

These representations are shown pictorially in Figure 6.1.

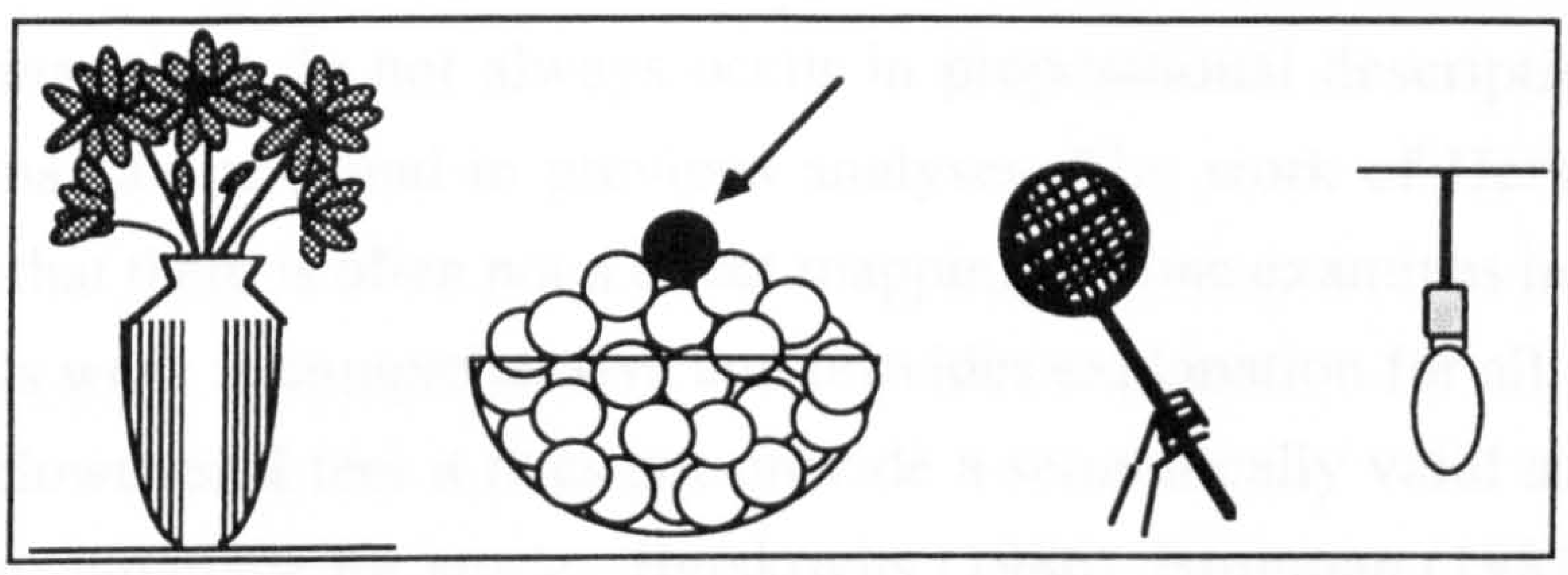


Figure 6.1 - Pictorial Representations of Appropriate IN Usage.

There are also many cases where the geometric relations or conditions of their notations do hold yet the predicted preposition would be unlikely to be used to describe certain situations. For example, Figure 6.2 shows a geometric representation which should, according to Classical accounts, be described as "the ball is IN the bowl". However, it is clear that English language users would be more likely to describe this scene as "the ball is UNDER the bowl".

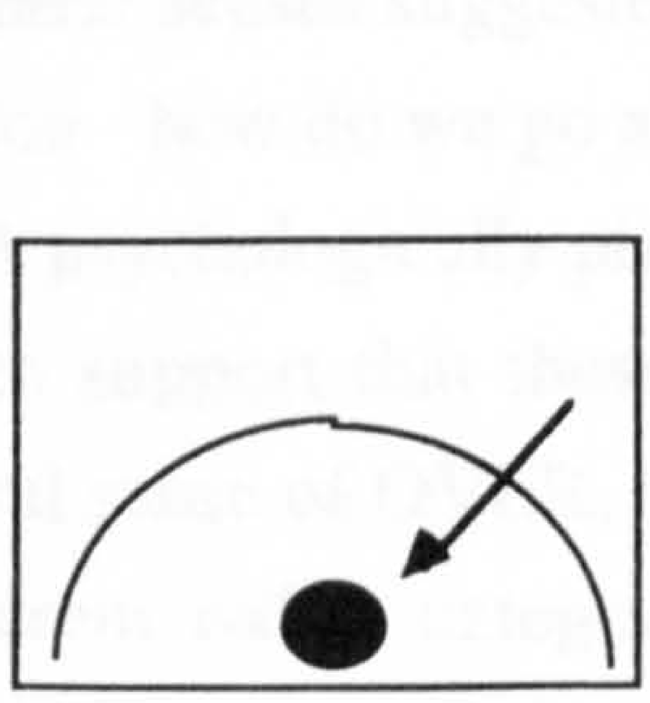


Figure 6.2 - The Ball is UNDER the Bowl.

These traditional analyses of spatial language attempt to show that linguistic expressions such as IN and ON have simple and direct relations to the state of affairs in the real world. Such a viewpoint contributed to the loss of favour felt by classical approaches. Clearly, these simple relations do not account for the multiplicity of prepositional use.

6.2.2 Cognitive Linguistics Examined

Cognitive Linguistic accounts such as Herskovits (1986), Vandeloise (1991), Cienki (1989), Brugman (1981), Lakoff (1987) and Brugman and Lakoff (1988) present accounts that require full specification of the spatial terms. These accounts do recognise, to some extent or another, the importance of functional factors.

Direct spatial mappings do not always occur in prepositional descriptions and many hidden problems can be found in previous analyses. The work of Herskovits (1986) does recognise that there is often not a direct mapping. If one examines her account it is obvious that this work is comprehensive and provides explanation for all uses of spatial prepositions. However, I feel it does not provide a semantically valid account of how we represent our language for space. Herskovits (1986), Brugman (1981), Vandeloise (1986), Cienki (1989) and Lakoff (1987) all present a full specification, prototype oriented account and objections to such approaches (such as the lack of cognitive economy) were fully discussed in Chapter Five.

Herskovits presents an account that in some ways bridges the gap between classical/objective approaches and the polysemical/prototype notion accounts. She posits a "core" meaning for a preposition. Unfortunately, this core meaning is spatially geometric in nature, as are the central senses suggested by Brugman and Lakoff. This leads us to ask the pertinent question - how do we go about selecting what should be the core or central geometric sense? A psychologically plausible core or central sense is the goal. Yet there is no evidence to support that these researchers have selected one. Certainly if one changed the central sense of OVER, the work by Brugman (1981) and Lakoff (1987) would yield different radial categories and secondary senses. As previously discussed in Chapter 4, there is very little evidence to support the conclusion that the central sense or ideal meaning proposed should be geometric in nature. What appears to be important is the functionality of the objects that we interact with in the world.

6.2.3 Classical and Cognitive Linguistic Accounts: Elements to Save for a Functional Geometric Theory

The present approach takes positive aspects from both Classical theory and Prototype theory. As previously discussed in Chapter 4, it is suggested that full specification should be abandoned in favour of a minimal specification of lexical entries. However, philosophical considerations of the Cognitive Linguistics approach have much to offer. I agree with the experientialist notion that perceptual and cognitive interaction with the world is of great importance. The paper by Garrod and Sanford (1989) and work by Coventry (1992) both take what I feel to be the positive elements from both the Classical and the Cognitive Linguistic approaches. I turn now to a consideration of the geometry involved in spatial language.

6.3 The Geometry of Space

6.3.1 What Geometry?

The previously discussed approaches can be further defined. One can describe them as classical versus cognitive linguistic, full versus minimal specification, prototype versus necessary and sufficient conditions and so on. The one thing that they do all agree on (with the notable exception of Vandeloise, 1991) is that the "core meaning" or "central sense" should be seen in terms of geometric relations present in the world. In other words, the core meaning or central sense is seen as primarily spatial. However, not one of these spatial, geometric approaches to locatives attempts to define the kinds of geometry that would be required.

More recent approaches recognise the vital importance of functionality (Vandeloise (1991), Garrod and Sanford (1989), Coventry (1992). However, it is important to recognise that even the approaches that do present a mainly functional approach do not give an account of the type of cognitive geometry that would be required. Indeed, Cuyckens (1993) criticises Vandeloise (1991) for his restricted interpretation of "functional". Vandeloise presents a cognitive-semantic analysis based on functional concepts but excluding any notions of the geometry involved. As Cuyckens points out:

> Geometric concepts are just as functional as Vandeloise's (properly functional) non-geometric concepts in that both result from our conceptualisation, perception, and interaction with the world.
>
> Cuyckens (1993), p.306

Coventry (1992) does attempt to provide some insight into this issue via his discussion of Talmy (1988). This work on force dynamics will be presented later in this chapter. Both geometric and functional concepts need to be represented in some kind of cognitive geometry of space. This kind of geometry should take into account the use of natural language. I turn now to a discussion of the kinds of geometries that might be required.

6.3.2 Crangle and Suppes: Geometrical Semantics for Spatial Prepositions

Crangle and Suppes (1989) recognise the lack of attention given to the types of geometry that would be needed to discuss spatial prepositions. In their paper they attempt to classify the types of geometry that they think might be involved in the use of locatives. This argument makes sense. The previously discussed approaches present accounts that involve the importance of spatial factors yet none of these accounts include any attempt to explain how we talk about these objects in the world. Analyses such as Bennett (1975) and Herskovits (1986) do recognise that we need geometrical and physical notions. However, no details are given of what these notions might be like. Crangle and Suppes (1989) point out that the problem partly lies in the fact that Bennett (1975) emphasises the relationship of words to other words and not the relationship between words and the world. Turning to Herskovits (1986) it can be seen that she makes no attempt to make explicit terms such as "interior" and "contiguous".

Crangle and Suppes (1989) recognise that any geometric representation of these accounts would have proved difficult to give using standard geometries. Instead, they present their own interpretation and draw the distinctions presented in Table 6.1.

Topology	The pencil is IN the box (box closed) One piece of rope goes OVER and UNDER the other
Affine geometry	The pencil is IN the box (box open) Mary is sitting BETWEEN Jose and Maria
Euclidean geometry	The pencil is NEAR the box
The geometry of oriented physical space	The book is ON the table Adjust the lamp OVER the table
Projective geometry	The post office is OVER the hill The cup is to THE LEFT OF the plate
Geometries that include figures and shapes with orienting axes	The dog is IN FRONT OF the house
Geometry of classical space-time	She peeled apples IN the kitchen

Table 6.1 - Kinds of Geometry and Examples of Prepositional Use from Crangle and Suppes (1989).

This complex geometry is given further information by the use of context. For example, the affine geometry for "the pencil is IN the box" (box open) can be represented as:

P is contained in the convex closure of B

where the convex closure is the set of all points lying on any segment connecting any two points in B. So using this affine geometry for "the flowers IN the vase", it becomes apparent that we need to make adjustments as only the stems are in the convex closure of the vase. Context has to fully come into play in a case such as "the infection IN his arm". The notion of containment is kept but it is a phenomenon rather than an object that is contained in the arm. This means that the affine geometry which states "I (infection) is contained in the convex closure of the A (Arm)" does not work; we need to rely on contextual features in order to explain this case.

6.3.3 The Need for a Cognitive Account of Space

It is easy to see that these geometries are complex and, with the addition of context issues, rather cumbersome. If we did use such geometries as language users then the process would certainly not be at a conscious level as most people do not have such a knowledge of geometry. Crangle and Suppes (1989) are basically saying that we apply a particular type of geometry to a particular spatial expression and any further information required is gained by the use of context. It is important to note that this example of the geometries, which we might require to use spatial language, relies on the familiar use of point, line and plane. Crangle and Suppes (1989) do recognise that this is unsatisfactory and that locatives must be expressed in terms of figures and their parts.

I argue that such a complex, mathematical geometry is not required. A cognitive account of space that recognises the interaction, by perception and conceptualisation, of language users and the world is required and which does not take as its starting point the points, lines and planes of Euclid and his successors. The functional account does not categorise different senses of a spatial preposition in terms of the different geometric representations that exist for it. Instead, it focuses on a functional sense as primary. This "core meaning" can yield the intuitively simple account that is sought and such a functional core is simply given different mappings in the world (rather than yielding different geometric relations and thus distinct, yet related, senses). Any geometry used for this functional account would be far removed from the geometry suggested by Crangle and Suppes. The geometry of point, line and plane has very little, and in some cases nothing, to do with the spatial prepositions (Coventry, 1992). Indeed, as Crangle and Suppes (1989) realise:

> It is clear that the geometry underlying ordinary language is intrinsically of a different character, being deeply intermixed with physics...There is not a well developed foundation in these terms and we are not able to begin where we would really like to. It is a matter for research not yet undertaken to provide a foundation of geometry more closely matching the use of concepts in ordinary language.
>
> Crangle and Suppes (1989), p.404

I feel that such research is now underway. Cohn and colleagues (1995, 1996) present a qualitative theoretical approach that deals with the kind of cognitive geometry that may be required in a discussion of space. This cognitive geometry will be discussed fully in relation to the functional geometric relations to which I must now turn.

6.4 The History of Functional Relations

6.4.1 Garrod and Sanford: Mental Models

The present argument uses as its launching point the discussion about functional relations given by Garrod and Sanford (1989) (for an account of this work see Chapter 5). I focus here on their account and use of mental models as interfaces between real and discourse world and then go on to discuss a possible cognitive geometry of space. Garrod and Sanford propose that language only relates to the world in a principled way through the use of <u>mental models</u>.

This approach takes into account the cognitive linguistic claim that language is not directly reflected in the world. So the utterances that we use, for example "the ball is IN the bowl", are only given their exact meaning in relation to these mental models. Garrod and Sanford suggest that a conceptual world is built up to represent the <u>functionality</u> of the relationship between objects in the environment rather than simply dealing with geometric relations directly in the world. Mental models may represent spatial relations using a functional geometry dependent on interaction with the environment.

As previously discussed, <u>functional control relations</u> define the use of spatial expressions and these are represented within mental models. This functional account places focus on the importance of location control; this is the way that a relatum controls the location of a referent through the physical forces of the world.

6.4.2 Real Versus Discourse World

It is readily apparent that the use of spatial language does not always follow precise real world rules. Indeed, we quickly come upon problems when we try to relate language directly to the world (as depicted in Figure 6.3).

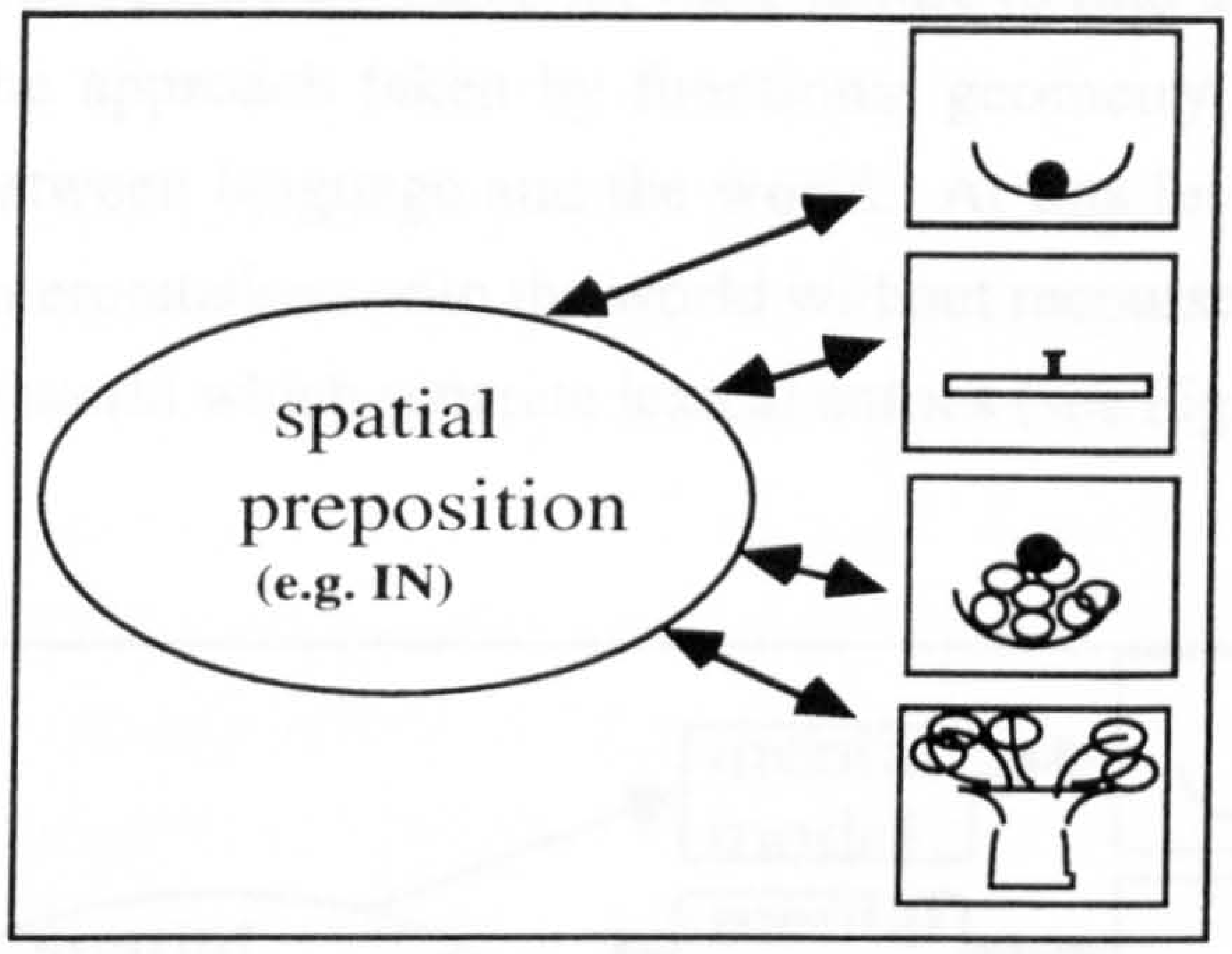


Figure 6.3 - Relating Language Directly to the World.

As Garrod (1991) suggests, we could try and solve the problem by accepting the view that we simply learn associations between words.

So, for example, one can examine Bennett's (1975) definition of IN:

IN: "locative interior" or "in y: locative (interior(y))".

It is easy to see that the core meaning can be applied to the prepositional phrase "The ball is IN the bowl". Firstly, we need to work out which ball-bowl representation could have the ball included in the interior of the bowl. Obviously the ball cannot be found in the substance of the bowl. So one could perhaps imagine a flat lid over the rim of the bowl that defines the space (Garrod and Sanford, 1989, Garrod, 1991). This allows for the use of IN as long as it is to be found within this notational space. However, it does not allow for a myriad of other uses of IN. For example, how can one account for "The crack IN the bowl", "The ball IN the bowl (where the ball is outwith the confines of the bowl) or "The flowers IN the vase"?

Figure 6.3 shows the situation if it was accepted that language related directly to the world. This is the kind of approach to encoding and decoding that was taken by the Classical approaches and partly accounts for their failure to find an ideal meaning within a minimal view. The approach taken by functional geometry states that there is an intermediate level between language and the world. At this level we are able to map different functional interpretations onto the world without recourse to different geometric representations in the world which separate lexical entries (see Figure 6.4).

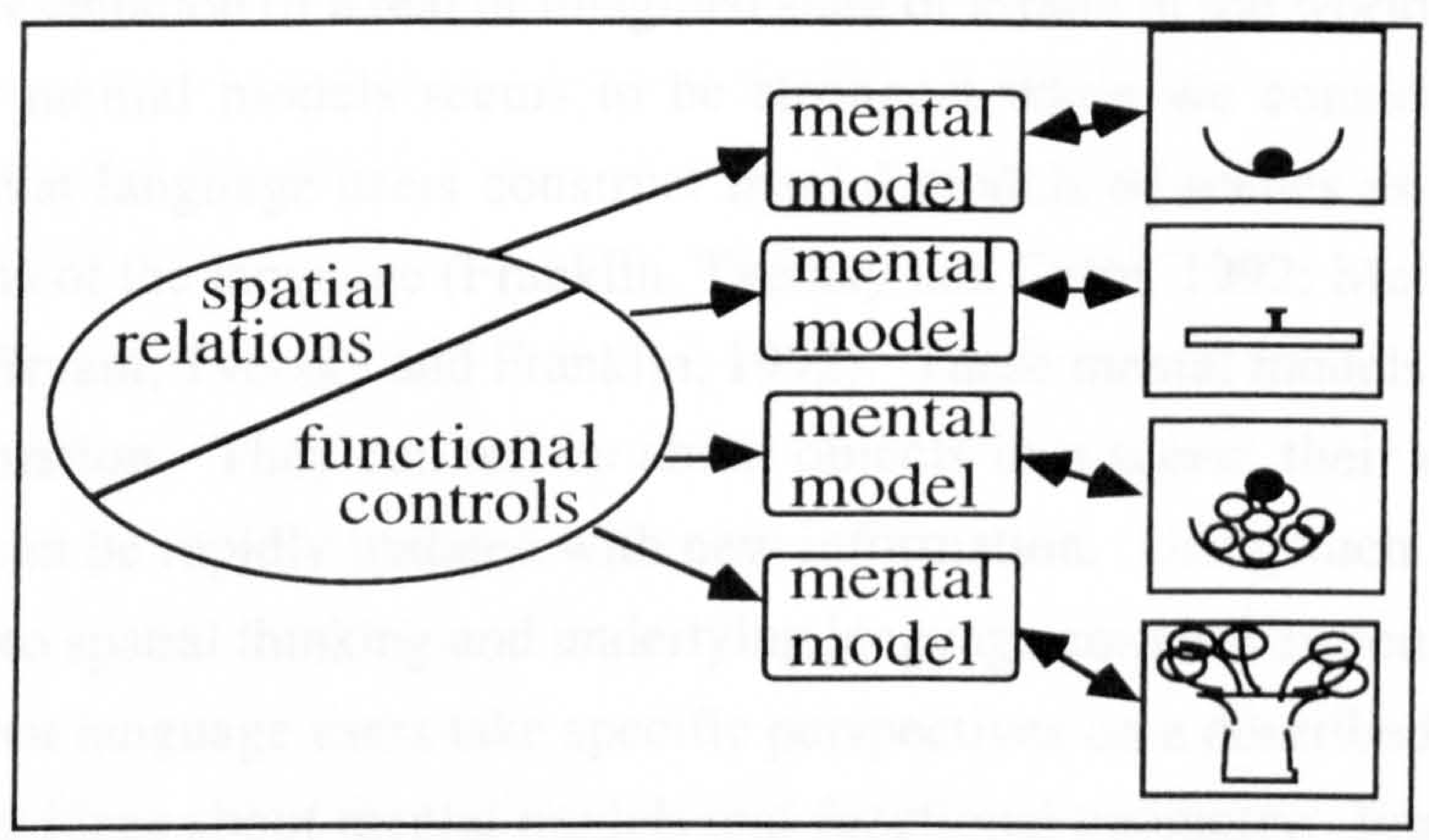


Figure 6.4 - Functional Geometric Mental Models.

6.4.3 Cognitive Mental Models of Space

Garrod and Sanford (1989) and Garrod (1991) claim that language relates to the world through the mediation of mental models. These models are mapped onto the world to produce various interpretations. The functional geometry of a scene is represented in these models and the functional geometric theory presented in this thesis encompasses this notion of mental models. Garrod and Sanford cite the maze game spatial dialogues (Garrod and Anderson, 1987) as evidence for such models. In these maze games players were each given a maze consisting of boxes connected by different links. Players were not able to see one another and the task was for player 1 to describe where they were in the maze to player number 2. Garrod and Anderson found that these pairs of players developed consistent description schemes. So, for example, some subjects adopted a Line description where they described which level of the maze that they were on and some subjects adopted a Co-ordinate description where they labelled parts of the maze with co-ordinates such as "E, two". Basically, Garrod and Anderson argued that each description type represented a different mental model of the same maze. However, it is important to discuss some further evidence for spatial models and also tackle the problem of indeterminacy.

Cognitive mental models have been proposed for the spatial domain (Johnson-Laird, 1983, Mani and Johnson-Laird, 1982, Payne, 1993, Franklin et al, 1992, Bryant et al, 1992). Johnson-Laird's (1983) conception of a mental model has certainly proved important to researchers within the field of language. Basically, a mental model is an analogue representation of a real or imagined state of affairs in the world (Payne, 1993). The case for mental models seems to be strongest when we consider space. The argument is that language users construct mental models of scenes as well as mental representations of the language (Franklin, Tversky and Coon, 1992; Mani and Johnson-Laird, 1982; Bryant, Tversky and Franklin, 1992). These mental models contain a great deal of information. They can tell us about objects in a scene, their orientation and location and can be rapidly updated with new information. Using such models we can get insights into spatial thinking and underlying language comprehension. Franklin et al (1992) state that language users take specific perspectives on a described scene and this fits in with our ideas about mental models and functional geometry. Franklin, Tversky and Coon (1992) note that:

> Although spatial mental models are derived from knowledge about the perceptual world, behaviour in an imagined world and behaviour in the real world do not always coincide.
>
> Franklin et al (1992), p.517

The functional models proposed initially by Garrod and Sanford (1989) account for this lack of direct connection between real and discourse world.

Imagery has been shown experimentally to constitute an appropriate mental model when we have determinate descriptions, i.e. ones which are specific. However, it is important to account for situations where there are indeterminate descriptions, since analogue mental representations are unable to deal with such descriptions. Indeed, Mani and Johnson-Laird (1982) showed experimentally that subjects could remember determinate descriptions far better than indeterminate ones.

Ioerger (1994) argues for an image based method of reasoning called ISR (indeterminacy in spatial reasoning). This dynamically constructs and examines multiple images in order to reason about locative phrases. Ioerger (1994) highlights the problem of indeterminacy by using a description given by Waltz and Bogess (1979).

Imagine the following description: "A fly is ON the wall. A shelf is ON the wall". You now have a mental representation of this scenario. If your constructed image involves the fly being below the shelf, then you would answer "yes" when asked "Is the fly below the shelf?". Ioerger points out that the answer should have been "unspecified" as the fly could in reality have been above the shelf. However, a specific image must be constructed so you arbitrarily choose exact locations for fly and shelf at some location on the wall.

Similarly, if told that "The ball is IN the bowl" you will form an image of a ball being in a bowl. If asked "Is the ball within the confines of the bowl?" and you answer "yes" again your answer should have been "unspecified". The functional geometric approach needs mental models that can represent multiple images of functional controls. Ioerger terms this problem the Indeterminacy Problem. How can it be solved?

What we need to do is reason with multiple images in order to have a mental model that can represent different facets of control. This results in a more dynamic model which can be used to reason about spatial descriptions that are indeterminate (Ioerger, 1994). If we examine Herskovits (1986) we see that she uses sense shifts to differing use types in the world. Her notations are rejected as they involve geometric relations in the world but also it is important to note that her need for sense shifts is nullified by the use of ISR multiple images.

The functional mental models argued for in this thesis are suggested to be dynamic and able to deal with multiple images of functional control.

6.5 A Geometry Without Angles

6.5.1 Introduction

The functional theory presented in this thesis argues several points. It states that functional, rather than geometric factors, are of primary importance. It also regards language as mediated by dynamic mental models embodying functional notions. Functional definitions for IN, ON and OVER are presented. It is suggested that language users take dynamic notions into account when selecting a spatial preposition. As was discussed earlier in this chapter, I accept much of the tenets of the Cognitive Linguistic approach. However, I am against the full specification of lexical entries for the reasons discussed earlier.

The functional definitions which are presented involve minimal specification in the mental lexicon. Inherently dynamic functional control relations of fContainment, fSupport and fSuperiority are argued to define the use of the spatial prepositions IN, ON and OVER respectively. These control relations and their ideal meanings are presented. It is proposed that each definition can be expressed by functional location controls which are dynamic in nature and it is suggested that language users make dynamic predictions, using these location controls, when selecting an appropriate preposition. The origins of the present notations have been traced (Herskovits, 1986; Garrod and Sanford, 1989) and my definitions build and expand upon these basic ideas.

Prior to this discussion of functional control relations, I examine how such functional notions of space can be represented cognitively. It is important to present not only a theory of the semantics of locatives but also recognise that an account of the cognitive geometry of space is required. A qualitative view of space proposed by Cohn (1996 a and b) is suggested as the starting point for such a cognitive geometry. Functional location control involves dynamic predictions and notions of force: one object must exert a type of dynamic force on another object. Similar notions of force presented by Talmy (1988) are also discussed. It is important to note that both Cohn (1996 a and b) and

Talmy (1988) provide accounts which are motivational in nature rather than definitional. Finally, I present a set of hypotheses which form the basis for the experimental work presented in the following three chapters.

6.5.2 The Functional Model: Ideas for a Geometry of Space

As was shown, the kind of geometries required to explain many of the previous approaches would be incredibly complex and rather unsuitable. Crangle and Suppes (1989) recognise that there has been a great lack of attention given to the cognitive geometry of space. One of the main problems is that we cannot characterise ordinary language with the notions of point, line and plane. Qualitative Spatial Reasoning (Cohn, 1996) is an account of space which, to a certain extent, complements the present Functional Geometric approach and helps explain these issues. Qualitative Spatial Reasoning is presented as an example of an alternative to focusing on points, lines and planes.

6.5.2.1 Qualitative Spatial Reasoning (QSR)

The language that we use to describe space is concerned with objects that are in the real world and not with the issues of point, line and plane. Crangle and Suppes (1989) were able to recognise this but unable to take the idea further. However, there is a recent approach, found within the field of artificial intelligence, termed qualitative spatial reasoning (QSR). This approach is committed to developing a qualitative theoretical approach to the cognitive geometry of space. As I have noted, little attention has been paid to the kind of geometry which might underlie spatial prepositions such as IN and ON. Primitive unanalysed spatial relations such as "enclosure" and "contact" have been offered but standard geometries have difficulty defining such geometric invariants. Most of our language about space is about objects in the real world and so trying to fit standard geometries around spatial language proves to be a difficult and pointless task.

This QSR account treats "a region of space" as the fundamental primitive and attempts to provide calculi which would allow a machine to represent space in more than one dimension. This is achieved without recourse to the quantitative analysis found in standard geometries. Cohn (1996a) notes that space is multidimensional and has not been adequately described by scalar quantities. The "region of space" as the fundamental element or starting point seems to be a more logical approach. Qualitative spatial reasoning can be applied to a variety of areas including robot navigation, engineering design and of course the semantics of spatial prepositions in natural language.

Locatives present perhaps the most obvious domain needing some kind of qualitative representation (Cohn, 1996a). The functional account, presented in this thesis, takes the emphasis away from the geometric and spatial; yet we must recognise that purely spatial representations do occur and that spatial factors are necessary for a complete account of prepositional use. What we need to find is a formal way of describing the meaning of natural language spatial prepositions (Cohn, 1996a), a way of understanding the space of ordinary language. Cohn begins his discussion of natural language with the recognition that it will be a difficult task due to the multiplicity of prepositional use.

6.5.2.2 Abandoning Points, Lines and Planes

It is traditional for a mathematical theory of space to consider points and lines as the primitive spatial entities. Such a theory sees regions as sets of points. The approach taken by QSR however recognises that the primitive spatial entities are regions. If required the points can be defined from regions. Why regions? Cohn lists several reasons:

1. in order to discuss physical objects it makes sense to argue that their spatial extension would be like a region rather than a lower dimensional entity.

2. when we use the word "point" in natural language we are not meaning a mathematical point.

3. it seems against intuition that regions can be defined as points with no dimensions which do not occupy a space.

adapted from Cohn (1996a), p.5

QSR readily accounts for notions such as enclosure even in the cases where objects have indeterminate boundaries.

6.5.2.3 RCC Theory: The Pointless Geometry

This theory of space has been termed RCC theory and it developed from work in the tradition of "pointless geometries" (Clarke, 1981, 1985; cited in Cohn, 1996b). RCC is a logical theory of space concerned with the problem of qualitatively representing the shape of a region. Regions are seen as primitive and therefore it is possible to define a wide range of spatial relations simply in terms of two primitive relations concerning space: Connection and Convexity. I first turn to an examination of the primitive Connection.

Connection is a broadly defined qualitative relation which ranges from simple contact/overlap between regions to the identity of regions. It is concerned with the closures of a region sharing a point. This collapses the distinction between a region, its closure and its interior as it is argued that these have no relevance for QSR. The definition for Connection is as follows: C(x,y)="x connects with y, where x and y are regions". The primitive is concerned with two regions, x and y, connecting. Connection is a powerful primitive and it is possible to use it to define many predicates and functions which capture interesting and useful topological distinctions. This can be given a topological interpretation in terms of points incident in regions. So it can hold when the topological closures of regions x and y share at least one point.

The second primitive relation is called Convexity. This notion relates to the presence in a region of interior spaces. These spaces are defined by the convex hull of the region (Cohn, 1996). This is the result of drawing a line or projecting a surface around the edges of the region in question. The notion of a convex hull is defined as **conv**(x) and is represented in Figure 6.5.

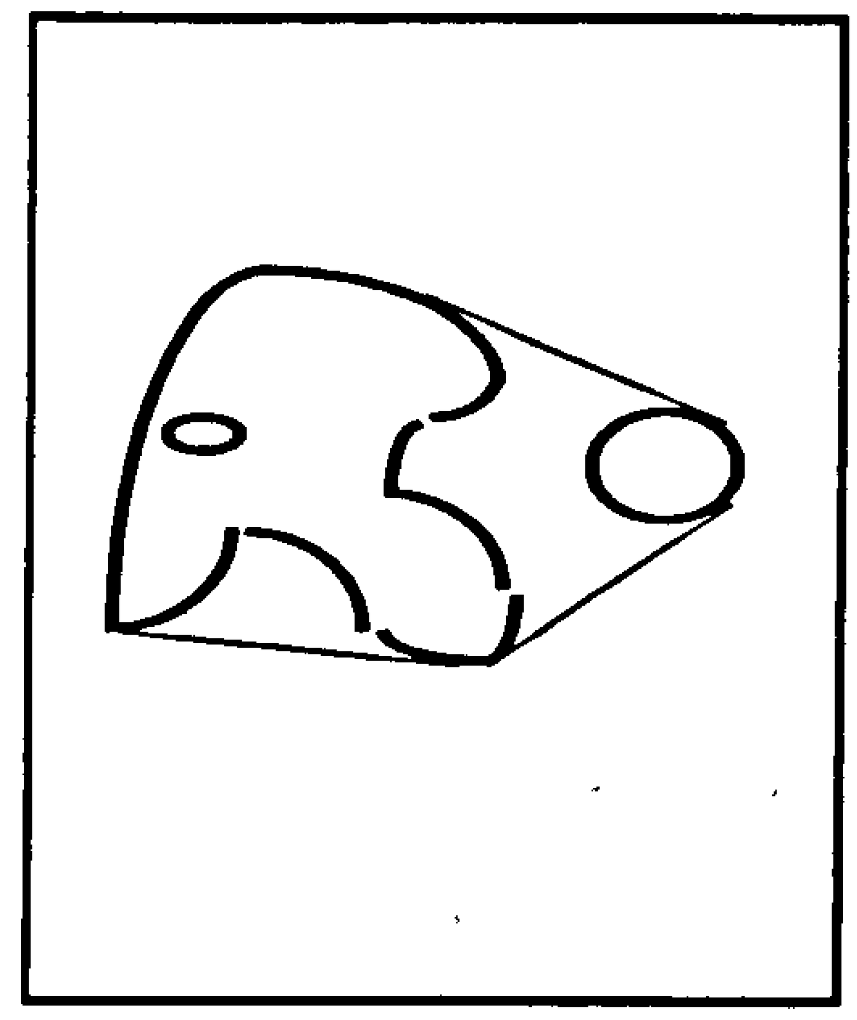


Figure 6.5 - The Convex Hull.

This primitive notion allows for geometric relations such as Topologically-inside (where inside is the part of the convex hull that is not occupied by the region itself), Scattered-inside and geometrically-inside to be properly defined without the use of traditional geometric notions of point, line and plane. Geometrically inside in 2D includes geometrically scattered inside and just geometrically inside. This geometric notion further subdivides into tunnel-inside and containable-inside.

6.5.2.4 QSR and Functional Geometry

It should be noted that QSR is but an example of the type of geometry that would be required to discuss space. It is clear that one cannot solve the geometry of space by discussing points, lines and planes and QSR is discussed because it places the importance on regions. QSR notions could be applied to the understanding of locative expressions. The notion of scattered inside can be exemplified by the case "The bird IN the tree" (see Figure 6.6).

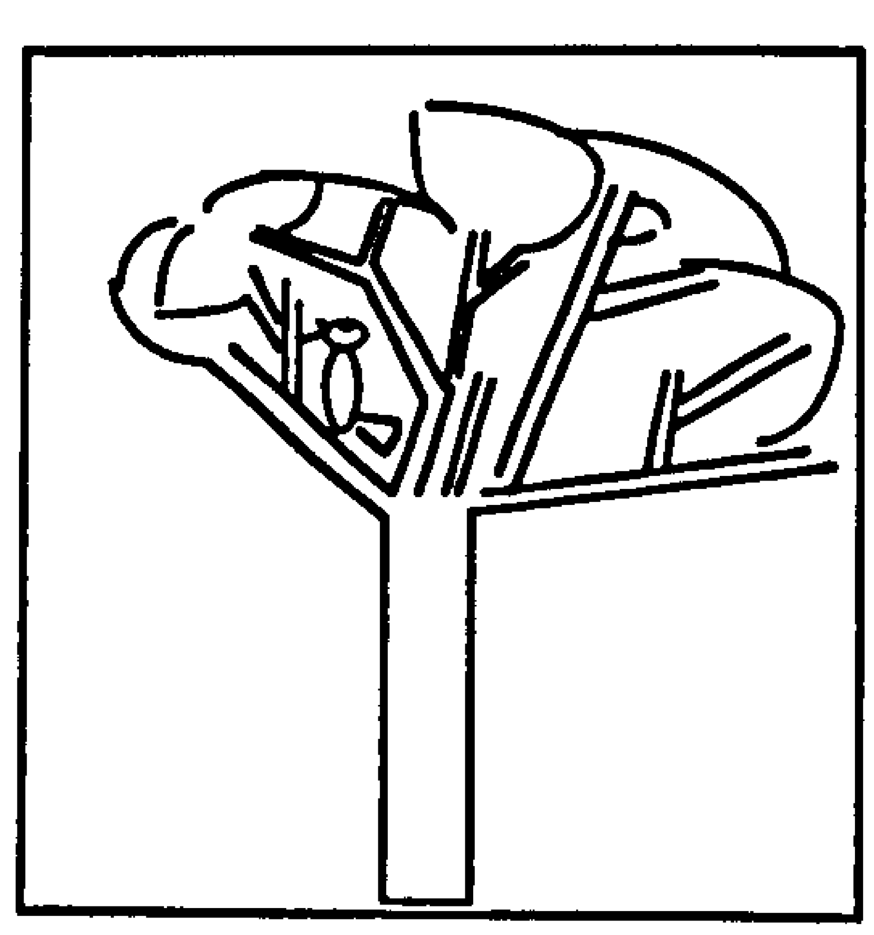


Figure 6.6 - The Bird IN the Tree.

Herskovits (1986) explains such a usage of IN as the bird being in a geometric volume bounded by the outline of the tree's branches. The notion of scattered inside does seem intuitively more appealing and more in line with a functional account. The notion of geometric inside can also be used to explain the cognitive geometry of cases such as "The flowers IN the vase" (see Figure 6.1). The weakest notion of being IN is the case where one region (x) is "IN" another region (y) when it overlaps with the region defined by the other's convex hull. Traditional geometries cannot adequately explain all these "senses" of IN and this particular geometry is an improvement in many ways.

This simple kind of qualitative geometry does go some way to giving us an intuitively satisfying account of our idea of IN, in terms of spatial enclosure. The most straightforward notion of IN is surely the case where the referent x region is fully enclosed by the region of the relatum y. This is a very basic spatial use of IN which could be explained by more standard geometries. However, IN is used in a myriad of ways which are not representations of this. It is more often the case that the referent is simply part of the convex hull of the relatum, i.e. outwith the spatial confines of the relatum. RCC theory could provide a cognitive geometric explanation for cases such as "the ball is IN the bowl" when the ball is outwith the confines of the bowl (see Figure 6.7).

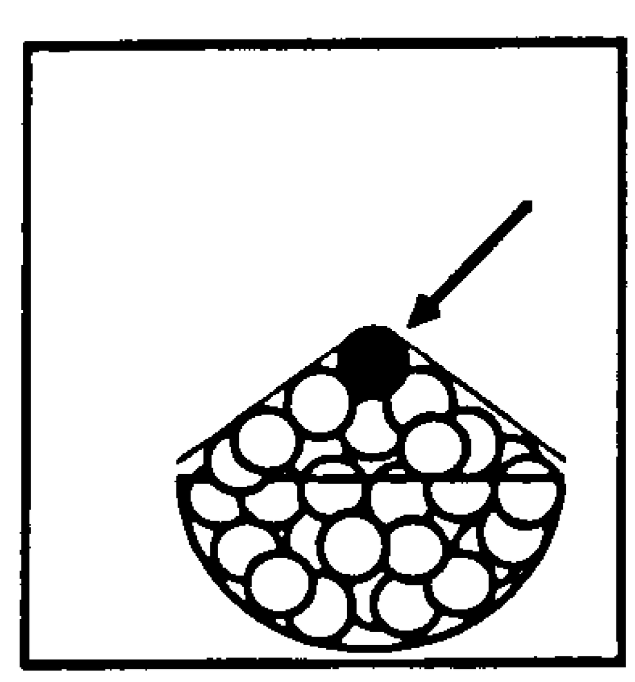


Figure 6.7 - The Convex Hull for Balls and Bowl Provided by RCC Theory.

Basically, the target referent ball (x) displaces a region which is geographically in the region defined by the convex hull of the bowl (y) and the other balls. Also this latter region of ball and bowls is connected to the ball (x). So by applying the notion of transitivity, the target becomes weakly enclosed by the bowl. Indeed, it is hypothesised that there should be a systematic drop in confidence in the IN judgements for situations where the ball is progressively further away from the confines of the relatum bowl.

Using this QSR account one can also give a geometric account of enclosure for dynamic situations which are extensively covered by the experimental work to be shown. Take the example of a bee buzzing around in a jar. People are likely to say that the bee is IN the jar. The bee can be seen as within the convex hull of the jar. It is in this vein that I make a hypothesis; in cases where the referent (x) is seen to be moving within the region of the convex hull of y the judgements of IN will not be reduced. This kind of dynamics should not lower judgements as the movement is within the convex hull and therefore accountable for.

Of course the inclusion of a referent (x) in the convex hull of a relatum (y) cannot fully describe the preposition IN. What this approach does is present some pertinent ideas of the kind of pointless geometry required to discuss spatial language. One should also note that there is a difficulty in setting the criteria of what constitutes a convex hull. If the QSR approach was used then the fly shown in Figure 6.8 would be rated as "IN the glass". This is clearly not the case even though the fly is in the convex hull of the relatum.

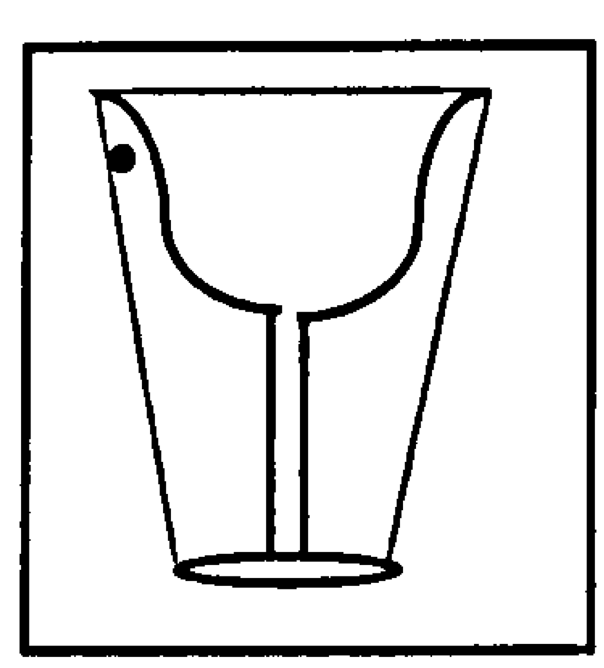


Figure 6.8 - ?The Fly IN the Glass.

The role played by the convex hull here would yield an incorrect definition. It should be noted that although the notion of convex hull works well in 2D it does not fare so well in 3D. The functional theory focuses on dynamic predictions made by language users which provide information for selecting appropriate prepositions. It is important to note that the dynamic location control prediction relating to selection of IN (fully discussed later in this chapter) states that when the glass moves the fly will move with it, in a correlated manner, by virtue of some degree of containment. The dynamic prediction cannot be upheld in Figure 6.8 and this fact more adequately explains why the fly is not IN the glass. QSR representations rely on the pure logic of space and cannot, therefore, deal with dynamic effects. Certainly, QSR provides an example of the genre of geometry that would be required but it is not proposed as the geometry on which functional primitives are based.

However, these geometric notions of enclosure go a long way to help explain the kind of "angle-free" geometry involved when we use spatial language. We interact with the world as we see it; interpreting it with our own conceptualisations and perceptions. The world may be spinning round constantly at an amazing rate but this fact is not of any immediate importance to us and does not form any part of our mental representations for navigating space. This is because such a factor is irrelevant. Similarly the kind of mathematicians' geometry that could be provided to explain spatial relations is really irrelevant to language users. I am interested in what objects can be used for, how objects interact and not with complicated notions of point, line and plane. The qualitative geometries described by Cohn and his colleagues yield work which can support powerful and intuitively plausible spatial reasoning. The QSR approach can be used to help describe the geometry of mental representations.

6.5.2.5 Conclusions

Qualitative spatial reasoning provides a motivational framework suited to our intended description of the cognitive geometry of space. However, the QSR approach alone is not sufficient as there are other factors involved in our navigation of space. Contact or enclosure is not enough when we can perceive that there is some kind of altered control. One must recognise dynamic notions of control as central to the functional geometric theory and it is important to be able to represent these notions of location control. The forces that are applied between objects are vital in the functional geometric theory and I now turn to the work of Talmy (1988). His work makes similar notions of force explicit.

6.5.3 The Functional Model: The Importance of Force

6.5.3.1 Force Dynamics

Talmy (1988) argues that a semantic category exists called "force dynamics". This category deals with how entities, or objects in the world, interact with respect to force. wish to recognise the importance of location control by discussing this related category. Even when referring to a static scene, it is proposed that functional geometry encodes dynamic forces that apply between the objects in a scene. The notion of dynamics is an important one and, as should be now familiar, it is suggested that language users take dynamic aspects of a situation into account when selecting a spatial preposition. Slightly different notions of force represented by location controls are important in the functional approach taken by Garrod and Sanford (1989), Coventry (1992) and, of course, the present work. Talmy's Force dynamics include the following concepts:

1. the exertion of force.
2. the resistance to a force.
3. the overcoming of this resistance.
4. blocking the force.
5. removal of the blockage of force.

Talmy asserts that these concepts are significant in the structure of language and, importantly, in the direct grammatical representation of prepositions. Force dynamics (FD) helps us to reason about the structure and nature of space. As Talmy notes "force dynamics organises (the) conceptions of physics and psychology with the naive as well as the scientific mental models" (p.51). Such a category suggests that relations exist beyond the geometric (Coventry, 1992). The functional geometric account recognises the importance of force and dynamic forces are encoded by the proposed functional geometric control relations.

6.5.3.2 Factors of Force Dynamic Patterns: Agonist and Antagonist

Complex force dynamics can be regarded as exhibiting an opposition of two forces. If we have two entities exerting force, one can be singled out as the focus, or the most salient, entity. We examine whether this entity, or Agonist, can successfully use its force tendency or whether it is overcome by the second entity. The second entity is known as the Antagonist and the effect it has on the Agonist, either overcoming or submitting, is also examined. The force tendency of the entity is either towards motion (action) or towards rest (inaction). The entity that can express its tendency against the opposer is seen as strongest. Talmy's four basic force dynamic patterns are now explained using diagrams adapted from Talmy (1988). The following key explains the meaning of the various symbols:

KEY
Circle = the Agonist and Curved box shape = Antagonist.
Plus sign = stronger entity and Minus sign = weaker entity.
Intrinsic Force Tendency of the Particular Entity: Black dot = entity is toward rest and Arrow sign = the entity is toward action.
The Result of the Force Applied: straight line with an arrow = action occurred and straight line with a black dot = rest occurred.

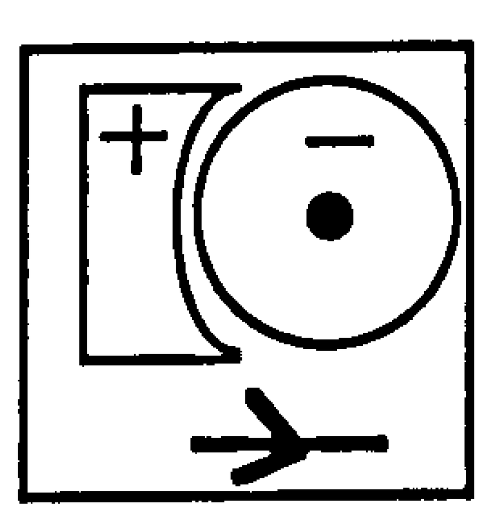


Figure 6.9 - Agonist (Rest) Versus Stronger Antagonist.

In Figure 6.9 the Agonist has a tendency towards rest that is being opposed by the stronger Antagonist. This Antagonist forces the Agonist to move when its tendency would prefer rest. An example would be a bale of hay kept in motion by high winds.

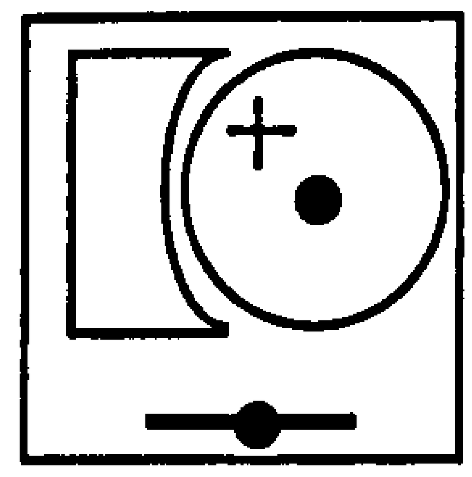


Figure 6.10 - Agonist (Rest) Versus Weaker Antagonist.

In Figure 6.10 the Agonist tends toward rest but in this case is stronger than the opposing force provided by the Antagonist and so is able to stay at rest. An example of this type of dynamic pattern would be someone managing to stay upright during a fierce gale.

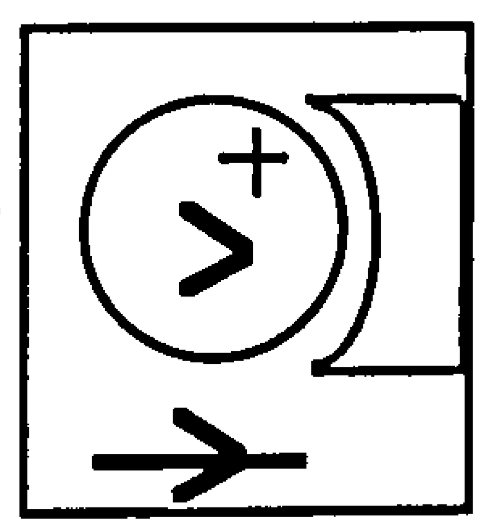


Figure 6.11 - Dynamic Agonist Versus Weaker Antagonist.

In Figure 6.11 the Agonist now wants to be dynamic. It is the stronger of the two and overpowers the Antagonist force opposing it. An example of this kind of pattern would be a person wading through a sticky, muddy swamp.

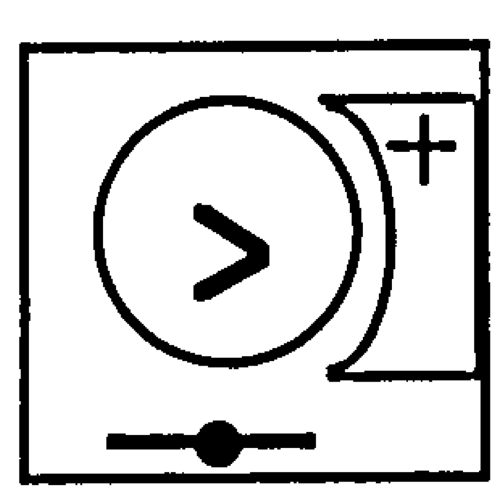


Figure 6.12 - Dynamic Agonist Versus Stronger Antagonist.

In Figure 6.12 the Agonist wants to be dynamic but in this case it is the weaker force. The Antagonist is able to block the Agonist. An example of this kind would be a stone lying stationary on the steep incline of a mountain because it was trapped by a ridge.

6.5.3.3 Force Dynamics and Control Relations

Force dynamics provides a physical and psychological framework to help generalise notions of force. I argue that force and control are important factors in the functional geometry proposed in this thesis. Basically Talmys' work gives alternative recognition to the notion of force as a semantic category and it is presented as motivational to the present notions. It shows that force is an important notion and a slightly different notion of force, involved in location control, is integral to the functional account. Talmy's work provides a psychologically valid way to represent "opposition to the force of gravity" or location control. Functional geometry takes dynamic forces into account and these forces apply between the objects in a scene. Intrinsic force properties can be ascribed to control relations. The work on force dynamics also gives us an insight into "naive thought and provide(s) a ready contrast with rigorous scientific thought" (Talmy, 1988, p.91). Traditional physics notions state that two objects interacting must be exerting an equal force upon one another. The work of Talmy provides an insightful alternative where one entity can be stronger than another. This relates to the functional proposals that state that control is important. Basically, the control of an entity under some functional relation is vital in prepositional use. So, if the relatum y fulfils its function as a container and imposes a stronger force upon the referent y the representation will be seen as x IN y.

6.5.4 Functional Control Relations

I now present the functional definitions and control relations which represent functional geometry. Inherently dynamic control relations are proposed for the spatial prepositions IN, ON and OVER. The functional controls proposed are termed fContainment (relating to IN), fSupport (relating to ON) and fSuperiority (relating to OVER).

It is important to realise that these functional controls are dynamic in nature. It is suggested that language users make dynamic predictions when selecting the appropriate prepositions. It is also important to note that the functional controls of fContainment, fSupport and fSuperiority are language dependent. It is suggested that the functional primitives (the control relations) are linked with real primitives which give them a grounding in the spatial and functional world.

6.5.4.1 The Principles of fContainment

I first present the functional control of **f**Containment. When a speaker states "Bring me the orange (x) that is IN the bowl (y)" (see Figure 6.13)

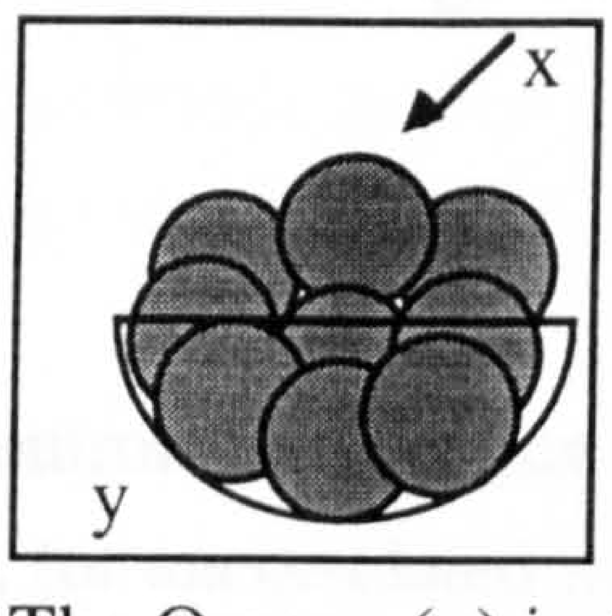


Figure 6.13 - The Orange (x) in the Bowl (y).

the listener knows that the orange (x) need not be fully enclosed by a 3D space or even physically contained in the space to be seen as "IN the bowl (y)". There is not a direct mapping between language and the real world. It appears that what is important is the function that the referent (x) and the relatum (y) are fulfilling. The orange may not be within the geometric confines of the bowl but it is clear to both speaker and listener that the bowl is acting as a functional container for the orange. What exactly does this functionality represent? Basically, if I were to bring the bowl to the speaker I can be fairly sure that the orange will come with the bowl. This notion neatly leads to a basic premise for the functional definition of IN. I propose the following definition of IN:

IN: x IN y: a 1-, 2-, or 3- dimensional object y **f**Contains a corresponding 1-, 2-, or 3- dimensional functionally controlled object x.

Cuyckens (1993) has suggested that a family resemblance structure termed "medium", focusing on the properties of the relatum, incorporates all the relevant aspects of dimensionality. This structure includes 3D and 2D porous and unbounded relatums. However, it has been suggested that the inclusion of dimensionality may be redundant (Vandeloise, 1991; Garrod and Sanford, 1989) and Cuyckens' structure means that we must fully specify in the mental lexicon. The present functional theory places emphasis (as does Vandeloise 1991) on the functional properties of the relatum; in the case of IN its ability to "functionally contain" the referent. Dimensions could, it is argued, be omitted from the definition and this would involve recognising the inclusion of a concept in a functionally controlling space.

The functional definition of IN can be fully expressed by the functional controls of fContainment represented in this ideal meaning. This functional containment can be defined as follows:

fContainment -y fContains x if y controls the location of x such that when y moves there will be a correlated movement in x, (or uncorrelated movement within the convex hull of y), by virtue of some degree of enclosure.

It is proposed that language users make dynamic predictions concerning fContainment. The dynamic prediction that objects x and y have the potential to move together in some way is used as a criterion for selecting IN as the appropriate preposition.

So, according to this account, "in-ness" reflects a type of dynamic location control where a container constrains the location of its contents. It is proposed that the spatial relation between the referent x and the relatum y is constrained by this physical/functional relationship of location control. Thus if one were to say "Matthew is IN the queue" then this can be functionally interpreted as a location control imposed on Matthew whereby Matthew's location can be predicted by the movement of the queue. Similarly "The word is IN the margin" can be interpreted functionally as a location control imposed by the page on the word's location.

By working within the functional framework many problems found previously with investigations relying on logical and geometrical concepts can be solved. For example, many geometric accounts do not allow for cases where the referent is larger than the relatum. This is not a problem for the functional theory. Sentences such as:

The racket(x) IN the hand(y)

The flowers(x) IN the vase(y)

can be accounted for because in both cases the relatum controls the location of the referent. In other words, the vase controls the location of the flowers such that ,if the vase moves, there will be a correlated movement by the flowers by virtue of some degree of enclosure.

6.5.4.2 The Principles of fSupport

The second functional control of fSupport is involved with the spatial preposition ON. The functional definition is as follows:

ON: x ON y: a 1-, 2-, or 3-Dimensional object y fSupports a 1-, 2- or 3-Dimensional functionally controlled object x.

This functional definition is be fully expressed by the functional controls of fSupport represented in this ideal meaning. Again the factor of control is important and support is functional. This functional support can be defined as follows:

fSupport - y fSupports x if y controls the location of x with respect to a unidirectional force (by default gravity) by virtue of some degree of contact between x and y.

Language users also make dynamic predictions contributing to the selection of ON. The basic prediction is that the object referent x would no longer be supported by the relatum object y if the relatum were removed. If x is ON y then the relatum y can be seen as functionally supporting x. Again there is a physical and functional relation in action whereby one object constrains the location of another object with respect to a force that is usually gravity (although gravity is just one such force). This functional account of ON can explain the uses of ON that were left unexplained by the Classical accounts discussed in Chapter 3. The following examples have been left largely unexplained (these are pictorially represented in Figure 6.14):

The book ON the table.

The light ON the ceiling.

The picture ON the wall.

The kite is ON the string.

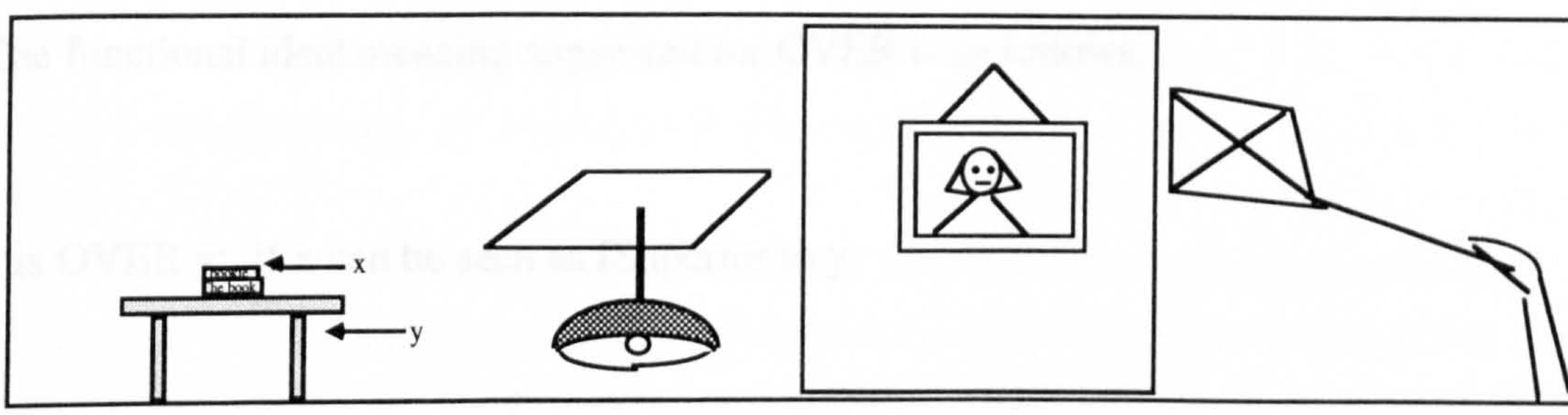


Figure 6.14 - Four Examples of Configurations represented by the Preposition ON.

We can describe the picture as "ON the wall" and the light as "ON the ceiling" because the wall and ceiling prevent them from falling. The location control of fSupport states that the relatums are protecting the referents from the force of gravity. The kite can be described as being ON the string. This can be explained by the fact the string fSupports the kite against the force of the wind.

The representation of "The book ON the table" shown in Figure 6.6 has previously been explained via notions of transitivity (Miller and Johnson-Laird, 1976; Herskovits, 1986). By using a functional geometric account this case can be explained using functional concepts. The book is seen as being "ON the table" because the table is seen as the functional supporter against the force of gravity. It does not matter that the floor under the table is also supporting the book; this fact is not functionally relevant.

6.5.4.3 The Principles of fSuperiority

The spatial preposition OVER presents a much more complicated issue. A suggested functional geometric control relation can be formulated and this is presented. However, it should be noted that the extensive work by Brugman (1981) and Lakoff (1987) provides a fuller explanation. As previously noted, there are problems with their approach which include the focus on full specification and their choice of central sense. It is suggested that there may be functional accounts which can explain the multiplicity of use found with the locative OVER. I concentrate, in this thesis, on only one of these "senses" but give preliminary suggestions for a functionally based account of OVER involving the other "senses" covered by Brugman and Lakoff (1988).

The functional ideal meaning suggested for OVER is as follows:

x is OVER y: if x can be seen as fSuperior to y.

The functional controls defining this preposition can be expressed by what I will term fSuperiority and this can be defined as follows:

fSuperiority - x is fSuperior to y if x, or something intrinsically associated with x, threatens to come into contact with y, or has come in contact with y, as a consequence of a gravitational force.

Again, it is suggested that language users make dynamic predictions using the control relation. Basically the dynamic prediction associated with OVER is that a referent object x, if dropped, would fall into the area of a relatum object y. This prediction provides information contributing to the selection of OVER as the appropriate preposition. The notion of "threaten" has a similar connotation to verbs such as "meet" or "oppose". Such verbs threaten contact between the subject and the object. The preposition OVER, it is argued, carries the same implication. However, there is an extra constraint that this threatened contact will be due to gravitational factors. For example, a bomber OVER his target is threatening contact of its bombs with the target. The experimental analyses of

OVER presented in the following chapters involves testing this functional superiority but also present a comparison between the preposition OVER and the preposition ABOVE. It is argued that whilst OVER has a directional meaning the related preposition ABOVE relates mainly to verticality.

It is important to take into account other uses of OVER where there is contact. It is suggested that this is due to a dynamic notion where contact has been threatened and then actually carried out. For example, in the sentence "She spread the table-cloth OVER the table" notions of support are disregarded and the mental model accessed is of fSuperiority. This is because threatened contact preceded the contact of cloth and table and this factor is salient.

6.5.5 Implications of Functional Geometry

Functional geometry incorporates the idea that prepositional meaning remains the same throughout its different uses. Different perspectives of the same scene may effect which preposition is assigned to a particular scene. This is made explicit by Coventry (1992). The objects being referred to by prepositions are of great importance in the sense of the functions they represent. By this we are referring to what they are traditionally used for and what they are able to do (the functions that they can perform). Coventry, Carmichael and Garrod (1994) have shown that whether an object is referred to as a plate or as a dish effects choice of preposition (in this case either the use of IN or ON). Figure 6.15 highlights this fact.

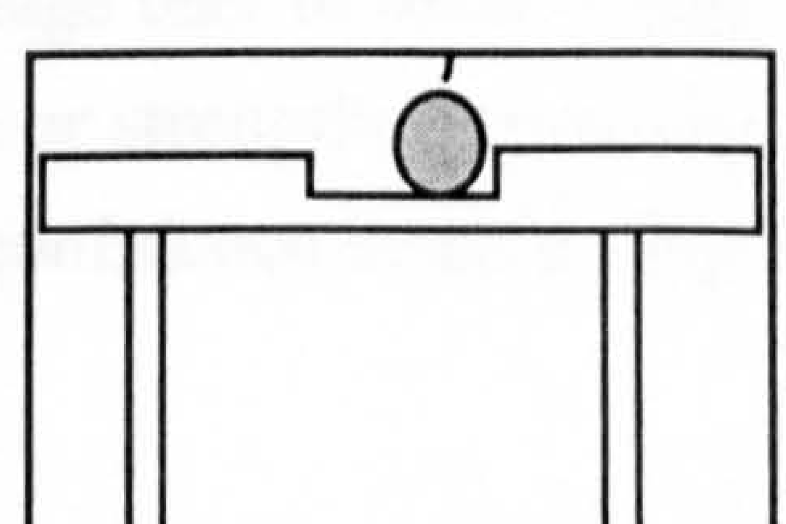


Figure 6.15 - The Apple is ON the Table as Compared to (?)The Apple is IN the Table.

In this example one would be unlikely to say that the apple is IN the table despite the fact that the conditions of functional containment and control are met. This seems to be secondary to the fact that one perceives a table's main function to be that of a supporter. The preposition ON, whose primary functional property is support, is more appropriate.

The functional control relations inherent in prepositions are only fully expressed with relation to our environment and the functionality of objects within it.

6.5.6 Predictions of the Functional Geometric Account

To summarise, it is proposed that the functional definitions and their functional controls are represented by the suggested dynamic control relations. The presence or absence of such functional control relations is accountable for prepositional choice. What exactly are these control relations and how do they operate? It is suggested that functional controls operate with the presence or absence of what I will call control factors. Factors such as Containment, Continuity, Altered Control and Position seem intuitively valid and are manipulated in the following experiments to examine affect on prepositional choice. The functional account is inherently dynamic and it is suggested that weakening or strengthening these dynamic location controls should affect prepositional choice. These Preposition experiments examine prepositional usage directly to ascertain the affect of various manipulations. Experiments are also carried out to examine prepositions indirectly. In such experiments I directly examine the validity of the theory by examining whether the suggested dynamic control relations and their predictions are actually used by language users.

So, the goals of the experimental work presented in the following three chapters are as follows:

1. To make explicit the notions of functional control. What are the factors that need to be present or absent for a language user to select a specific preposition? It is suggested that factors which will weaken or strengthen dynamic controls for IN, ON and OVER will also weaken or strengthen confidence in these prepositions.

2. To show that the suggested location controls are psychologically valid. In other words, I intend to show that the use of a preposition is directly influenced by the suggested dynamic functional controls and predictions. Although accounts have been presented that recognise the failings of a geometric approach, most influencially the work of Garrod and Sanford (1989), there have been no comprehensive accounts defining what control relations are and showing the psychological validity of these intuition based control relations.

Chapter 7

The Experiments Investigating Functional Geometry: Examining Prepositional Choice Using Static Scenes

7.1 General Introduction to the Experimental Investigations

This chapter presents experimental evidence for the functional geometrical notions of fContainment, fSuperiority and fSupport discussed in the previous chapter. The aim of this, and the following chapters, is to show that the intuitions and predictions of this theory can be upheld experimentally. Several experiments were run to investigate the existence of a functional geometry. Investigations examined proposed control relations and functional definitions. This involved both direct and indirect testing of spatial prepositions. The scenes used in the experimental investigations mainly involved ping-pong balls and glass bowls.

7.1.1 The Direct Method

The direct method involved eliciting prepositional confidence judgements about the aptness of different spatial descriptions. These Preposition Experiments involved subjects making a rating, on a Lickert type scale, of how well a certain spatial preposition described a scene. Relationships between the prepositions and between functional and spatial factors were analysed. Both dynamic and stationary scenes were used and they focused on analyses of IN, ON and OVER. The present chapter focuses on the direct empirical work involving static scenes. These experiments test the fundamental propositions formed by this functional theory as they directly address the relationship between confidence of preposition and functional control. Several functional, spatial and physical factors are varied to examine the effect on prepositional choice. Chapter 8 will discuss presentations using dynamic scenes which are designed to test how differing dynamic information about scenes can effect confidence in spatial descriptions. These presentations further examine the claim that functional controls make dynamic predictions that relate to the preposition chosen. Again, factors are varied to examine the effect on prepositional choice. The scenes also involve movements which are suggested to weaken or strengthen functional controls.

7.1.2 The Indirect Method

The indirect method examined whether the proposed control relations for IN, ON and OVER were actually in operation by testing judgements about the degree to which the relatum controls the location of the referent within each scene. This location control can be expressed through dynamic predictions initially discussed in Chapter 6. The fContainment notion predicts that language users will pick IN if they perceive that the referent and relatum have the potential to move together. fSuperiority states that a criterion for selecting OVER is as follows: if the language user can predict that the referent, if dropped, would fall into the area of the relatum. Finally, for fSupport it is suggested that dynamic predictions are used when deciding on the appropriateness of the locative ON. Basically, a criterion for selecting ON is as follows: if language users can predict that the referent would change position if the relatum were removed.

In these Independent Judgement experiments subjects were asked to predict whether the objects in a scene would alter after a suggested movement. Such Independent Judgement experiments did not test prepositions directly. These experiments are presented in Chapter 9 and the results are also correlated with the confidence ratings for identical scenes in the Preposition experiments. This was carried out to examine whether the dynamic predictions of fSupport, fContainment and fSuperiority actually related to confidence of ON, IN and OVER/ABOVE.

7.2 Introduction to the Preposition Experiments

Five experiments were carried out to examine the effect of varying several factors on confidence of prepositional judgements. Examples of the prepositional scenes can be viewed on video-tape (see Appendix U for further information). These overall experiments included both static and dynamic scenes. The analyses focus on the locatives IN and ON. OVER is also examined and these analyses include comparison of use with the spatial preposition ABOVE. These experiments were designed to test the previously discussed notions of functional geometric representation and examine experimentally the proposed control relations. The previously discussed controls for IN, ON and OVER are as follows:

fContainment: y fContains x if y controls the location of x such that when y moves there will be a correlated movement in x, (or uncorrelated movement within the convex hull of y), by virtue of some degree of enclosure.

fSupport: y fSupports x if y controls the location of x with respect to a unidirectional force (by default, gravity) by virtue of some degree of contact between x and y.

fSuperiority: x is fSuperior to y if x, or something intrinsically associated with x, threatens to come into contact with y, or has come in contact with y, as a consequence of a gravitational force.

If these inherently dynamic controls are vital to the selection and use of prepositions then it is proposed that the absence or presence of factors involved in fContainment, fSuperiority and fSupport should affect prepositional judgements. If x and y being able to move together in some way is central to the use of IN then altering factors that could make this possible will affect prepositional confidence ratings. If a dynamic prediction of fSuperiority is that x should fall into the area of y when dropped, then altering factors that would make this a possibility will affect confidence in OVER. Finally, if the dynamic prediction of fSupport is that the x would change position if y was removed, then factors that make this a possibility will affect ON confidence. Both the static and dynamic presentations involve scenes which have been graded for various physical, functional and geometric factors that affect dynamic predictions. These factors are discussed in the General Design section. It is argued that the manipulations presented will tap into the factors involved in location control.

Five overall experiments examining confidence ratings for various spatial prepositions were carried out. These experiments, as a whole, examined both static and dynamic scenes. It is important to note that these experiments all use very similar methodologies. For example, all the Preposition experiments use the same Lickert type scale to measure prepositional confidence, and they examine related factors. It is perhaps more useful to think of the experiments as constituting various related groups of presentations. In this chapter I am interested in the results found by manipulating various factors in stationary scenes. Some of the overall experiments involved the addition of dynamics into similar scenes and these presentations will be discussed in Chapter 8.

7.3 Coding of the Preposition Experiments

The five experiments have been coded as PREP1, PREP2, PREP3, PREP4 and PREP5 as follows:

PREP1 - This preliminary experiment was carried out to examine whether intuitions about functional relations were in evidence. This examination of prepositional confidence presented a selection choice of IN, ON and OVER. The experiment involved both static and dynamic presentations of balls and bowls. Mean values for confidence ratings of these three prepositions can be seen in Appendix C. The static presentations from PREP1 examined the factors of Containment, Position, Continuity, Orientation and Transitivity. The Dynamic presentations discussed in Chapter 8 examined the effect of Prior Vertical Dynamics and also the effect of Prior Context.

PREP2 - This experiment focused on static scenes. The ball and bowl presentations directly examined prepositional choice and involved IN, ON, OVER, UNDER, ABOVE, and BELOW. Analyses examined IN, ON OVER and ABOVE and mean values for these confidence ratings can be seen in Appendix G. These static presentations examined the factors of Containment, Partial Containment, Altered Control, Position, Continuity, Vertical Height and Horizontal Position.

PREP3 - The presentations shown within this experiment focused on intuitions concerning the locative ON. Prepositional choice consisted of IN, ON, OVER, UNDER, ABOVE and BELOW. This experiment included both dynamic and static scenes. Analyses examined ON and mean values for these confidence ratings can be seen in Appendix J. The static presentations examined the factors of Primary Support, Secondary Support and Tension of Secondary Support. The Dynamic presentations discussed in Chapter 8 examined Tilt and Dynamic Ball effects.

PREP4 - These presentations focused on dynamic scenes. The spatial prepositions IN, ON, OVER, UNDER, ABOVE and BELOW formed the selection choice. Analyses examined IN, ON , OVER and ABOVE and mean values for these confidence ratings can be seen in Appendix M. The factors of Continuity, Dynamics and Position were also examined and these dynamic presentations are discussed in Chapter 8.

PREP5 - These presentations also focused on dynamic scenes. Again the selection choice consisted of IN, ON, OVER, UNDER, BELOW and ABOVE. Analyses examined IN, ON, OVER and ABOVE and mean values for these confidence ratings can be seen in Appendix P. The factors of Continuity, Dynamics and Position were examined and these dynamic presentations will be discussed in Chapter 8.

In this chapter I will discuss the presentations which examine only stationary scenes. In chapter 8 the dynamic scenes will be examined and it should be noted that some of these presentations are in part included in two overall experiments (PREP3 and PREP1) which are discussed in this chapter. Although five experiments were run it is helpful to realise that they form a series of related presentations that can be segregated into dynamic/static scenes and also into related factors. The present chapter focuses on the static presentations shown in PREP1, PREP2 and PREP3. It should be noted that different presentations often examine identical factors. For example, a series of presentations from both PREP1 and PREP2 investigate the factor of Containment.

7.4 General Design of the Static Presentations

7.4.1 The Factors

The static presentations involved showing subjects various stationary scenes graded for factors that were suggested to influence prepositional choice. The factors were selected on an intuitive basis as candidates for the functional and physical factors that influence prepositional choice. Some of these factors, for example Position and Continuity, are also examined in the dynamic presentations discussed in Chapter 8. These factors are combined in several ANOVA designs. The static scenes involved either a ping-pong ball or a weight as referent and a glass bowl or plywood/plank of wood as relatum. I now discuss the individual factors used in these experiments. The ANOVA designs employed are presented prior to the relevant presentation.

7.4.1.1 Position

The position of ball to bowl is varied in the static and dynamic presentations. It was predicted that simple geometric position would affect prepositional judgements. This would be expected in any spatial account. Figure 7.1 illustrates the five basic positions used throughout all the Preposition experiments.

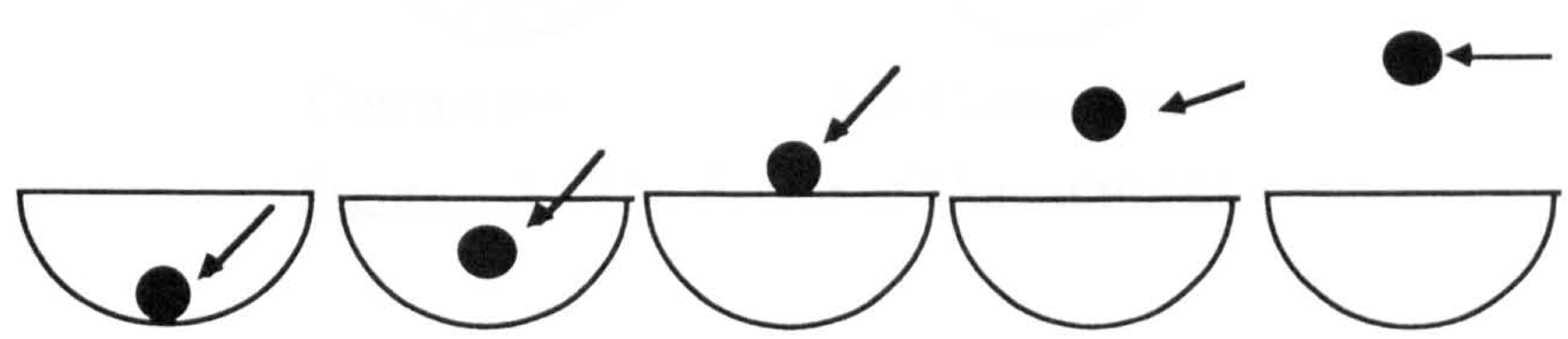


Figure 7.1 - The Five Basic Relative Positions of Ball to Bowl.

A series of PREP1 static presentations also examined the effect of three different positions on IN confidence when orientation of the bowl was manipulated.

7.4.1.2 Containment and Partial Containment

Varying levels of Containment (provided by surrounding balls) are manipulated to examine the effect on location control (particularly fContainment). For example, it is predicted that partial containment will result in a weaker control of the bowl over the ball as compared to containment. It is suggested that the ball and bowl will be seen as less likely to have the potential move together when there is only partial containment and therefore confidence of IN will be weaker (see Figure 7.2).

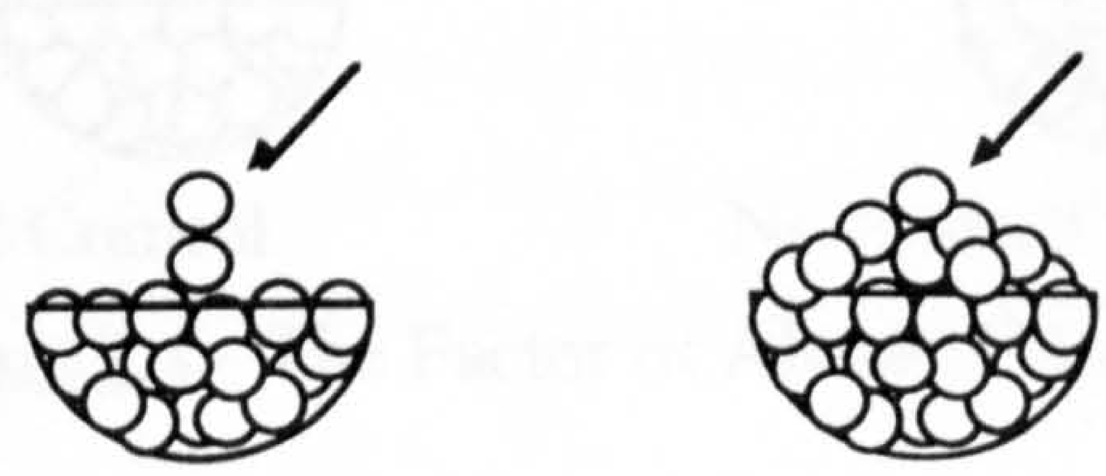


Figure 7.2 - The Factor of Partial Containment.

It is also predicted that containment will increase control of the bowl over the ball as compared to no containment. Containment scenes should result in stronger confidence of IN than the comparable no containment scenes (see Figure 7.3).

Containment No Containment

Figure 7.3 - The Factor of Containment.

Any effects on confidence of OVER and ON were also examined.

7.4.1.3 Altered Control

Altered control (provided by wire attached to the referent ball) is examined as this should also result in weaker control provided by the relatum. It is expected that this will effect the notions of fContainment that state that the relatum must control the location of the referent. If the referent has another form of control, i.e. the wire, then the control is weakened and confidence of IN should drop for such altered control scenes (see Figure 7.4 for a pictorial representation). The effect of this altered control on confidence of OVER and ON was also examined.

Altered Control No Altered Control

Figure 7.4 - The Factor of Altered Control.

7.4.1.4 Continuity

Another factor investigated was the effect of continuity versus no continuity. The referent ball was either the same colour as the other balls (i.e. white) or black (see Figure 7.5 for a pictorial representation). This was introduced to examine the effect on IN, ON and OVER.

No Continuity Continuity

Figure 7.5 - The Factor of Continuity.

7.4.1.5 Horizontal and Vertical Position

Horizontal and Vertical Position of a single ball in relation to a glass bowl was varied to examine the effect on confidence of OVER and ABOVE. It is argued that factors that increase the likelihood of "x falling into the area of y" (for example, certain horizontal positions) will increase confidence in OVER. In an investigation of the controls associated with fSuperiority two Vertical Positions (medium height versus high height) and three Horizontal Positions (the ball was positioned directly over the bowl, over the rim of the bowl or the same distance beyond the rim of the bowl) were examined.

7.4.1.6 Transitivity

Transitivity of the locative IN was examined by asking subjects to make confidence ratings with respect to the referent ball and a small inner bowl and also with respect to a large outer bowl. Figure 7.6 provides an example of such a scene.

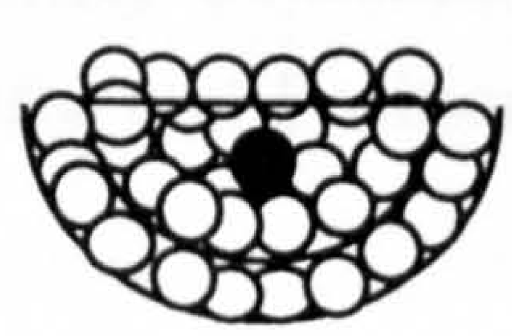


Figure 7.6 - The Factor of Transitivity.

7.4.1.7 Primary and Secondary Support

Primary and Secondary Supports were varied by degrees to examine effect on confidence of ON. The effect of Secondary Support type (weak/strong) attached to the referent and Tension of this Secondary Support (tight/loose/unattached) are examined. This is examined in conjunction with type of Primary Support (plank of wood/bent plywood). Figure 7.7 shows a scene with a tight secondary support (in this case chain) and a plywood primary supporter. It is argued that factors that increase control provided by the relatum (primary support) involved with supporting the referent from the force of gravity will increase ON confidence.

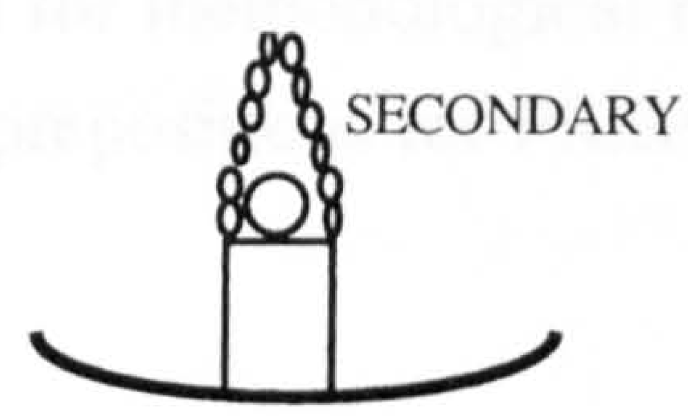


Figure 7.7 - The Factors of Primary and Secondary Support.

The task is to discover experimentally the physical factors that operate within these functional controls and in a sense these factors will be our functional control relations. The static preposition scenes were run within experiments PREP1, PREP2 and PREP3. The differences in method are presented prior to the results.

7.4.2 The Basic ANOVA Designs for the Static Presentations

The static presentations from PREP1 examined the effect of Containment and Position (2x4), Continuity (t-test), Transitivity and Position (2x5) and Position after Orientation (one way ANOVA).

The static presentations from PREP2 examined the effect of Containment, Altered Control and Position (2x2x5), Partial Containment, Altered Control and Position (2x2x3), Continuity, Altered Control and Position (2x2x5) and Horizontal Position, Height and Preposition (2x2x3).

Finally, the static presentations from PREP3 examined the effect of Primary Support, Secondary Support and Tension of Secondary Support (2x2x3).

7.4.3 Data Analysis

The confidence judgements for the various graded descriptions were sorted for each scene according to each preposition. Results will be presented for IN, ON and OVER/ABOVE and probability levels lower than 0.08 will not be reported. The PREP1 studies discussed in these experimental chapters only presented subjects with a choice of three prepositions and for methodological reasons (discussed in Chapter 10) this choice was increased to six prepositions for PREP2, PREP3, PREP4 and PREP5.

Certain scenes from PREP2 and PREP3 were repeated as a test for consistency. For PREP2 the repeat scenes were 9/49, 20/50, 13/57, and 30/53. For PREP3 the repeats were 25/44, e.g. 1/11, e.g. 2/31, e.g. 3/15 and e.g. 4/12. No significant t values were obtained and this shows that the ratings made by subjects were consistent over time.

7.4.4 The Factors and Functional Control Relations

It is important to note that these factors were manipulated to tap into inherently dynamic notions of fContainment and IN, fSupport and ON and fSuperiority and OVER. It is suggested that the scenes rated as highly IN are graded for factors that make correlated movement possible. For example, it is predicted that scenes depicting full containment and no altered control will be rated as more highly IN that scenes with no containment (or partial containment) and altered control. It is also predicted that support from the force of gravity must be provided by the primary support for language users to select IN and therefore an alternative control provided by a secondary support will weaken use of ON. Such an altered control makes it less likely that a language user can predict that the referent will alter position if the relatum were to be removed. Finally, it is predicted that scenes where the ball is directly over the bowl will be rated as more highly OVER than scenes where the ball is positioned beyond the rim of bowl (in such a case the dynamic prediction that the ball can fall into the area of y when dropped cannot be upheld).

7.5. The PREP1 Presentations

7.5.1 Introduction

The following PREP1 presentations examined the effect of various factors on the spatial prepositions IN, ON and OVER. Focus was mainly on the location control involved with IN and fContainment. Several presentations from this overall experiment are discussed both in this chapter and also in Chapter 8. Four separate groups of static presentations were analysed. These examined Containment and Position (2x4 ANOVA), Continuity (t-tests), Position after Orientation (a one-way ANOVA) and Transitivity (2x5 ANOVA). The Method for PREP1 is now presented and each series of static presentations from this experiment will be preceded by a individual Design section.

7.5.2 Method for PREP1

7.5.2.1 Subjects

The 30 subjects were all undergraduates at the University of Glasgow and were tested in group situations. All subjects were native English speakers.

7.5.2.2 Apparatus and Materials

The materials used consisted of three perspex bowls of increasing size, transparent thread, one black ping-pong ball and several white ping-pong balls. Red material was used as the backdrop. The materials were filmed using a Sony DXC M3A television camera, in colour with no sound. After filming the resulting video-tape was edited using an RM-GE 10U editing control unit and a double JVC BR-S610ES VHS video recorder. Questionnaire booklets containing statements corresponding to scenes from the final video and also instructions were compiled (see Appendix A). Forty graded scenes were filmed.

7.5.2.3 Stimuli

Scenes involving the ball (x) as referent and the bowl (s) as relatum (y) were filmed in graded and repeated groupings. Transparent thread was attached to the referent ball and used in both the dynamic scenes and those where other balls were not present. An informal pilot study was conducted with undergraduate students to discover various relationships between referent (x) and relatum (y) which could contribute to the idea of a functional geometry. Certain scenes involved the ball (x) and the bowl (y) placed into a larger bowl. These scenes consisted of six corresponding statements. Three statements referred to the small bowl and three to the large bowl. These trials were edited onto the tape twice to allow adequate judging time. A five minute break was allowed after trial 20. Filmed scenes were edited onto a destination tape in a random order for 5 seconds per trial. Twenty seconds of black was shown between each scene.

Subjects answered three basic statements corresponding to each trial in the form NP + (Prep. + NP) after viewing each trial. Each statement was rated using the corresponding Lickert scale. The scale of 1-5 rated how well subjects thought the statement described the scene from 1 = Highly Unlikely to 5 = Most Likely. The basic statements were as follows (see Table 7.1).

The ball is **in** the bowl	1	2	3	4	5
The ball is **on** the bowl	1	2	3	4	5
The ball is **over** the bowl	1	2	3	4	5

Table 7.1 - Statements Presented in PREP1.

7.5.2.4 Procedure

The subjects were tested in a group situation and each received an identical questionnaire which included instructions. These instructions were explained verbally. and subjects were informed that this was a simple language experiment. The subjects were verbally instructed that the ball (x) referred to in the statements would usually be the black ball except in one case where x was indicated by a pointer and in cases where only one ball was present in the scene. It was indicated that some scenes would be shown twice. Subjects were also informed that dynamic scenes would be shown and that judgements should be made after viewing the whole trial. In some cases the ball stopped moving and this was indicated as the point of judgement. It was also stressed that the Lickert scale must be rated for each statement per scene. Subjects were instructed that statements should be read prior to the relevant trial appearing on screen. Individuals were able to ask questions to clarify any details. The number of each scene was called out to the subjects. After the experiment the questionnaires were collected from each subject.

7.5.3 PREP 1 : The Containment and Position Presentations

7.5.3.1 Design

These presentations examined the effect of Containment (containment versus no containment) and Position (P2-P5) on the location control involved with fContainment and IN. Counter effects on OVER and ON were also examined. Two factors that were expected to affect judgements of control were included in this design. Firstly, the presence of balls other than the referent x (containment) versus only the referent x present(no containment) was manipulated. Secondly, the relative position of a ping-pong ball and bowl were varied (using basic Positions 2-5). Eight scenes were involved and the factors were organised into 2x4 ANOVA designs. Figure 7.8 gives a pictorial representation of these scenes.

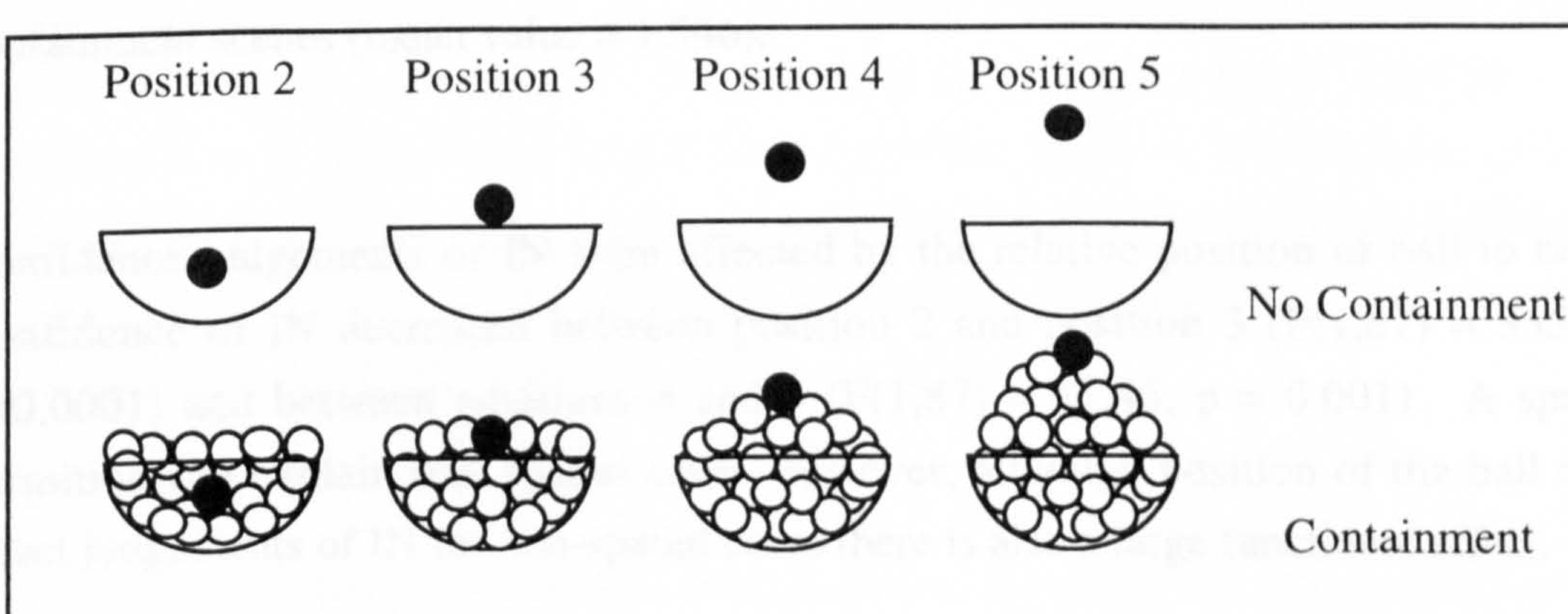


Figure 7.8 - The 2x4 ANOVA Design for the PREP1 Containment and Position Presentations.

It was predicted that having containment would increase IN confidence and that increasing position would reduce confidence.

7.5.3.2 Results

First, the PREP1 scores for scenes 5, 3, 4, 2 and 13, 12, 15, 14 for IN were subjected to a repeated measures 2x4 ANOVA. Randomised order of these scenes are represented pictorially in Appendix B. The reliable main effects and interaction are illustrated in Table 7.2. Mean confidence ratings for these eight scenes are shown in Figure 7.9.

Reliable Main Effects and Interaction for IN Judgements - PREP1	
Containment	$F(1,29) = 55.38$, $MSe = 1.83$, $p<0.0001$
Position	$F(3,87) = 202.88$, $MSe = 0.571$, $p<0.0001$
Pos x Cont	$F(3,87) = 9.51$, $MSe = 0.775$, $p<0.0001$

Table 7.2 - Significant Results for PREP1 ANOVA Examining IN Confidence.

The manipulations produced reliable main effects and a reliable interaction. Containment (mean value = 3.24) produced more confidence in IN judgements than no containment scenes (mean value = 1.546).

Confidence judgements of IN were affected by the relative position of ball to bowl. Confidence of IN decreased between position 2 and position 3 ($F(1,87) = 355.36$, $p<0.0001$) and between positions 4 and 5 ($F(1,87) = 11.45$, $p = 0.001$). A spatial definition can explain true spatial cases, however, although position of the ball does effect judgements of IN for non-spatial cases there is also a large functional effect.

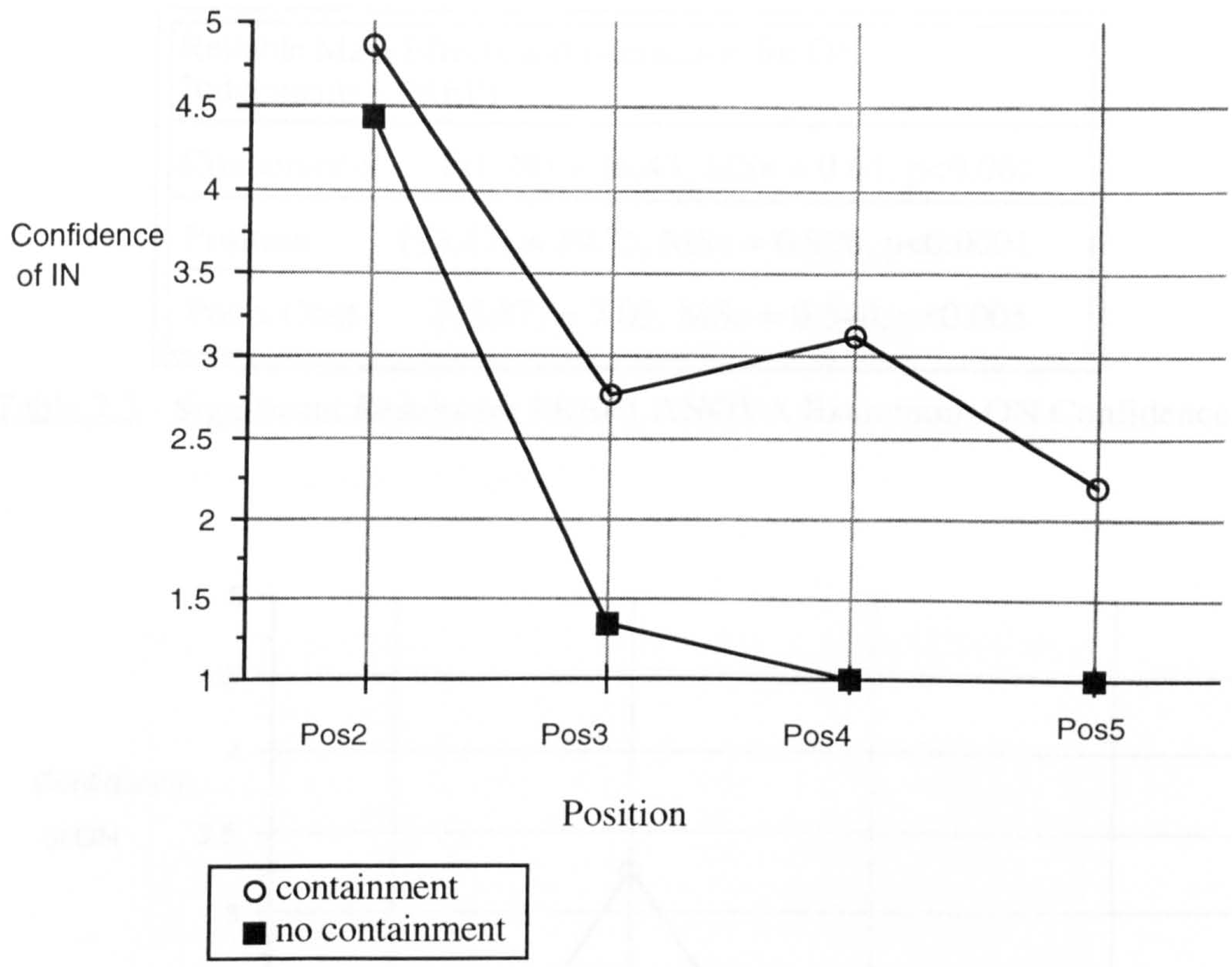


Figure 7.9 - The Combined Effect of Position and Containment for the PREP1 ANOVA Examining IN Confidence.

There is a combined effect of Position and Containment (see Figure 7.2). Position 4 is judged to be more IN than Position 5 ($F(1,87) = 16.87$, $p<0.0001$). Position 4 involves the referent x being outwith the area of the relatum y and surrounding objects are an important factor in rating this as IN, despite a lack of geometrical controls. For positions 3 to 5 judgements of IN increase when there is containment present ($F(1,87)>27.881$, $p<0.0001$ in all cases). In position 2 the ball is within the confines of the bowl, however, we can see that even at this spatial position containment has a slight effect on confidence of IN ($F(1,87) = 3.636$, $p = 0.06$).

An identical 2x4 ANOVA paradigm was applied to the scores for ON confidence and the results are listed in Table 7.3. Mean confidence ratings for these 8 scenes are shown in Figure 7.10.

Reliable Main Effects and Interaction for ON Judgements - PREP1	
Containment	F(1,29) = 18.43, MSe = 0.64, p<0.001
Position	F(3,87) = 39.75, MSe = 0.996, p<0.0001
Pos x Cont	F(3,87) = 7.05, MSe = 0.540, p<0.005

Table 7.3 - Significant Results for PREP1 ANOVA Examining ON Confidence.

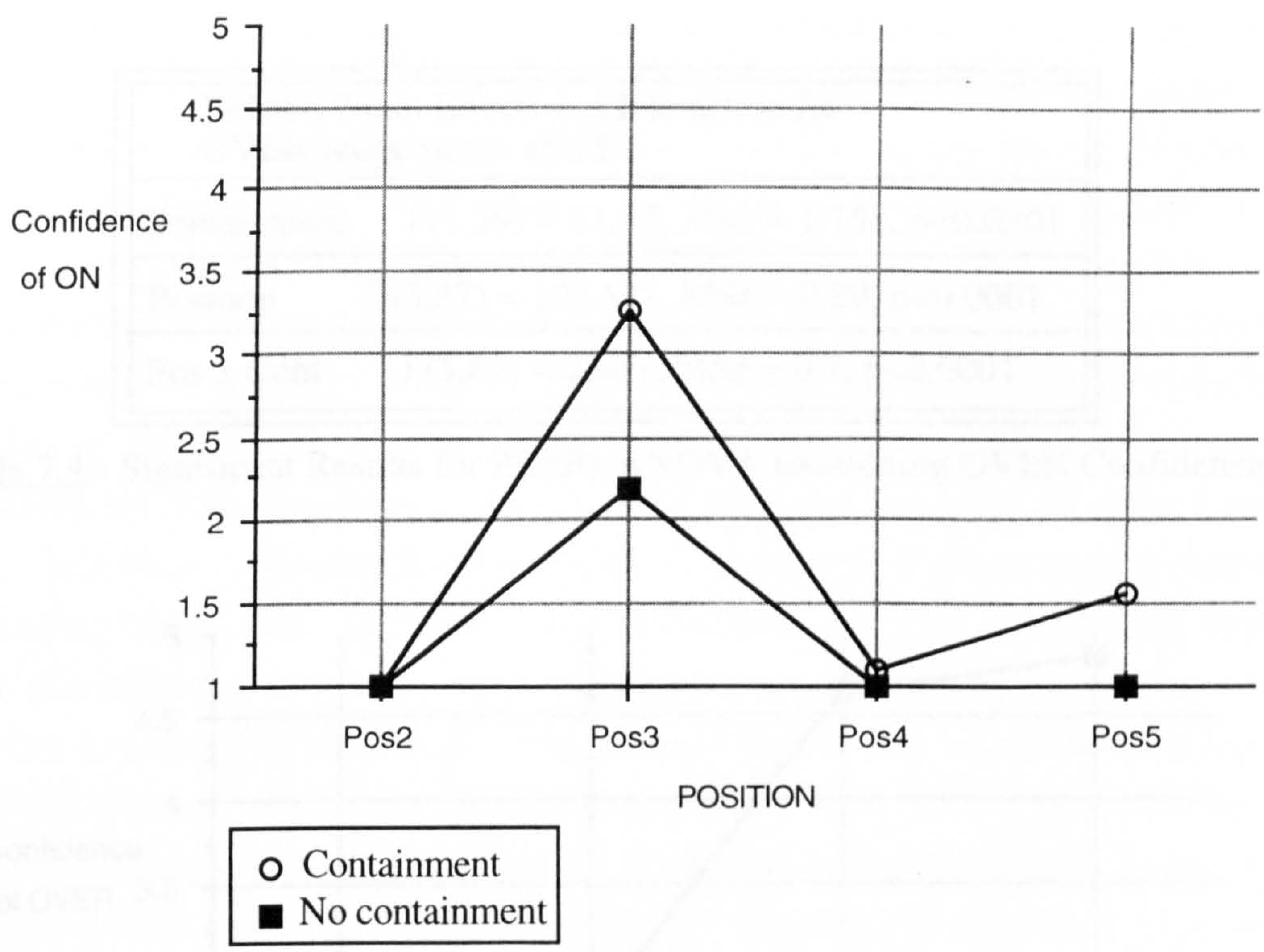


Figure 7.10 - The Combined Effect of Position and Containment for the PREP1 ANOVA Examining ON Confidence.

The manipulations produced reliable main effects and a reliable interaction. Containment increases confidence of ON (containment = 1.733, no containment = 1.292). This is seen most dramatically for position 3 (where the ball is touching the rim of the bowl), F(1,87) = 33.624, p<0.0001. The mean values for position 3 scenes with containment is 3.267 and for no containment is 2.167. There is no effect at position 4 as it appears that subjects are highly unlikely to select ON for this position, favouring IN. The extreme height position 5 results in a slightly higher confidence in

ON when containment is present (F(1,87) = 8.923, p<0.01). It is suggested that at this height the subjects perceive that the bowl is providing support from the force of gravity rather than any kind of functional enclosure or containment. Relative position of ball to bowl is significant (P2 = 1, P3 = 2.72, P4 = 1.05, P5 = 1.283).

OVER confidence was then examined using the identical 2x4 paradigm. The reliable main effects and interaction are illustrated in Table 74. The mean confidence ratings for the eight scenes are shown in Figure 7.11.

Reliable Main Effects and Interaction for OVER Judgements- PREP1	
Containment	F(1,29) = 83.77, MSe = 1.758, p<0.0001
Position	F(3,87) = 105.647, MSe = 0.89, p<0.0001
Pos x Cont	F(3,87) = 28.01, MSe = 0.7, p<0.0001

Table 7.4 - Significant Results for PREP1 ANOVA Examining OVER Confidence.

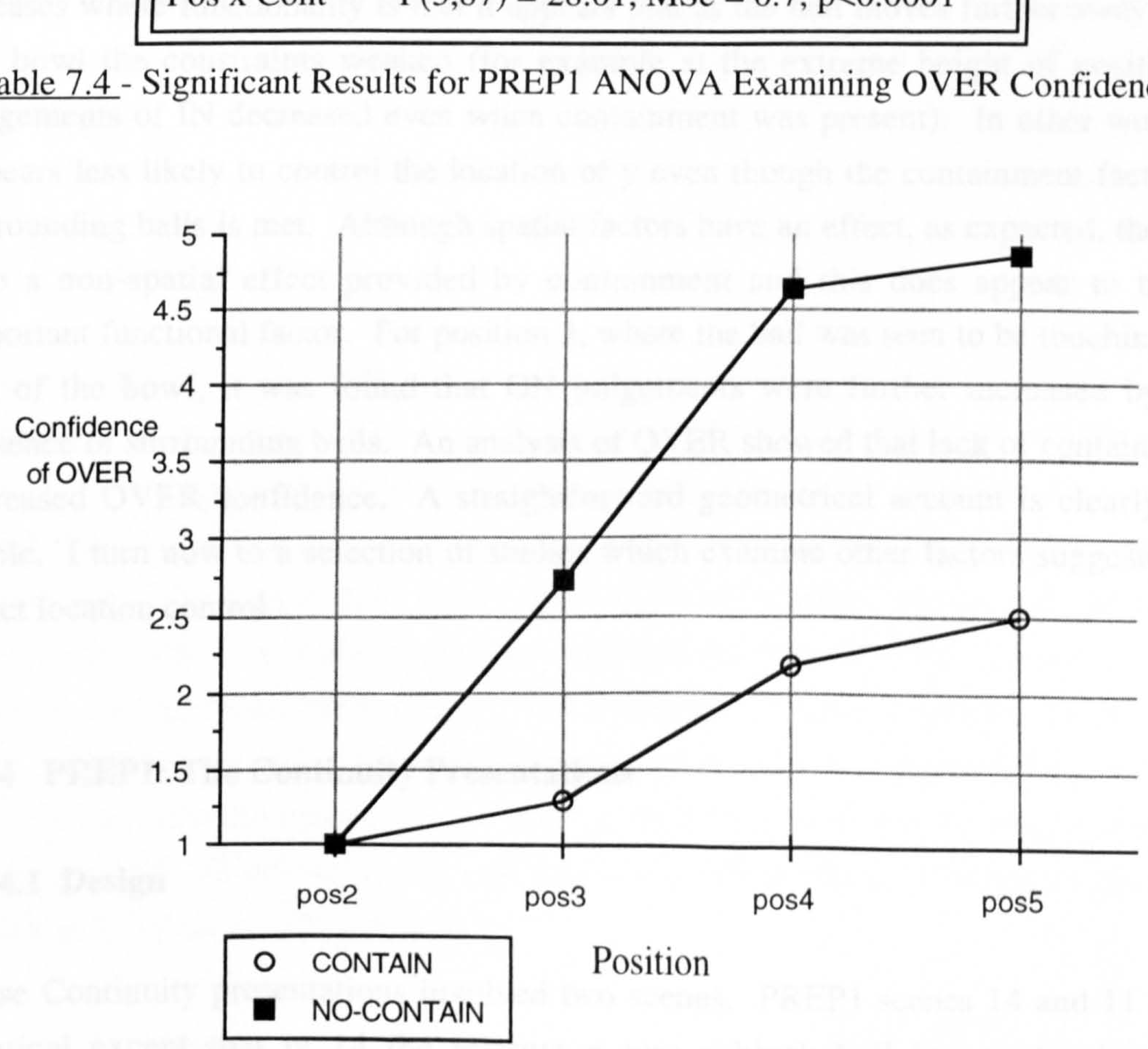


Figure 7.11 - The Combined Effect of Position and Containment for the PREP1 ANOVA Examining OVER Confidence.

There is an effect of Containment but in the opposite direction to IN and ON (containment = 1.742, no containment = 3.31). Judgements of OVER increase when there is a lack of containment ($F(1,87) > 44.012$, $p<0.0001$ in all 3 cases). Position has the expected effect (P1 = 1, P2 = 2.02, P3 = 3.4, P5 = 3.68).

7.5.3.3 Discussion

As predicted varying the factors of Position and Containment did have a significant effect on prepositional choice. It was found for the analysis of IN that in the non-spatial cases where the referent was outside the rim of the relatum other balls provided a functional control so that the referent could be seen to control the location of the relatum. This functional control was absent in the scenes where there are no other balls present and correspondingly judgements of IN decreased. It should also be noted that in cases where functionality is met it appears that as the ball moves further away from the bowl the constraints weaken (for example at the extreme height of position 5 judgements of IN decreased even when containment was present). In other words y appears less likely to control the location of y even though the containment factor of surrounding balls is met. Although spatial factors have an effect, as expected, there is also a non-spatial effect provided by containment and this does appear to be an important functional factor. For position 3, where the ball was seen to be touching the rim of the bowl, it was found that ON judgements were further increased by the presence of surrounding balls. An analysis of OVER showed that lack of containment increased OVER confidence. A straightforward geometrical account is clearly not viable. I turn now to a selection of studies which examine other factors suggested to affect location control.

7.5.4 PREP1: The Continuity Presentations

7.5.4.1 Design

These Continuity presentations involved two scenes. PREP1 scenes 14 and 11 were identical except that in 14 the relatum x was a black ball (no continuity with surrounding balls) and in scene 11 the relatum x was a white ball (continuity with surrounding balls) (see Figure 7.12). These scenes were both at the extreme height Position 5. The effect of Continuity on OVER, IN and ON were examined using within-subjects t-tests.

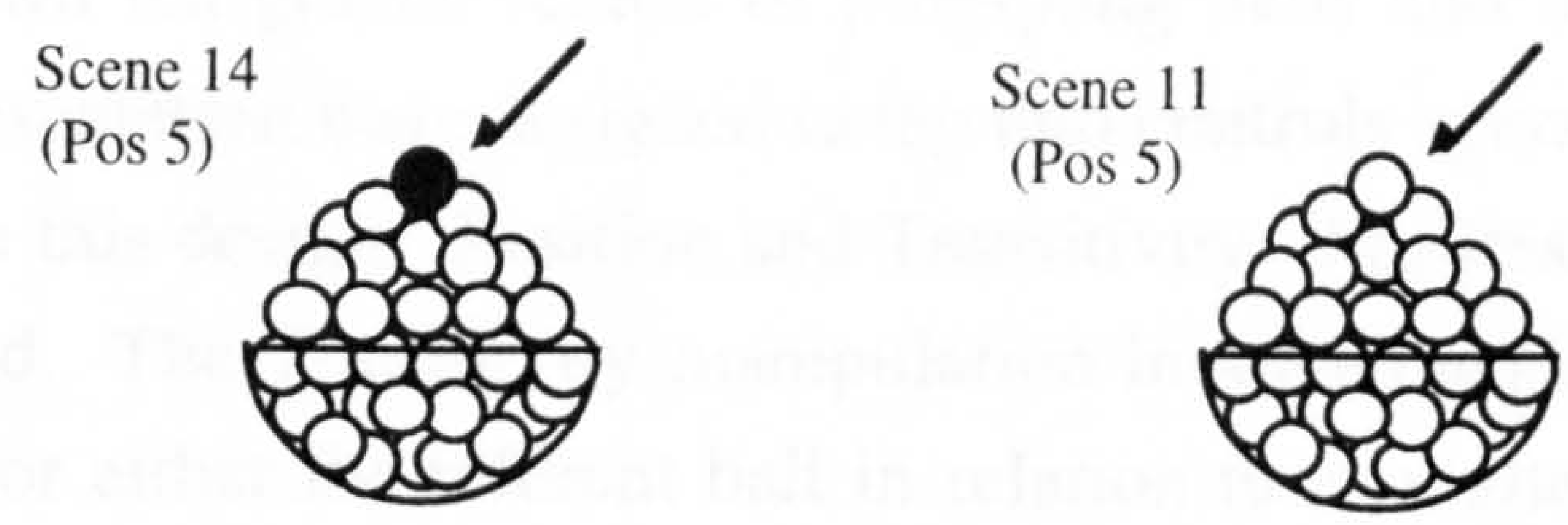


Figure 7.12 - The PREP1 Continuity Presentations.

7.5.4.2 Results

First, a within subjects t-test was performed on this data for confidence of IN. The obtained value t(29) = 2.408 is significant at the 0.05 level. The presence of continuity increases judgements of IN for this high position scene. Turning to ON we can see that lack of continuity (black referent ball) increases confidence in ON (t(29) = 2.276, $p<0.05$).

7.5.4.3 Discussion

I suggest that where both the referent and the surrounding objects are identical then they appear more like a collective whole and more likely to be able to potentially move together. It is suggested that this is mainly a visual phenomena. It is also important to note that the significant effect is relatively small. When the referent x is black and thus distinct from the surrounding balls then it is more in focus perceptually and may specifically seem less likely to survive a potential movement. This difference would appear to be functional but is a perceptual sense rather than in a directly interactional sense. Lack of continuity increases ON judgements and it is suggested that the black referent ball visually appears to be getting supported as it can be singled out for attention due to its colour in this rather unlikely ON position. Continuity does not significantly effect OVER judgements.

7.5.5 PREP1: The Transitivity Presentations

7.5.5.1 Design

Subjects were shown ten graded scenes of ping-pong balls and bowls. The scenes involved in this presentation were designed to tap into controls operating for IN. There were two factors in this design: Position and Transitivity. For Position the five basic positions were used. The Transitivity manipulation involved asking subjects to rate confidence of IN for either the referent ball in relation to a smaller inner bowl or in relation to a larger outer bowl. The factors were organised into 2x5 ANOVA designs and this design is shown in Figure 7.13. It was predicted that use of IN should not be transitive. This basically means that subjects confidence in IN should decrease when asked for confidence ratings in relation to the ball and large bowl.

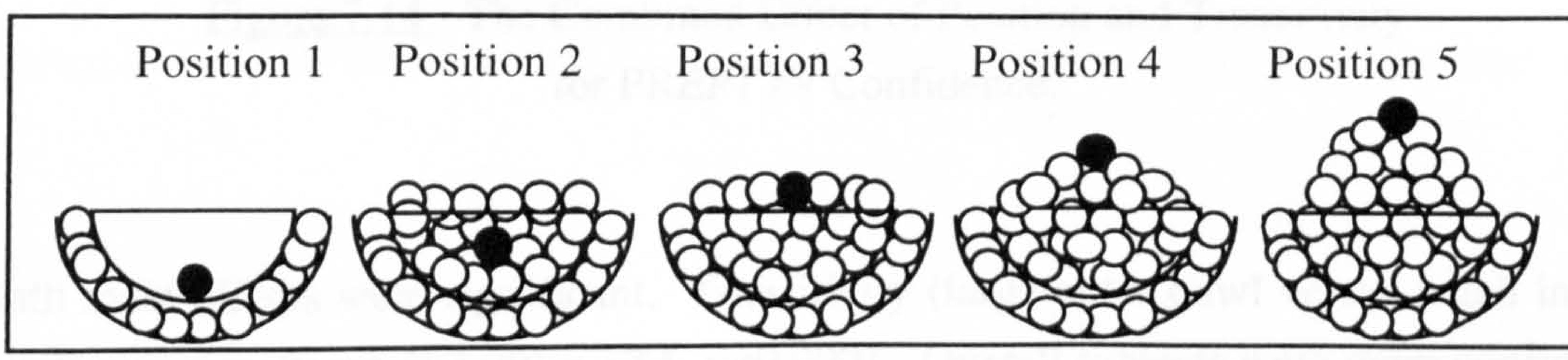


Figure 7.13 - The 2x5 ANOVA Design for the PREP1 Transitivity Presentations.

7.5.5.2 Results

PREP1 scenes 16, 18, 20, 19, 17, for small inner bowl and large outer bowl judgements of IN were subjected to a 2x5 repeated measures ANOVA (see Appendix B for pictorial representations). The mean confidence ratings for these 10 scenes are shown in Figure 7.14.

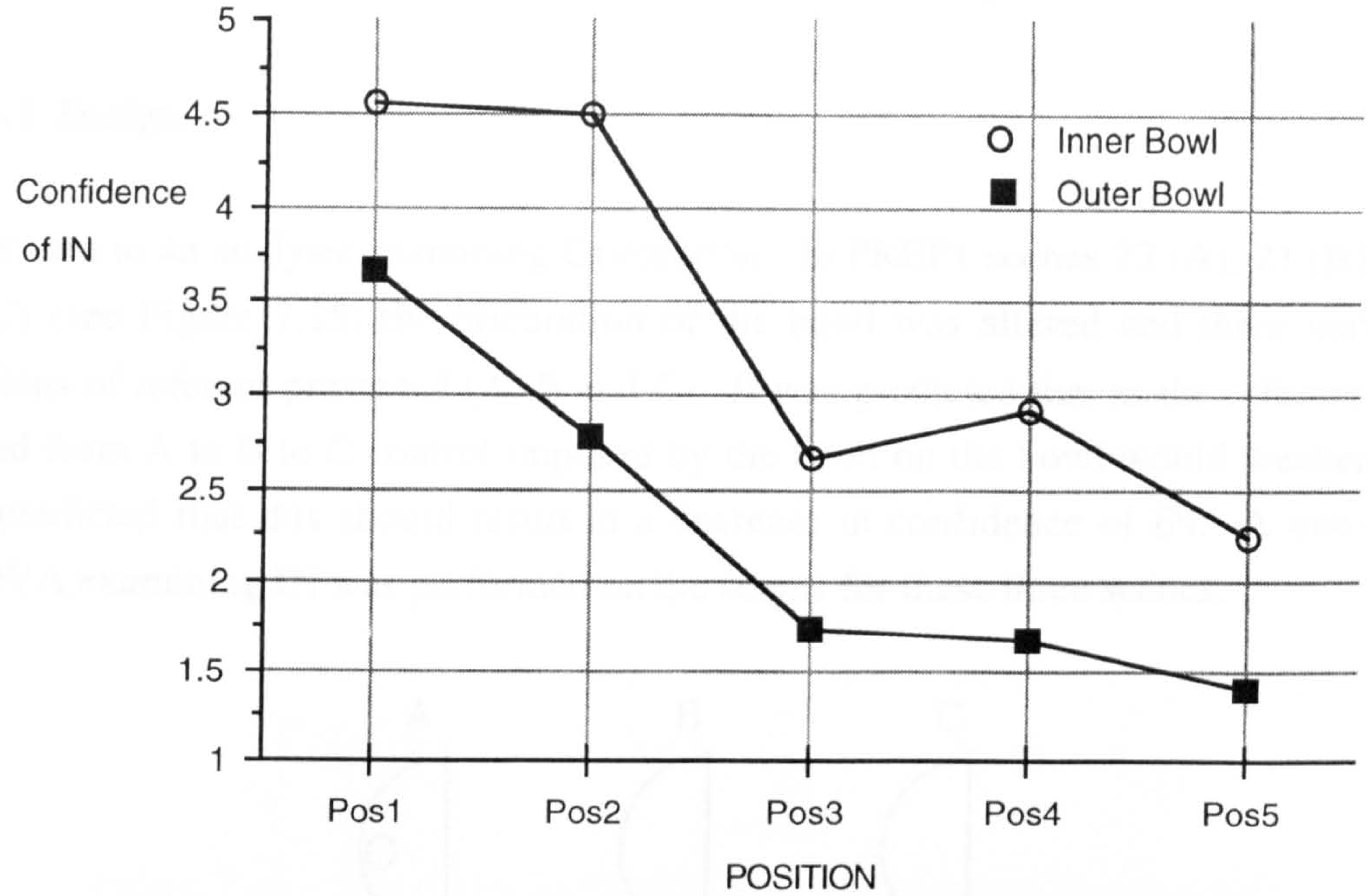


Figure 7.14 - The Combined Effect of Position and Transitivity for PREP1 IN Confidence.

Both main effects were significant. Transitivity (large outer bowl versus small inner bowl) was significant, $F(1,29) = 39.5$, $p<0.0001$. Overall subjects were more confident of using IN to describe the scene when referring to the ball and the small bowl (mean value = 3.38). When asked for a confidence rating for the ball (which was within the small bowl) in relation to the large outer bowl subjects were less likely to select IN (mean value = 2.253). As would be expected the main effect of Position was significant, $F(4, 116) = 49.788$, $p<0.0001$. The interaction was borderline significant, $F(4,116) = 2.263$, $p = 0.066$. Further analysis revealed that there was no effect of transitivity over all five positions ($F(1,116) > 12.07$, $p<0.001$ in all cases).

7.5.5.3 Discussion

Confidence of IN decreased when subjects were asked about the referent ball in relation to the large outer bowl. These results give experimental evidence showing that, as expected, IN is not a transitive relation.

7.5.6 PREP1: The Position after Orientation Presentations

7.5.6.1 Design

I now turn to an analysis examining Orientation. In PREP1 scenes 23 (A), 21 (B) and 25 (C) (see Figure 7.15) the orientation of the bowl was altered and three varying positions of referent presented (A, B and C). It was predicted that as the referent ball moved from A to B to C control imposed by the bowl on the bowl would weaken. It was predicted that this should result in a decrease in confidence of IN. A one-way ANOVA examining IN was performed on the scores for these three scenes.

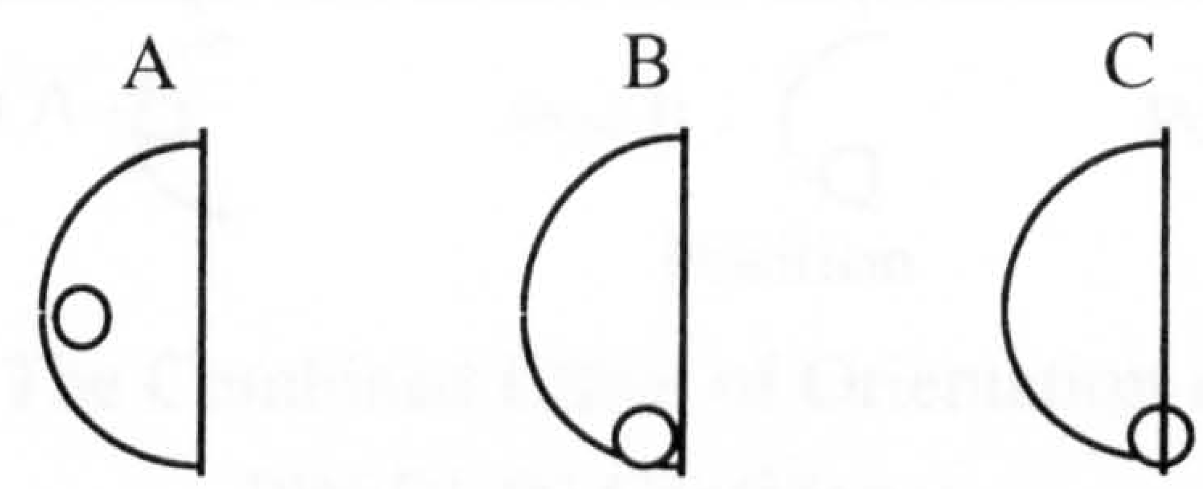


Figure 7.15 - The One-Way ANOVA Design for the PREP1 Orientation Presentations.

7.5.6.2 Results

A one-way ANOVA was carried out on scenes 23, 21 and 25 for confidence of IN. The mean confidence judgements are shown in Figure 7.16. The obtained value, $F(2,58) = 35.47$, $MSe = 1.055$ was found to be significant at the 0.0001 level. Further analysis significant differences between all three positions ($F>8.36$, $p<0.01$ in all cases). Confidence of IN decreases from position A through to position C.

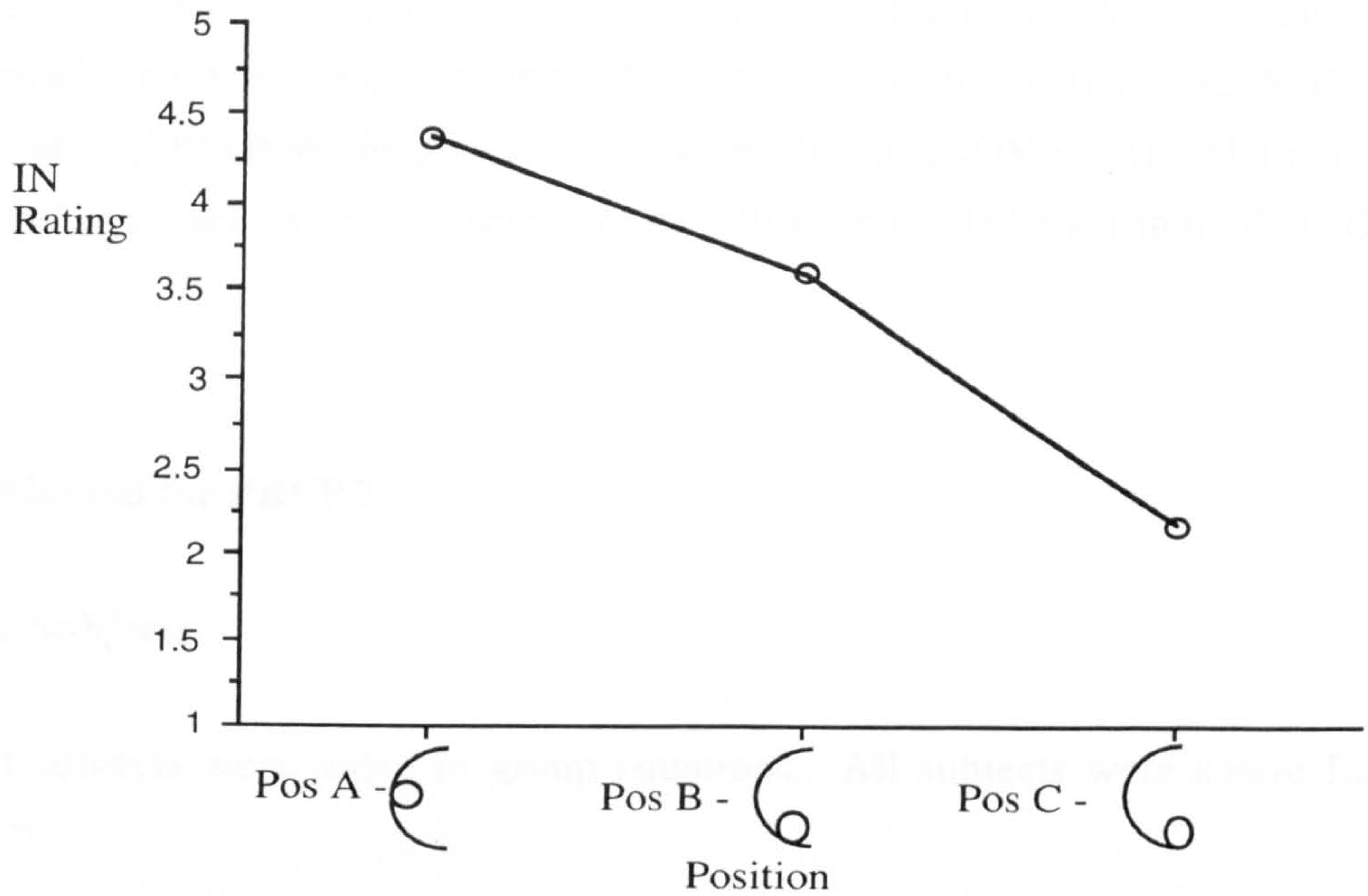


Figure 7.16 - The Combined Effect of Orientation and Position for PREP1 IN Confidence.

7.5.6.3 Discussion

As predicted the position of the ball to the bowl does affect judgements of IN. It is argued that when the ball is positioned on the tip of the bowl it appears less likely to move with the bowl than when the ball is located within the bowl. It can be seen that as the ball moves position (making it more and more unlikely for it to move in a correlated way with the relatum bowl) then confidence of IN to describe these scenes reduces correspondingly. The bowl is not imposing as strong a location control on the ball when in Positions B or C. Indeed the location control is weaker for Position C than for Position B.

7.6 The PREP2 Presentations

7.6.1 Introduction

The following PREP2 presentations examined the effect of various factors on the spatial prepositions IN, ON, OVER and ABOVE. The location controls of fContainment, and to a lesser extent fSupport and fSuperiority, were examined. Four separate groups of presentations were analysed. These examined Containment, Altered

Control and Position (2x2x5 ANOVA), Partial Containment, Altered Control and Position (2x2x3 ANOVA), Continuity, Altered Control and Position (2x2x5 ANOVA) and Horizontal Position, Height and Preposition (2x2x3 ANOVA). The Method is now presented and each series of presentations will be preceded by a individual Design section.

7.6.2 Method for PREP2

7.6.2.1 Subjects

The 54 subjects were tested in group situations. All subjects were native English speakers.

7.6.2.2 Apparatus and Materials

The materials used consisted of a perspex bowl, transparent thread, wire, one black ping-pong ball and several white ping-pong balls. A black arrow was used as a pointer and green material as the backdrop. The materials were filmed using a Sony DXC M3A television camera, in colour with no sound. After filming the resulting video-tape was edited using an RM-GE 10U editing control unit and a double JVC BR-S610ES VHS video recorder. Questionnaire booklets containing statements corresponding to scenes from the final video and also instructions were compiled (see Appendix D). A checklist containing the basic types of scenes was used in this study (see Appendix F). Subjects were asked questions such as "Is the ball touching the rim of the bowl?" or "Is the ball inside the bowl?" in order to check that subjects were viewing the two-dimensional video images in the intended way i.e. the way they would actually appear in a three-dimensional world. Fifty-eight graded scenes were filmed and four scenes were repeated to test for consistency.

7.6.2.3 Stimuli

Fifty-eight scenes involving the ball (x) as referent and the bowl (s) as relatum (y) were filmed in graded and repeated groupings (see Appendix E). Transparent thread was attached to the referent ball and used in scenes where other balls were not present.

Filmed scenes were edited onto a destination tape in a random order for 5 seconds per trial. Twenty seconds of black was shown between each scene. The number of the scene was also displayed before the trial.

Subjects answered six basic statements corresponding to each trial in the form NP + (Prep. + NP) after viewing each trial. Each statement was rated using the corresponding Lickert scale. The scale of 1-5 rated how well subjects thought the statement described the scene from 1 = Highly Unlikely to 5 = Most Likely. The statements were as follows and order of presentation was randomised within statements (see Table 7.5).

The ball is **over** the bowl	1 2 3 4 5
The ball is **in** the bowl	1 2 3 4 5
The ball is **below** the bowl	1 2 3 4 5
The ball is **above** the bowl	1 2 3 4 5
The ball is **under** the bowl	1 2 3 4 5
The ball is **on** the bowl	1 2 3 4 5

Table 7.5 - Statements Presented in PREP2.

7.6.2.4 Procedure

The subjects were tested in a group situation and each received an identical questionnaire which included instructions. These instructions were explained verbally. and subjects were informed that this was a simple language experiment. The subjects were verbally instructed that they should pay special attention to the ball (x) indicated by the pointer. It was also stressed that the Lickert scale must be rated for each statement per scene. Subjects were instructed that statements should be read prior to the relevant trial appearing on screen. Individuals were able to ask questions to clarify any details. Each scene was preceded by a numbered caption and the number of each scene was called out to the subjects. After the experiment the questionnaires were collected from each subject.

7.6.3 PREP2: The Containment, Altered Control and Position Presentations

7.6.3.1 Design

These PREP2 presentations involved twenty scenes. The factors used were Altered Control (wire versus no wire attached to the referent ball), Containment (presence of surrounding balls versus no surrounding balls) and Position (all 5 basic positions were used). Notions of **f**Containment predict that if the referent ball does not have the potential to move with the relatum bowl then use of IN should become less likely. Altered Control was introduced in order to reduce the likelihood of potential movement as it provided an alternate source of location control. An analysis of ON is also presented as this preposition also involves high levels of location control. Predictions about ON are more difficult, however, I expect to see an effect of these three factors. Also it appears that functional controls act on a continuum and a strong control for IN should influence control for ON. The 2x2x5 ANOVA design used for these presentations is illustrated in Figure 7.17.

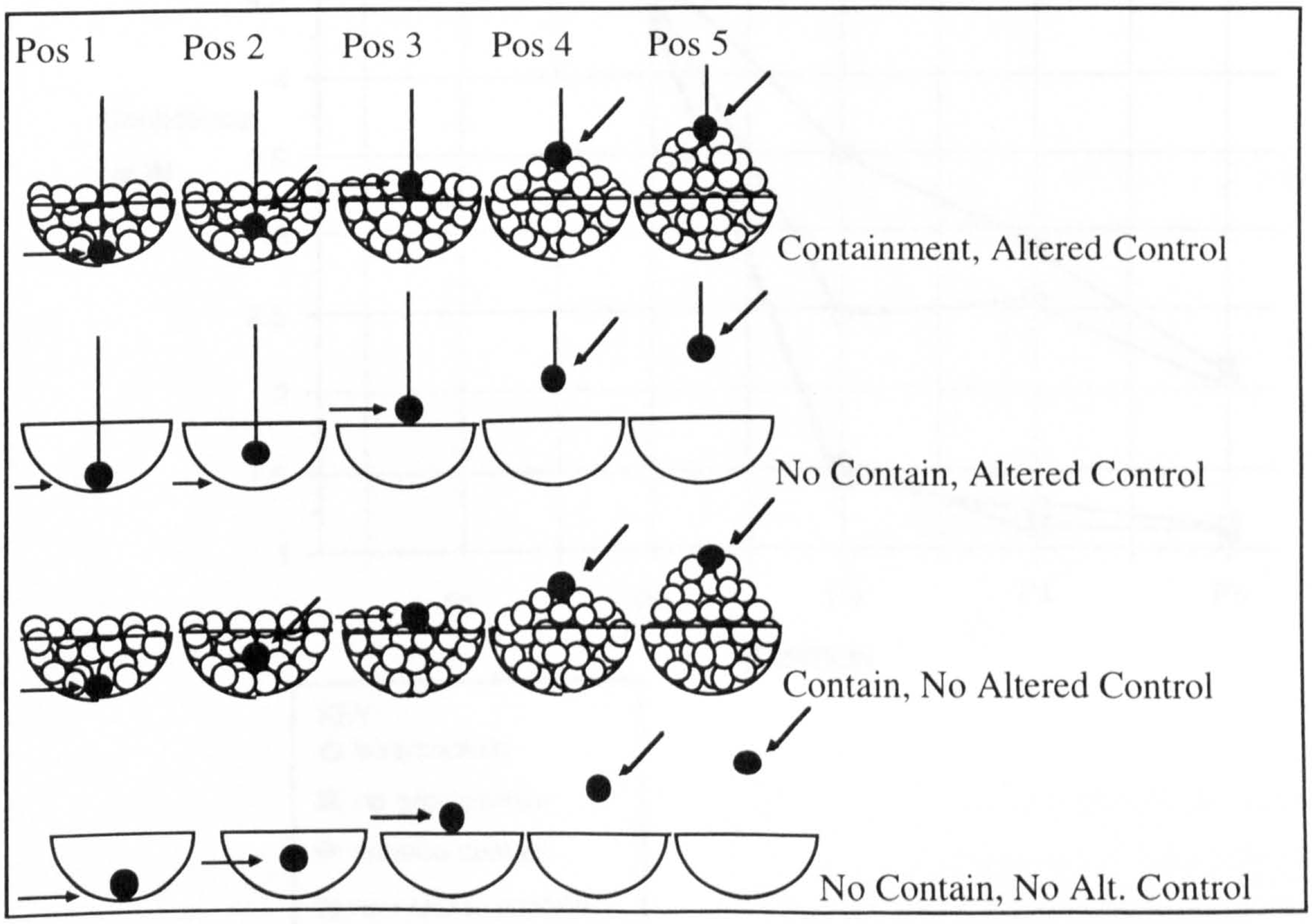


Figure 7.17 - The PREP2 2x2x5 ANOVA Design Examining Containment, Altered Control and Position.

The PREP1 presentations examining Containment and Position (P2-P4) showed that presence of containment in non-spatial positions increased IN confidence as compared to non-spatial positions where no containment was present. Similar results are expected in this series of PREP2 presentations.

7.6.3.2 Results

The scores for scenes 25,55,42,52,18,19,26,4,31,47,8,20,6,22,29,7,2,21,51 and 56 (see Appendix E for the randomised order presented to subjects) were subjected to a repeated measures 2x2x5 ANOVA. . The mean confidence scores for the judgements of IN descriptions are shown in Figure 7.18. The reliable main effects and interactions are listed in Table 7.6.

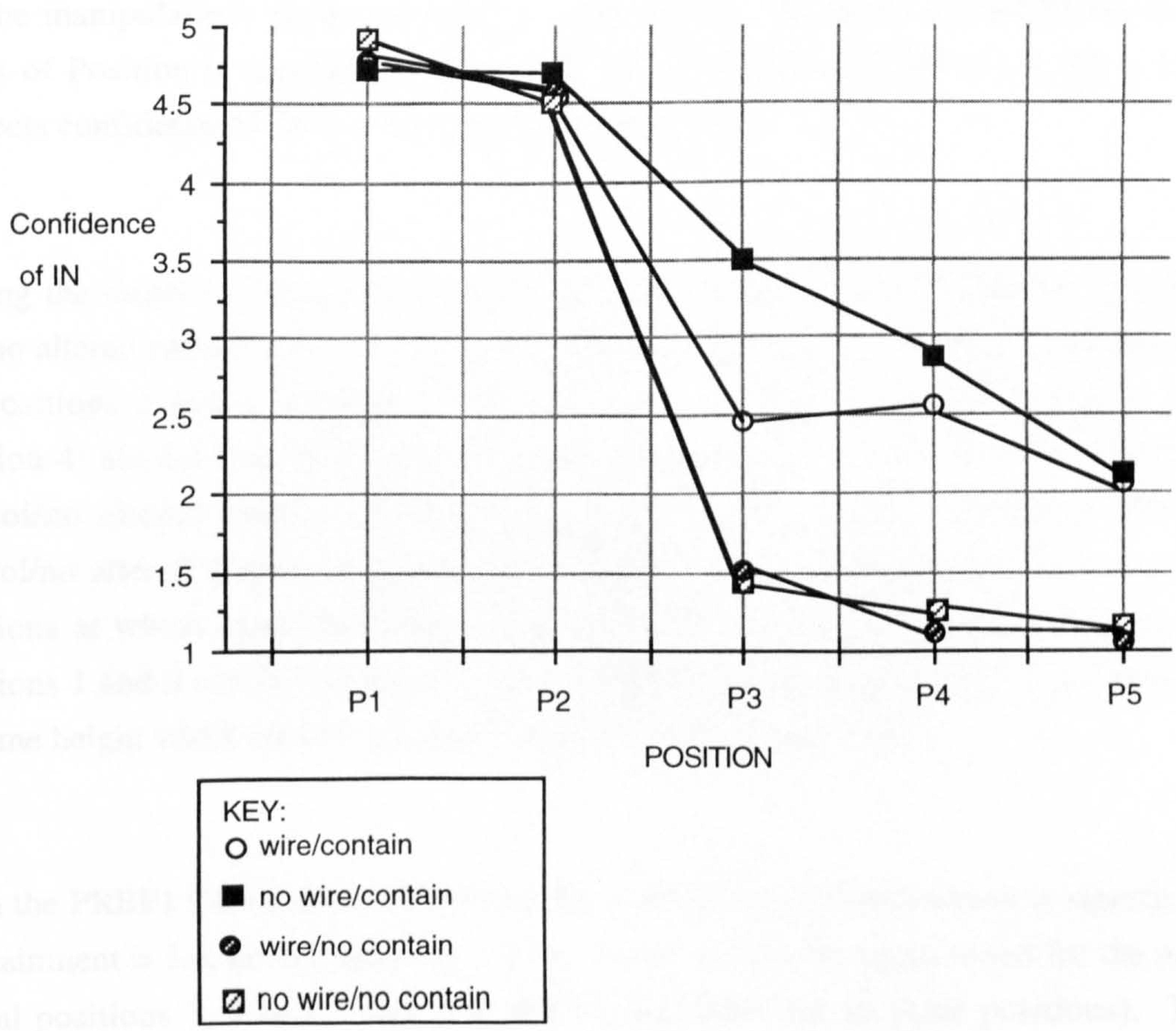


Figure 7.18 - The Combined Effect of Containment, Altered Control and Position for PREP2 IN Confidence.

Reliable Main Effects and Interaction for IN Judgements - PREP2	
Wire(altered control)	$F(1,52) = 7.03$, $MSe = 1.06$, $p=0.01$
Containment	$F(1,52) = 82.77$, $MSe = 2.12$, $p<0.0001$
Position	$F(4,208) = 418.078$, $MSe = 1.21$, $p<0.0001$
WireXCont	$F(1,52) = 4.34$, $MSe = 1.1$, $p<0.05$
WireXPos	$F(4,208) = 3.952$, $MSe = 0.596$, $p<0.01$
ContXPos	$F(4,208) = 39.23$, $MSe = 0.789$, $p<0.0001$
WireXContXPos	$F(4,208) = 6.7$, $MSe = 0.569$, $p<0.0001$

Table 7.6 - Significant Results for the PREP2 Altered Control, Containment and Position ANOVA Examining IN Confidence.

All the manipulations produced reliable main effects. As found in PREP1 the main effect of Position is significant (P1 = 4.8, P2 = 4.6, P3 = 2.2, P4 = 1.9, P5 = 1.6). Subjects confidence of IN decreases as position increases.

Having the target ball attached to a wire reduced confidence in IN (altered control = 2.9, no altered control = 3.1) as expected. The presence of wire effects IN judgements for positions 3 and 4 (position 3: altered control = 1.98, no altered control = 2.5, position 4: altered control = 1.79, no altered control = 2.03). For position 3 altered control/no altered control $F(1,208) = 23.1$, $p<0.0001$ and for position 4 altered control/no altered control $F(1,208) = 4.9$, $p<0.05$. It is suggested that these are the positions at which functional factors become important in prepositional judgement. Positions 1 and 2 can be explained by using spatial notions and position 5 presents an extreme height which means it is unlikely that x could move with y.

As in the PREP1 Containment ANOVAs the main effect of Containment is significant (containment = 3.4, no containment = 2.6). These effects are again found for the non-spatial positions 3, 4 and 5 ($F(1,208)>69.74$, $p<0.0001$ for all three positions). The presence of an altered control only reduces confidence of IN in scenes where containment is present (($F(1,208) = 11.02$, $p<0.01$). Indeed, for positions 3 and 4 with containment and altered control versus no altered control, $F(1, 208) >5.37$, $p<0.05$.

An identical ANOVA was then carried out to investigate confidence of ON. The confidence judgements for descriptions containing ON are shown in Figure 7.19 across the 5 positions. The significant main effects and interactions are listed in Table 7.7.

Reliable Main Effects and Interaction for ON Judgements - PREP2	
Wire(altered control)	$F(1,52) = 6.94$, $MSe = 0.745$, $p=0.01$
Containment	$F(1,52) = 6.191$, $MSe = 1.84$, $p<0.05$
Position	$F(4,208) = 71.43$, $MSe = 2.87$, $p<0.0001$
WireXCont	$F(1,52) = 17.37$, $MSe = 1.01$, $p<0.0001$
WireXPos	$F(4,208) = 2.67$, $MSe = 0.988$, $p<0.05$
ContXPos	$F(4,208) = 8.29$, $MSe = 1.26$, $p<0.0001$
WireXContXPos	$F(4,208) = 14.34$, $MSe = 0.81$, $p<0.0001$

Table 7.7 - Significant Results for PREP2 ANOVA Examining the Effect of Altered Control, Containment and Position on ON Confidence.

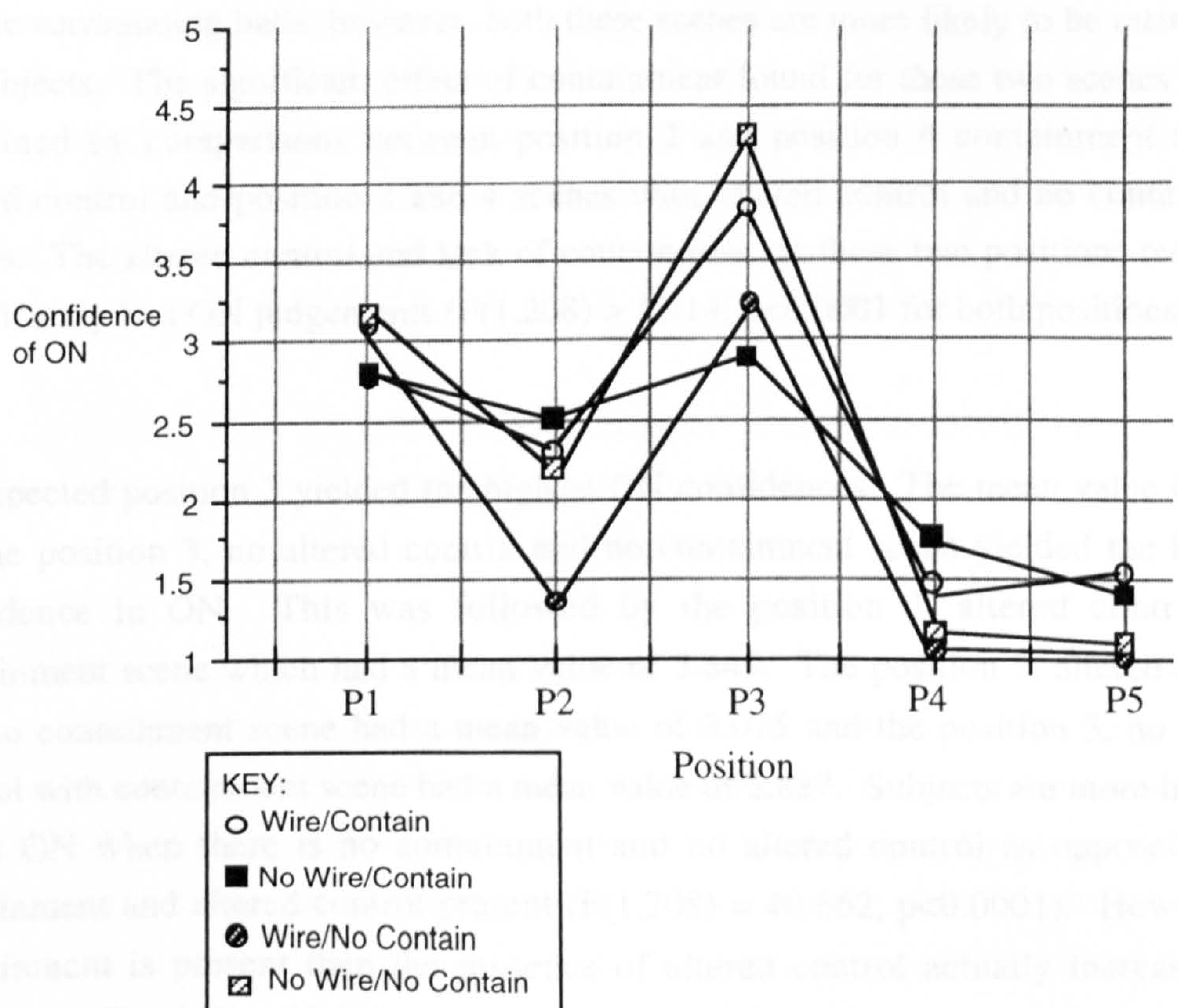


Figure 7.19 - The Combined Effect of Containment, Altered Control and Position for PREP2 ON Confidence.

Firstly, examining the main effects it can be seen that the presence of an altered control slightly reduces confidence in ON overall (wire = 2.153, no wire = 2.292). There is also a significant effect of Containment overall (containment = 2.326, no containment = 2.119). As found in PREP1 there is a significant effect of position. Means comparisons between positions 2 through to 4 are significant ($F(1, 208) > 25.18$, $p<0.0001$). The high means found for position 1 (2.9) and position 3 (3.5) are where the ball either touches the base of the bowl or touches the rim of the bowl.

All the interactions were significant and the means comparisons of the three way interaction for this ANOVA best reveal the rather complicated results found. Examining the mean confidence ratings for this ANOVA reveals that the most interesting effects occurred at positions 2, 3 and 4. As expected position 3, where the ball touches the rim of the bowl, reveals the highest ON confidence. Increased judgements at position 1 reflect the fact that the ball is touching the base of the bowl. The main effect of Containment reflects the manipulation results found for position 2 and position 4. For position 2 and position 4 subjects were most likely to select ON when there was containment but no altered control. These scenes do provide support via the surrounding balls, however, both these scenes are more likely to be rated as IN by subjects. The significant effect of containment found for these two scenes can be explained by comparisons between position 2 and position 4 containment and no altered control and position 2 and 4 scenes with altered control and no containment scenes. The altered control and lack of containment on these two positions results in significantly less ON judgements ($F(1,208) > 15.14$, $p<0.0001$ for both positions).

As expected position 3 yielded the highest ON confidences. The mean value (4.189) for the position 3, no altered control and no containment scene yielded the highest confidence in ON. This was followed by the position 3, altered control and containment scene which had a mean value of 3.849. The position 3, altered control and no containment scene had a mean value of 3.075 and the position 3, no altered control with containment scene had a mean value of 2.887. Subjects are more likely to select ON when there is no containment and no altered control as opposed to no containment and altered control present ($F(1,208) = 40.662$, $p<0.0001$). However, if containment is present then the presence of altered control actually increases ON confidence ($F(1,208) = 30.383$, $p<0.0001$).

7.6.3.3 Discussion

As expected an altered control reduced selection of IN for the non-spatial positions 3 and 4. It is argued that the control provided by the bowl over the contents is weakened by the altered source of control provided by wire. It is argued that the referent is perceived as less likely to have the potential to move with the relatum. Containment, as noted in the PREP2 study, increases IN confidence. Lack of containment reduces the control that the bowl can impose on the referent ball. Such reduced control makes it less likely that the referent and relatum could move together in a correlated manner. The results for ON are more complicated but as noted previously these scenes were designed mainly to tap into IN judgements. The main use of ON occurs for position 3 where the ball is touching the rim of the bowl. Here I found that altered control only reduced judgements of ON when there was no containment provided by other balls. Indeed, in scenes where containment was provided altered control actually increased ON confidence. It is suggested that this is due to the fact that wire wrapped around the ball may focus subjects attention to the fact that the referent ball is balanced on the rim. Certainly one would expect that altered control would be perceived as a secondary support and result in lower confidence in ON, however, it is suggested that these static scenes do not directly tap into the inherently dynamic controls involved with ON. A dynamic manipulation involving Altered Control and focusing on ON is presented in Chapter 8. Scenes which directly tap into judgements of ON are also discussed later in this chapter.

7.6.4 PREP2: The Partial Containment, Altered Control and Position Presentations

7.6.4.1 Design

Containment factors have been shown to influence confidence for IN and ON. The following ANOVAs examining IN and ON introduce another containment factor, that of Partial Containment. Three factors are included in the design of the following analysis. As in the previous study the factor of Position (using only positions 3-5) was varied as was the factor of Altered Control. The factor of Partial Containment is also introduced; the target ball could either be well surrounded by other balls (containment) or only partially surrounded (partial containment). It is predicted that scenes involving partial containment will reduce judgements of IN as the control imposed by the bowl will be weakened due to the lack functional containment. As before it is predicted that the presence of wire as an altered control will reduce confidence of IN. Judgements should be even further weakened in scenes where both partial containment and altered control are present. An analysis of ON is included to examine any counter effects. A 2x2x3 ANOVA design was used and this is illustrated in Figure 7.20.

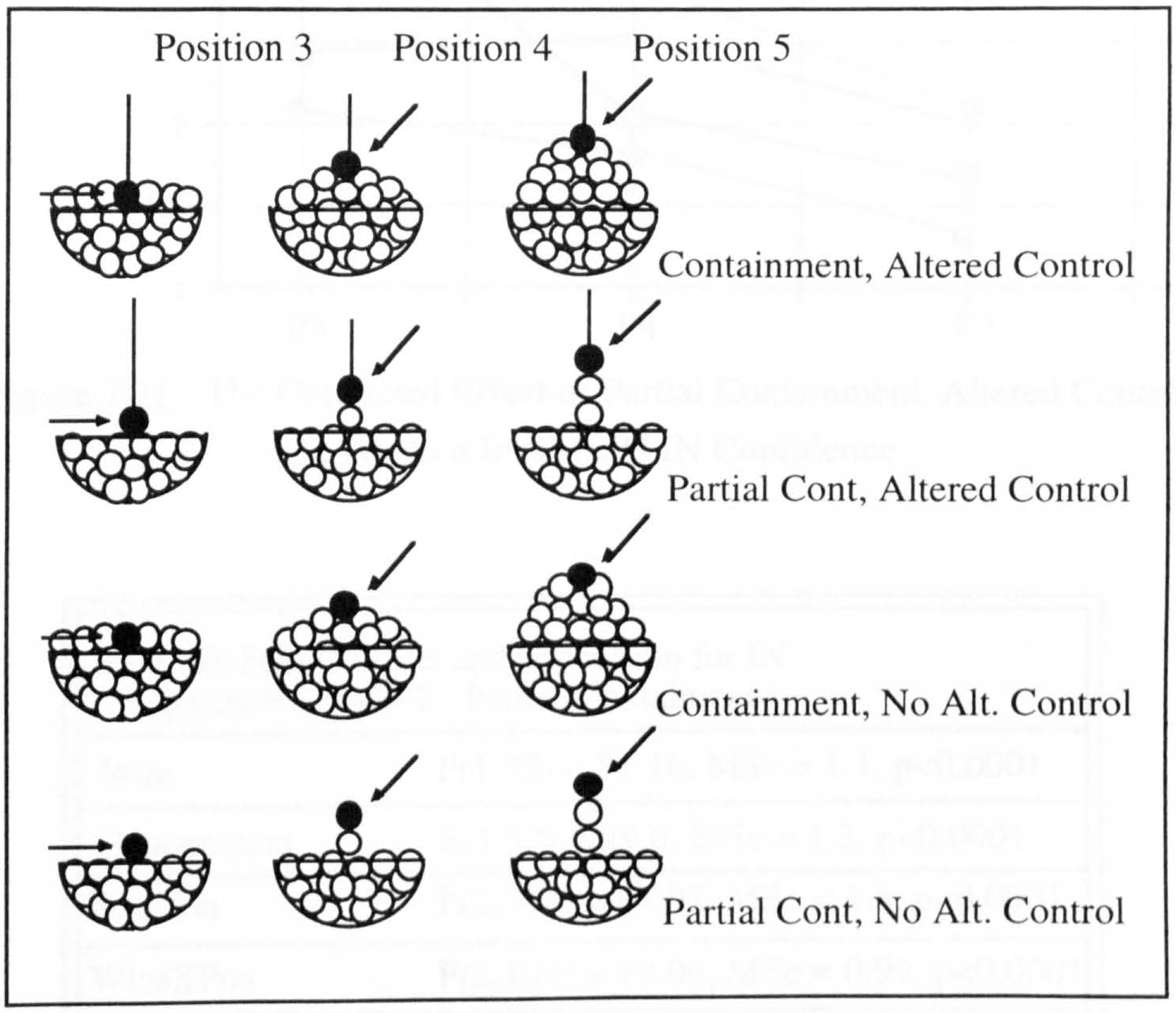


Figure 7.20 - The PREP2 2x2x3 ANOVA Design Examining Altered Control, Partial Containment and Position.

7.6.4.2 Results

The PREP2 Scenes 42,52,18,11,38,5,6,22,29,32,46 and 34 for IN were subjected to a 2x2x3 repeated measures ANOVA (see Appendix E for the randomised order presented to subjects). The mean confidence ratings for IN descriptions over the three factors is shown in Figure 7.21. All significant main effects and interactions are listed in Table 7.8.

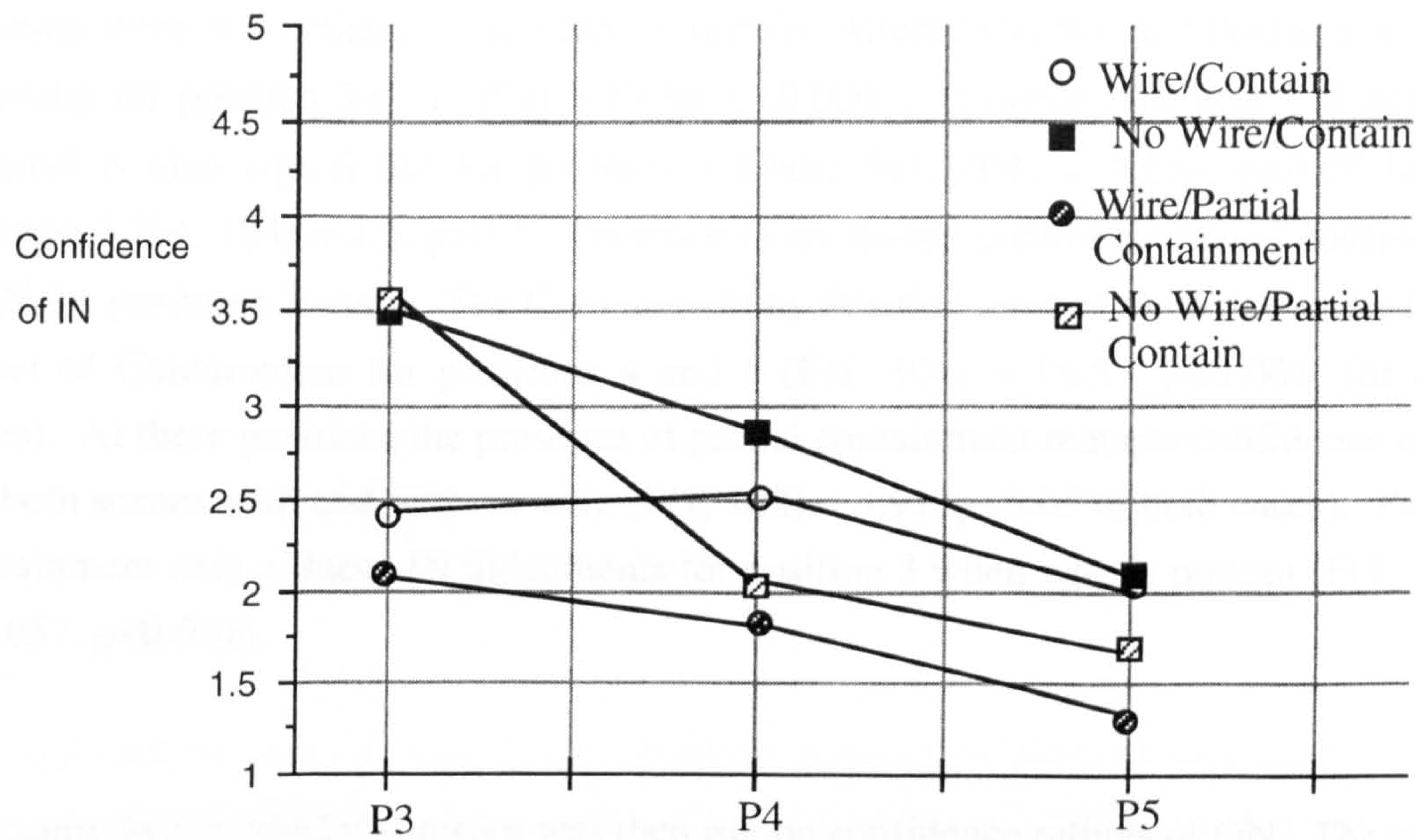


Figure 7.21 - The Combined Effect of Partial Containment, Altered Control and Position for PREP2 IN Confidence.

Reliable Main Effects and Interaction for IN Judgements - PREP2 - Partial Containment	
Wire	$F(1,52) = 51.16$, $MSe = 1.1$, $p<0.0001$
Containment	$F(1,52) = 29.6$, $MSe = 1.3$, $p<0.0001$
Position	$F(2,104) = 44.07$, $MSe = 1.5$, $p<0.0001$
WireXPos	$F(2,104) = 19.06$, $MSe = 0.99$, $p<0.0001$
ContXPos	$F(2,104) = 4.75$, $MSe = 0.847$, $p<0.05$

Table 7.8 - Significant Results for PREP2 Partial Containment ANOVA Examining IN Confidence.

All the manipulations produced reliable main effects. When the referent ball was attached to a wire confidence in IN decreased dramatically (altered control = 2.031, no altered control = 2.626). A similar effect occurred with the Partial Containment factor (containment = 2.572, partial containment = 2.085). There was also a significant effect for Position (P3 = 2.887, P4 = 2.311, P5 = 1.788).

The two interactions of Wire (Altered Control) by Position and Containment by Position were also reliable. The effect found for Altered Control and Position is most dramatic for position 3 ($F(1, 104) = 87.94$, $p<0.0001$. However, the effect of Altered Control is also significant for position 4 where $F(1, 104) = 4.279$, $p<0.05$ but at position 5 $F(1, 104) = 2.5$, $p>0.1$. Presence of an altered control decreases confidence of IN for positions 3 and 4. The Containment by Position interaction is due to the large effect of Containment for positions 4 and 5 ($F(1, 104) = 15.53$, $p<0.001$, for both cases). At these positions the presence of partial containment reduces confidence of IN for both scenes with and without wire ($F(1, 102) = 4.91$, $p<0.05$ in both cases). Partial containment only reduces IN judgements for position 3 when wire is present ($F(1, 104) = 3.057$, $p<0.001$).

The same 2x2x3 ANOVA design was then run on confidence ratings of ON. The mean confidence ratings for ON descriptions over the three factors are shown in Figure 7.22. The significant main effects and interaction are listed in Table 7.9.

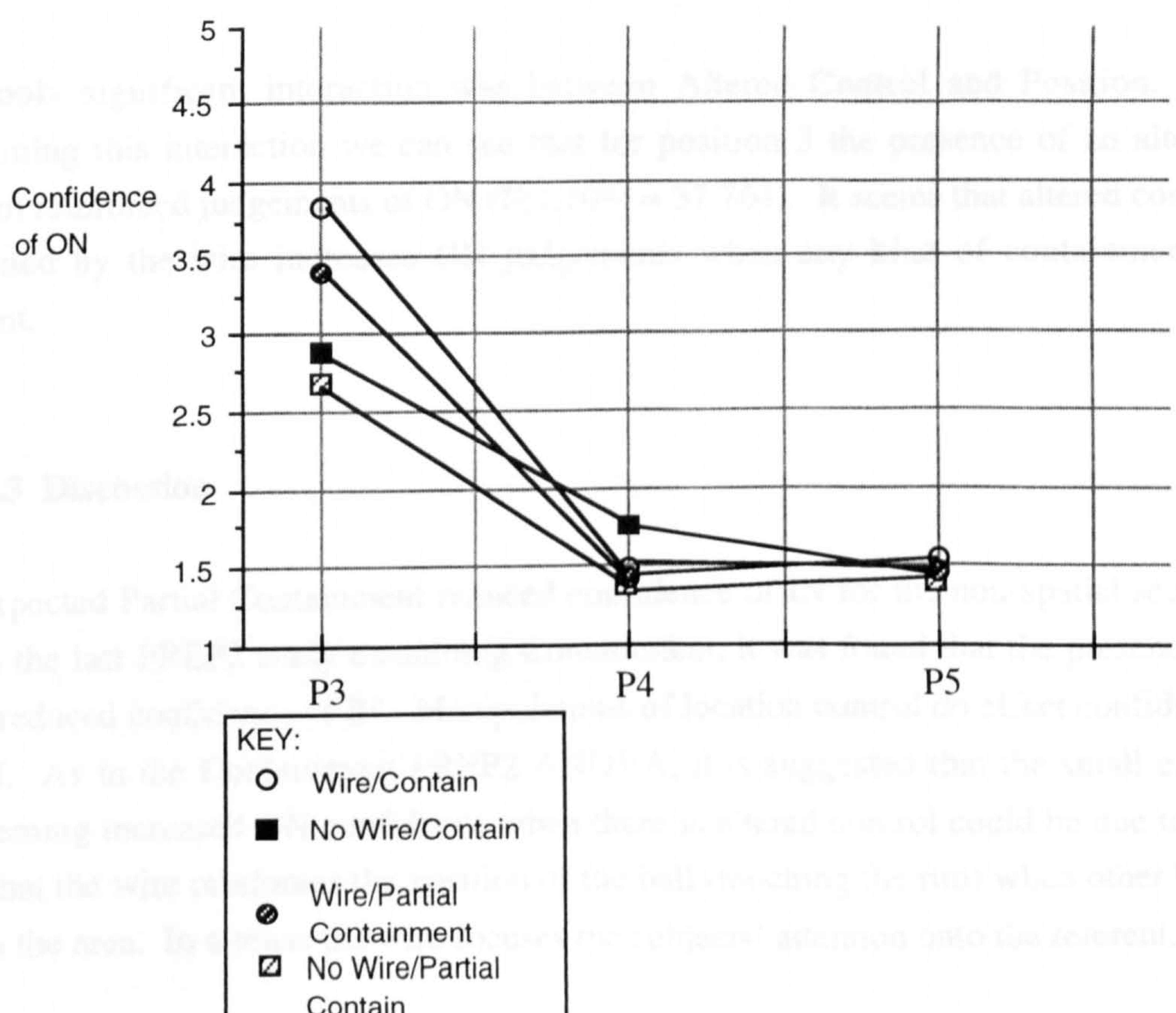


Figure 7.22 - The Combined Effect of Partial Containment, Altered Control and Position for PREP2 ON Confidence.

Reliable Main Effects and Interaction for ON Judgements - PREP2 -Partial Containment	
Wire(altered control)	F(1,52)=12.06, MSe=1.06, p<0.001
Containment	F(1,52)=10.29, MSe=0.88, p=0.002
Position	F(2,104)=112.03, MSe=1.82, p<0.001
WireXPos	F(2,104)=13.15, MSe=1.01, p<0.0001

Table 7.9 - Significant Results for PREP2 Partial Containment ANOVA Examining ON Confidence.

The main effects were all significant. Subjects were more likely to select ON overall when altered control was present (wire = 2.170, no wire = 1.887) and also when full containment was present (containment = 2.15, partial containment = 1.91). The effect of Position was significant overall (P3 = 3.16, P4 = 1.51, P5 = 1.42).

The only significant interaction was between Altered Control and Position. By examining this interaction we can see that for position 3 the presence of an altered control reinforced judgements of ON (F(1,104) = 37.764). It seems that altered control provided by the wire increases ON judgements when any kind of containment is present.

7.6.4.3 Discussion

As expected Partial Containment reduced confidence of IN for the non-spatial scenes. As in the last PREP2 study examining Containment, it was found that the presence of wire reduced confidence of IN. Manipulations of location control do effect confidence of IN. As in the Containment PREP2 ANOVA, it is suggested that the small effect concerning increased ON confidence when there is altered control could be due to the fact that the wire reinforces the position of the ball (touching the rim) when other balls are in the area. In a sense the wire focuses the subjects' attention onto the referent.

7.6.5 PREP2: The Continuity, Altered Control and Position Presentations

7.6.5.1 Design

The factor of Continuity in relation to Altered Control and Position was examined in a PREP2 study of the locative IN. The factor of Altered Control was manipulated once again as was the factor of Position (P1-P5 were used in this study). The factor of Continuity was also introduced and this involved the referent ball being either continuous with surrounding balls (White) or not continuous with surrounding balls (Black). These factors were organised into a 2x2x5 ANOVA design examining IN (see Figure 7.23). Presentations shown as part of PREP1 have already shown an effect of continuity.

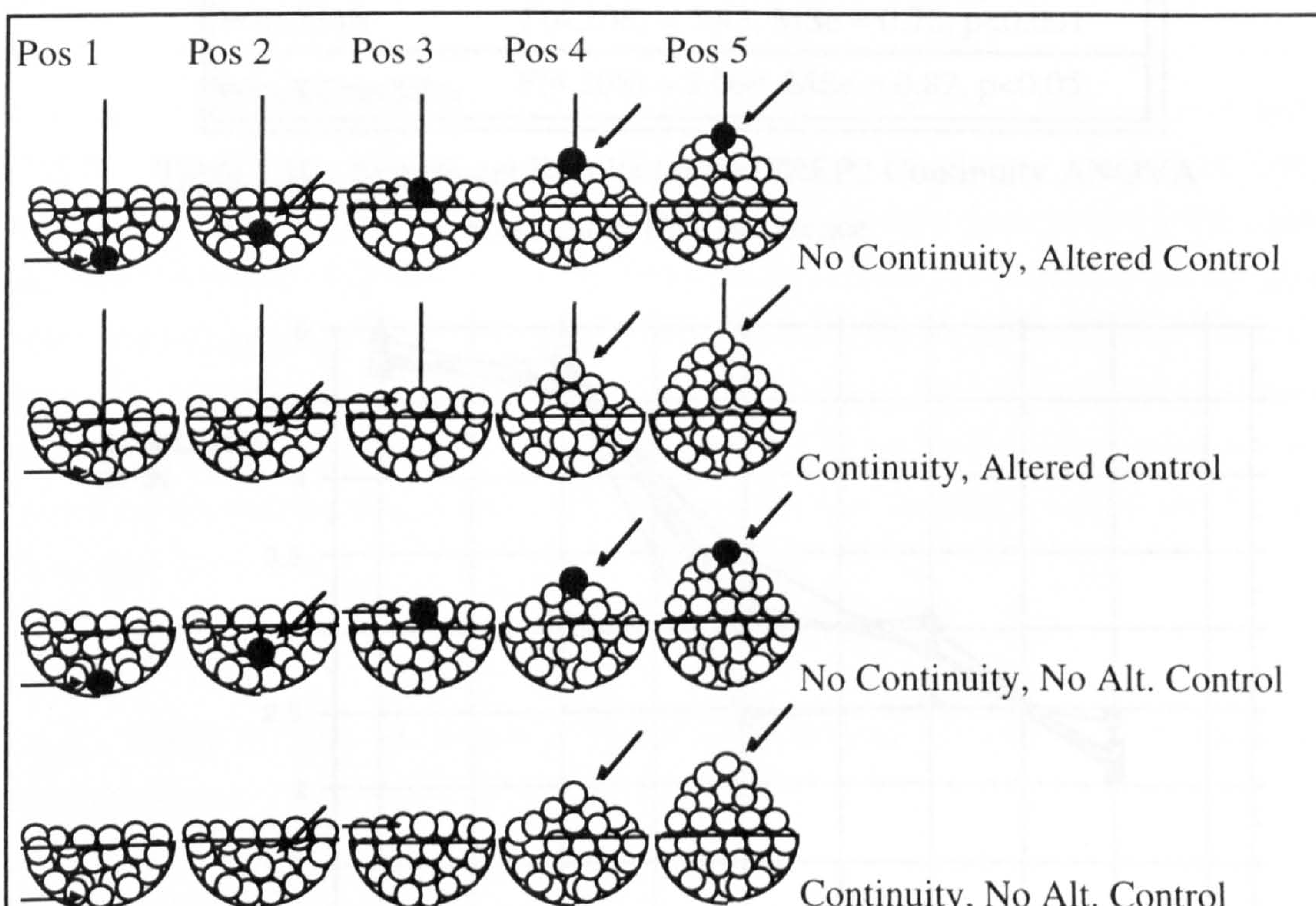


Figure 7.23 - The PREP2 2x2x5 ANOVA Design Examining Continuity, Altered Control and Position.

7.6.5.2 Results

The scores for scenes 25, 55, 42, 52, 18, 1, 35, 48, 15, 40, 8, 20, 6, 22, 29, 12, 3, 30, 44 and 9 were subjected to a repeated measures 2x2x5 ANOVA. The mean confidence ratings for IN descriptions over the three factors is shown in Figure 7.24. Significant main effects and interactions are listed in Table 7.10.

Reliable Main Effects and Interactions for IN Continuity PREP2 ANOVA	
Wire	$F(1,52) = 6.58$, $MSe = 1.09$, $p=0.013$
Continuity	$F(1,52) = 7.52$, $MSe = 0.6$, $p<0.01$
Position	$F(4,208) = 146.7$, $MSe = 2.1$, $p<0.0001$
WireXCont	$F(1,52) = 3.93$, $MSe= 1.3$, $p=0.053$
WireXPos	$F(4,208) = 5.45$, $MSe = 0.78$, $p<0.001$
WireXContXPos	$F(4,208) = 3.069$, $MSe = 0.82$, $p<0.05$

Table 7.10 - Significant Results for the PREP2 Continuity ANOVA Examining IN Confidence.

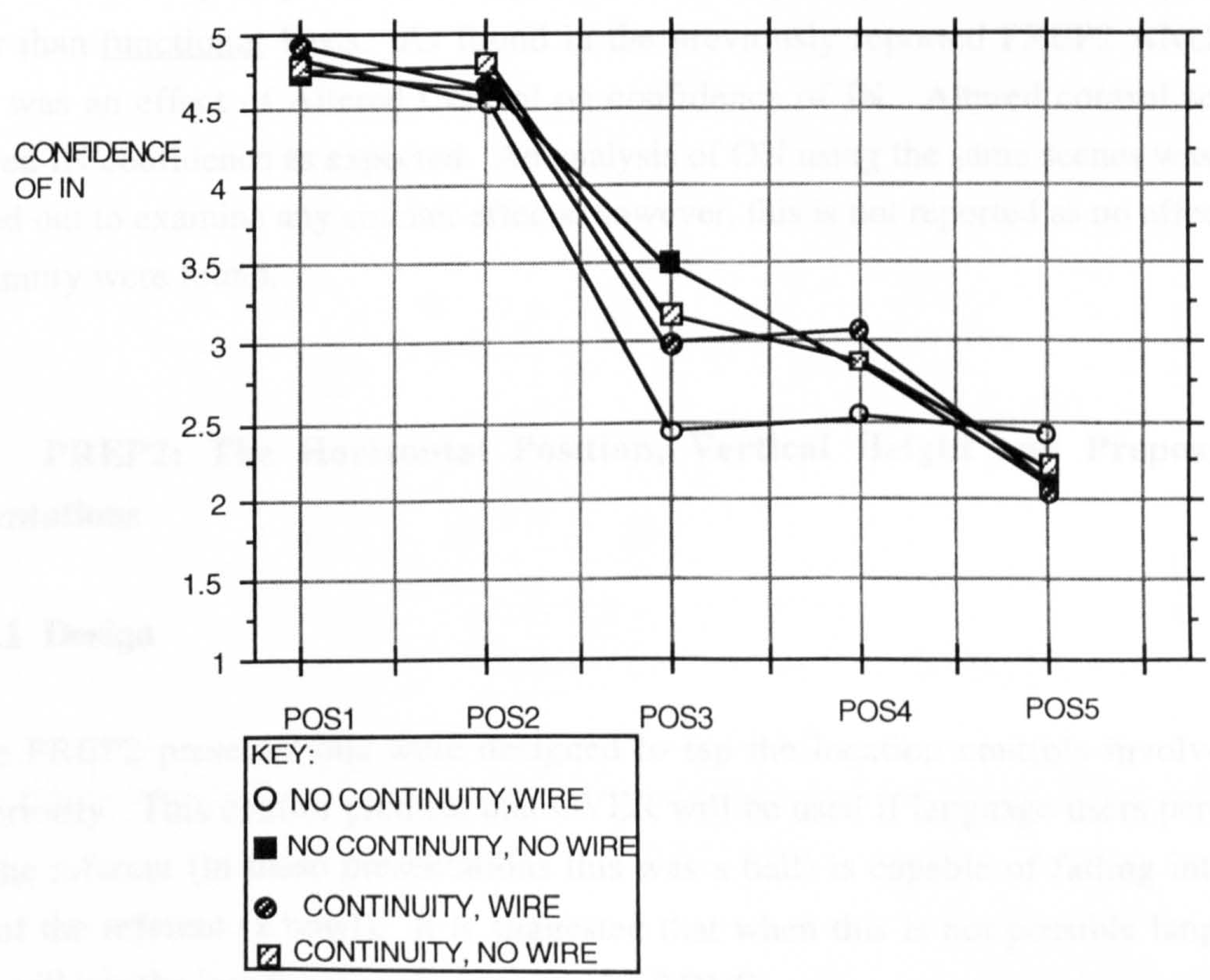


Figure 7.24 - The Combined Effect of Altered Control, Continuity and Position for PREP2 IN Confidence.

The main effects were all significant. Subjects were more likely overall to select IN when there was no altered control present (altered control = 3.402, no altered control = 3.566). Subjects were more likely, overall, to select IN when there was continuity present (continuity = 3.549, no continuity = 3.419). There was also a significant effect of Position as expected.

The borderline interaction between Altered Control and Continuity revealed that confidence of IN increases when there is no altered control and no continuity present ($F(1, 208) = 9.45$, $p<0.01$).

7.6.5.3 Discussion

It was found that overall Continuity increases confidence of IN. Similarly in the PREP1 presentations it was found that continuity at position 5 increased IN confidence as compared to no continuity at this position. It is suggested that differences found in PREP1 and PREP2 with regards to Continuity can be viewed as differences in perception. It is suggested that continuity is not an important factor in location control and that continuity only acts as a very weak control, perhaps more on a purely <u>visual</u> rather than <u>functional</u> basis. As found in the previously reported PREP2 ANOVAs there was an effect of Altered Control on confidence of IN. Altered control scenes reduced IN confidence as expected. An analysis of ON using the same scenes was also carried out to examine any counter effects, however, this is not reported as no effects of Continuity were found.

7.6.6 PREP2: The Horizontal Position, Vertical Height and Preposition Presentations

7.6.6.1 Design

These PREP2 presentations were designed to tap the location controls involved in fSuperiority. This control predicts that OVER will be used if language users perceive that the referent (in these presentations this was a ball) is capable of falling into the area of the referent (a bowl). It is suggested that when this is not possible language users will use the less functional preposition ABOVE.

It was predicted that the spatial preposition OVER would have a different range from the preposition ABOVE. Basically if subjects can predict that the referent ball x will fall into the area of the bowl y, then it will be more likely that the functional preposition OVER will be chosen rather than the less functional spatial preposition ABOVE. Similarly, when there is a weaker location control (i.e. if there is no threatened contact with the bowl perceived) then judgements of ABOVE should increase as this preposition is not sensitive to notions of fSuperiority.

The scenes used in this study involved a single ping-pong ball located in various positions above a glass bowl. There were three factors in this design. First, the choice of Preposition (OVER versus ABOVE) was examined as a factor. Second, the height of the ball above the bowl (either medium or high) was varied. Third, the Horizontal Position (HP) relative to the bowl was varied. This involved the ball being either directly over the centre of the bowl (HP1), being located over the rim of the bowl (HP2) or being the same distance beyond the rim of the bowl (HP3). A 2x2x3 ANOVA design was used. The scenes used to compare OVER and ABOVE in this design are illustrated in Figure 7.25.

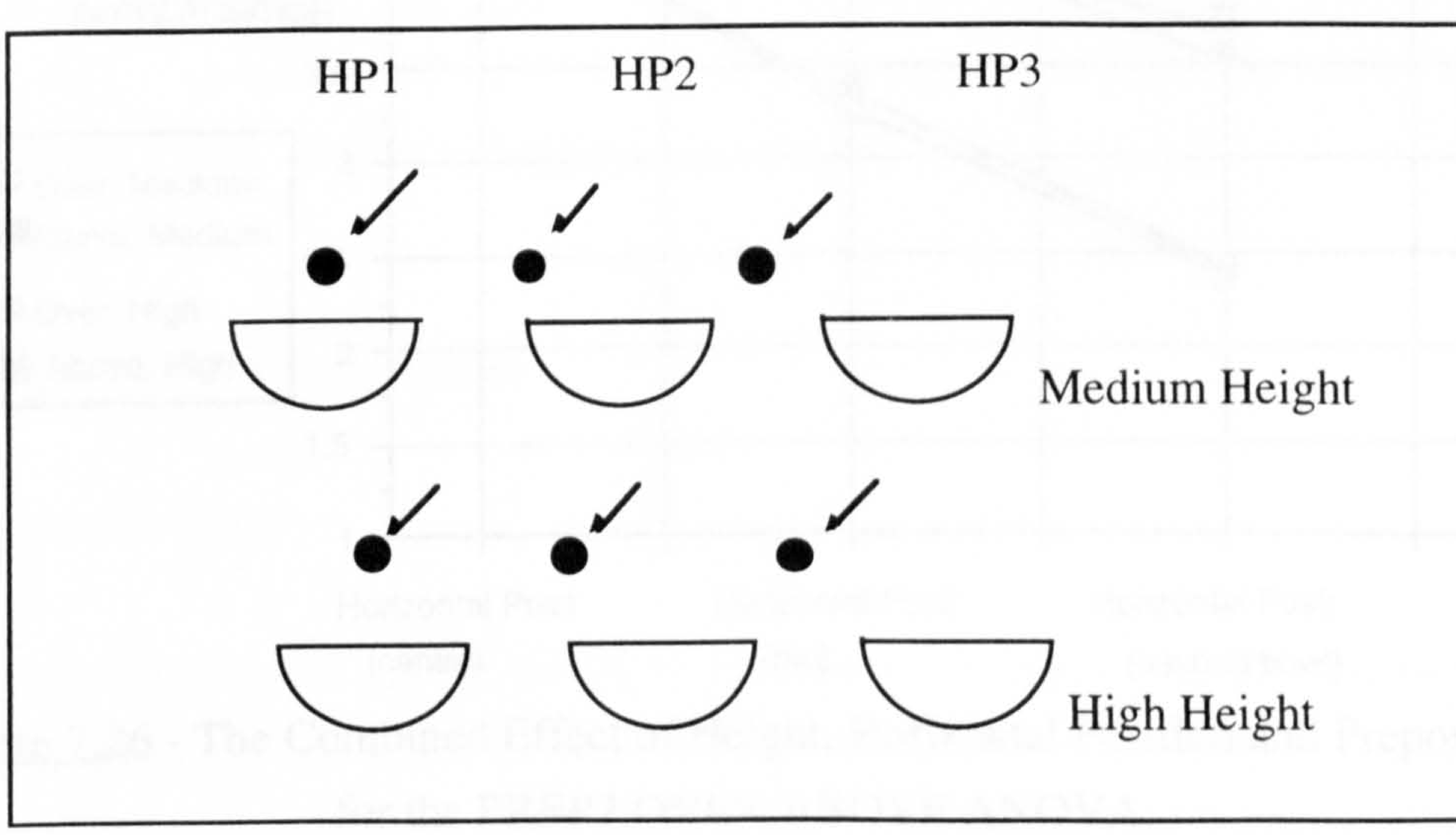


Figure 7.25 - The PREP2 2x2x3 ANOVA Design Examining Height, Horizontal Position and Preposition.

7.6.6.2 Results

PREP2 scenes 14, 54, 43, 24, 37 and 58 examining OVER and ABOVE were subjected to a 2x2x3 repeated measures ANOVA (see Appendix E for the randomised order presented to subjects). The mean confidence judgements for these scenes are shown in Figure 7.26 and the reliable main effects and interaction are listed in Table 7.11.

Reliable Main Effects and Interaction for the PREP2 OVER/ABOVE ANOVA	
Preposition	F(1,51) = 35.39, MSe = 2.8, p<0.0001
Horiz.Pos	F(1,51) = 64.46, MSe = 1.96, p<0.0001
PrepXHoriz.Pos	F(2,102) = 7.13, MSe = 2.3, p<0.01

Table 7.11 - Significant Results for the PREP2 OVER and ABOVE ANOVA.

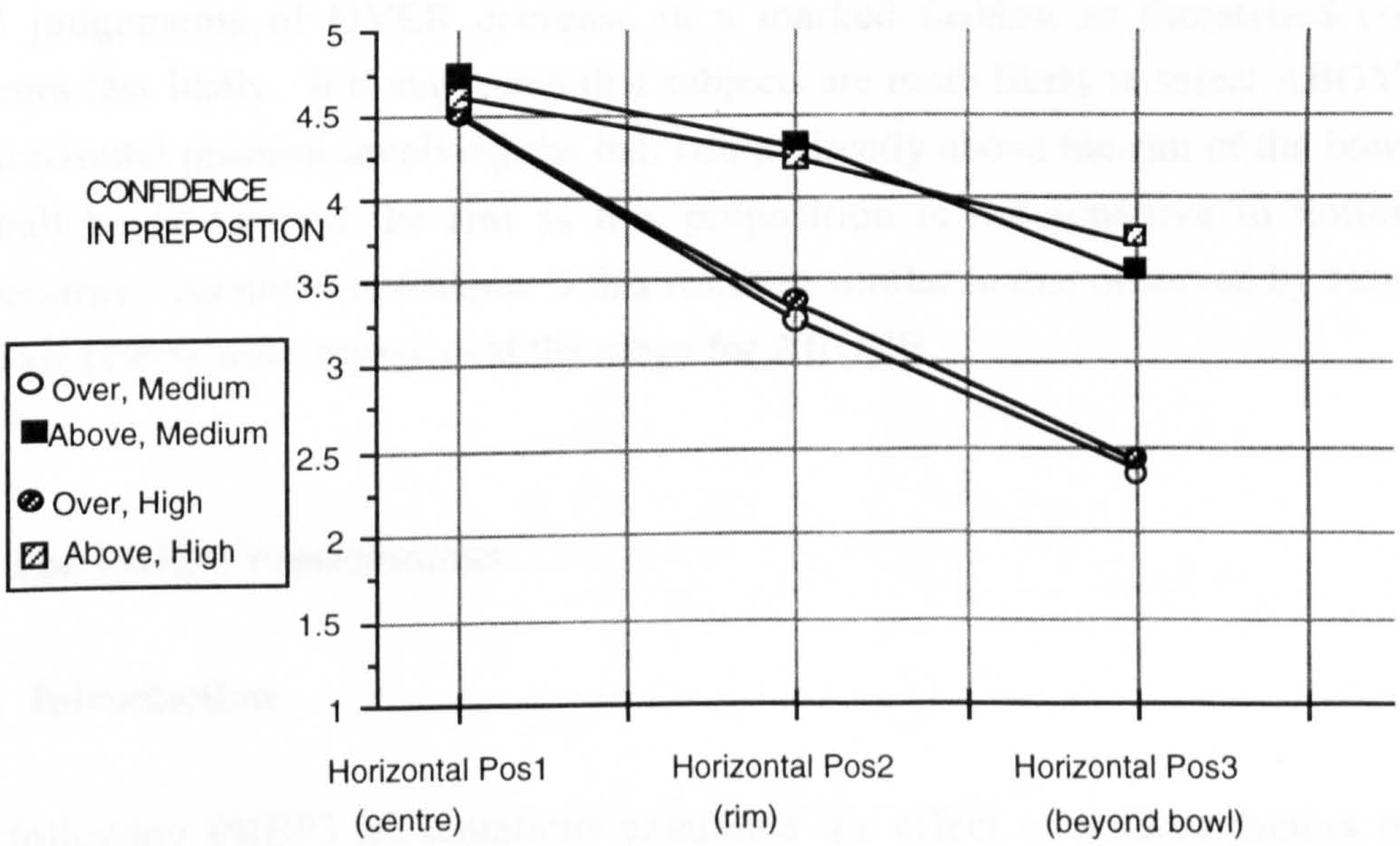


Figure 7.26 - The Combined Effect of Height, Horizontal Position and Preposition for the PREP2 OVER/ABOVE ANOVA.

The only reliable main effects were for Preposition (over = 3.407, above = 4.208) and also for Horizontal Position (HP1 = 4.587, HP2 = 3.808, HP3 = 3.03). Overall subjects prefer to use ABOVE descriptions rather than OVER descriptions. Subjects are also sensitive to the precise horizontal relationship between the ball and the bowl.

There was also a reliable interaction between Preposition and Position. Confidence in OVER and ABOVE is indistinguishable for horizontal position 1. However, for horizontal positions 2 and 3 subjects are significantly more confident of ABOVE descriptions ($F(1,102) > 20.63$, $p<0.001$ for both horizontal positions).

7.6.6.3 Discussion

As can be seen in Figure 7.26 the Horizontal Position affects confidence for both OVER and ABOVE judgements, however, the effect is much more marked for OVER. It is argued that this is due to the fact that OVER is sensitive to the control imposed by fSuperiority. When the ball is directly over the bowl there is a high degree of threatened contact present, however, as the ball moves away from the centre of the bowl judgements of OVER decrease in a marked fashion as threatened contact becomes less likely. It is suggested that subjects are more likely to select ABOVE for the horizontal position involving the ball being directly above the rim of the bowl and the ball being beyond the rim as this preposition is not sensitive to notions of fSuperiority. As noted in Chapter 5 this result in similar to that observed by Hayward and Tarr (1995) who investigated the range for ABOVE.

7.7. The PREP3 Presentations

7.7.1 Introduction

The following PREP3 presentations examined the effect of various factors on the spatial preposition ON and the location control involved with fSupport. A group of presentations examining the effect of Primary Support, Secondary Support (providing altered control) and Tension of Secondary Support are discussed in this chapter. Another group of presentations examing Tilt and Dynamics will be discussed in Chapter 8. The method for this overall experiment, including the design of the static scene presentations, is now presented.

7.7.2 Method for PREP3

7.7.2.1 Design

The PREP3 stationary presentations involved 12 graded scenes involving a weight as referent and a plank of wood or plywood as the relatum. Three factors were included in this design. First, two types of Secondary Support (altered control factors) were manipulated. This involved either wire or chain being used as the secondary support attached to the referent. Second, the type of Primary Support was manipulated. The referent was either in contact with a supple plywood relatum, or a rigid plank of wood relatum. This Primary Support was the relatum referred to in the confidence statements, for example "The ball is ON the Plywood". Third, the Tension of the Secondary Support (altered control) was varied. The Secondary Support was either taut, loose or simply hanging off. The resulting 2x2x3 ANOVA design is illustrated in Figure 7.27.

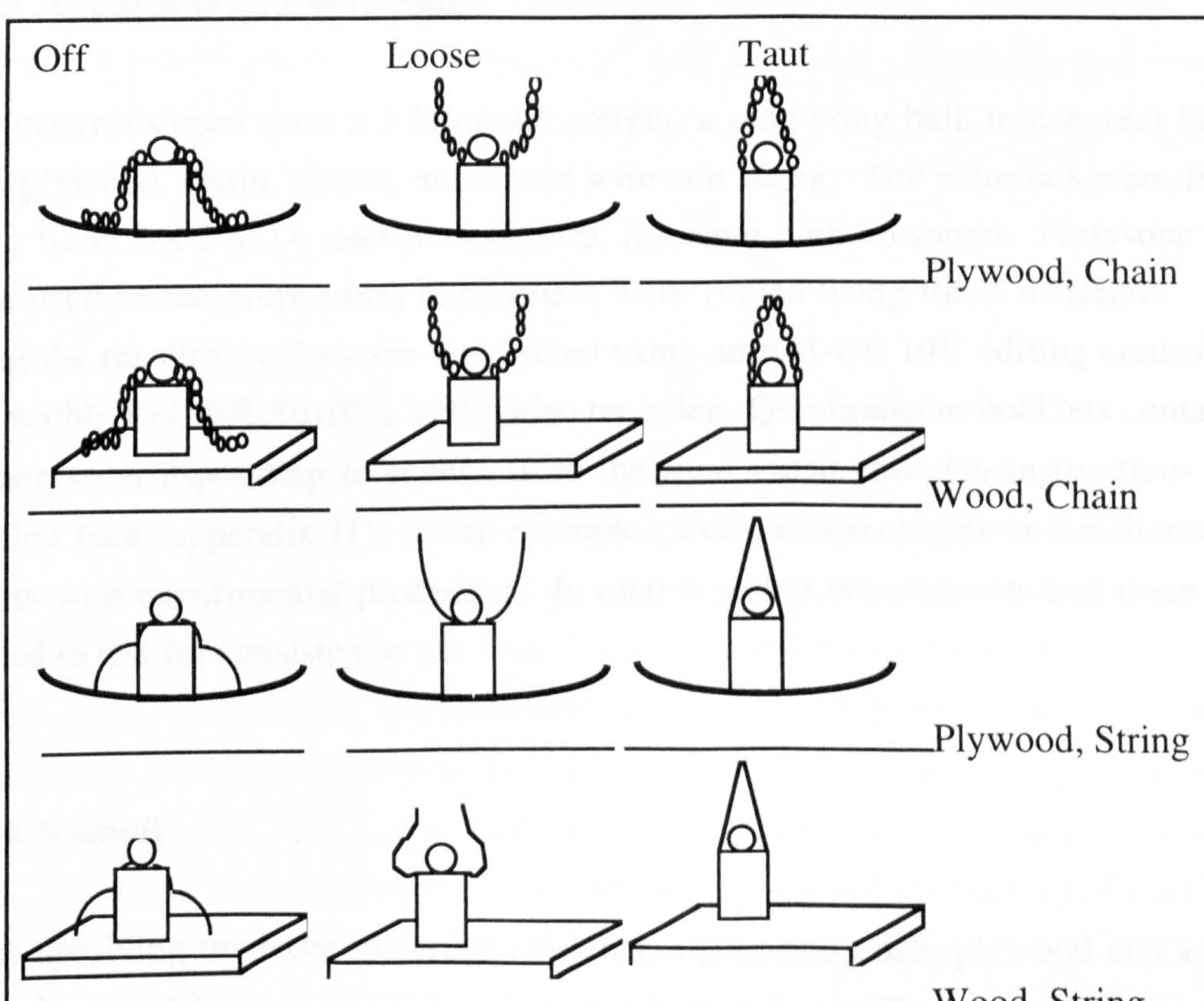


Figure 7.27 - The PREP3 2x2x3 ANOVA Design Examining Continuity, Altered Control and Position.

According to the functional account it would be expected that these manipulations of perceived control would affect subjects' confidence in ON. It was predicted that the presence of an altered control acting as secondary support should reduce ON confidence with reference to the primary support. Basically, if subjects perceive that support from the force of gravity is not being provided by the main supporter then they will be less likely to select ON. It was also predicted that the type of secondary support and also its tension should influence this decision (a stronger secondary support, such as chain, pulled taut is predicted to weaken control from the primary support more effectively than a weak secondary support, such as string, that is loose).

7.7.2.2 Subjects

The 36 subjects were all undergraduates at the University of Glasgow. All subjects were native English speakers.

7.7.2.3 Apparatus and Materials

Basic materials used were a 2 kilogram weight, a ping-pong ball, transparent thread, wood, plywood, chain, thread, household wire and string. The materials were filmed using a Sony DXC M3A television camera, in colour with no sound. Forty-one basic scenes used in the preposition experiment were filmed using these materials. After filming the resulting video-tape was edited using an RM-GE 10U editing control unit and a double JVC BR-S610ES VHS video recorder. Questionnaire booklets containing statements corresponding to scenes from the final video and also instructions were compiled (see Appendix H). Four examples were also included to familiarise the subjects with experimental procedure. In total 5 scenes were repeats and these were included to test for consistency.

7.7.2.4 Stimuli

Scenes involving the basic materials (weights, a ping-pong ball, plywood and a plank of wood) were filmed in graded and repeated groupings. The relatum objects were supported off camera and transparent thread was used in certain scenes. Filmed scenes were edited onto the tape in a random order for 12 seconds per trial. Approximately 10 seconds of black was shown between each scene. The number of the trial was also displayed before each trial. Subjects answered six basic statements corresponding to each trial in the form NP + (Prep. + NP) after viewing each trial. Each statement was rated using the corresponding Lickert scale. The scale of 1-5 rated how well subjects thought the statement described the scene from 1 = Highly Unlikely to 5 = Most Likely. The basic statements are shown in Table 7.12.

The weight is **over** the wood	1	2	3	4	5
The weight is **on** the wood	1	2	3	4	5
The weight is **under** the wood	1	2	3	4	5
The weight is **below** the wood	1	2	3	4	5
The weight is **in** the wood	1	2	3	4	5
The weight is **above** the wood	1	2	3	4	5

Table 7.12 - Basic Statements Presented in PREP3.

In this statement type the weight is the referent and the wood is the relatum. Other statement types involved combinations of ball or weight referents and wood or plywood relatums.

7.7.2.5 Procedure

The subjects were tested in a group situation and each received an identical questionnaire which included instructions. These instructions were explained verbally. and subjects were informed that this was a simple language experiment. The subjects were verbally instructed to pay special attention to the object indicated by the pointer. It was also stressed that the Lickert scale must be rated for each statement per scene.. Subjects were instructed that statements should be read prior to the relevant trial appearing on screen and also that the relatums (the plywood and the plank of wood) were being supported off-camera. Individuals were able to ask questions to clarify any details. Each scene was preceded by a numbered caption and the number of each scene was called out to the subjects. At the beginning of the tape a scene was shown depicting the types of material used to ensure that subjects were aware of their strength and capacity. After the experiment the questionnaires were collected from each subject.

7.7.2.6 Results

This study from PREP3 involved scenes that were designed specifically to tap into any functional controls relating to ON and fSupport. PREP3 Scenes 7, 27, 17, 34, 21, 5, 9, 12, 20, 16, 26, and 36 (see Appendix I for randomised order presented to subjects) were subjected to a repeated measures ANOVA. The mean confidence judgements for this 2x2x3 ANOVA are shown in Figure 7.28 for all factors of the design. The reliable main effects and borderline interaction are listed in Table 7.13.

Reliable Main Effects and Interaction PREP3 - ON	
Primary Support	$F(1,34) = 4.27$, $MSe = 0.270$, $p<0.05$
Tension	$F(1,68) = 4.22$, $MSe = 0.342$, $p=0.02$
Prim.Sup.xTension	$F(2,68) = 3.01$, $MSe = 0.205$, $p=0.06$

Table 7.13 - Significant Results for the PREP3 ANOVA Examining ON Confidence.

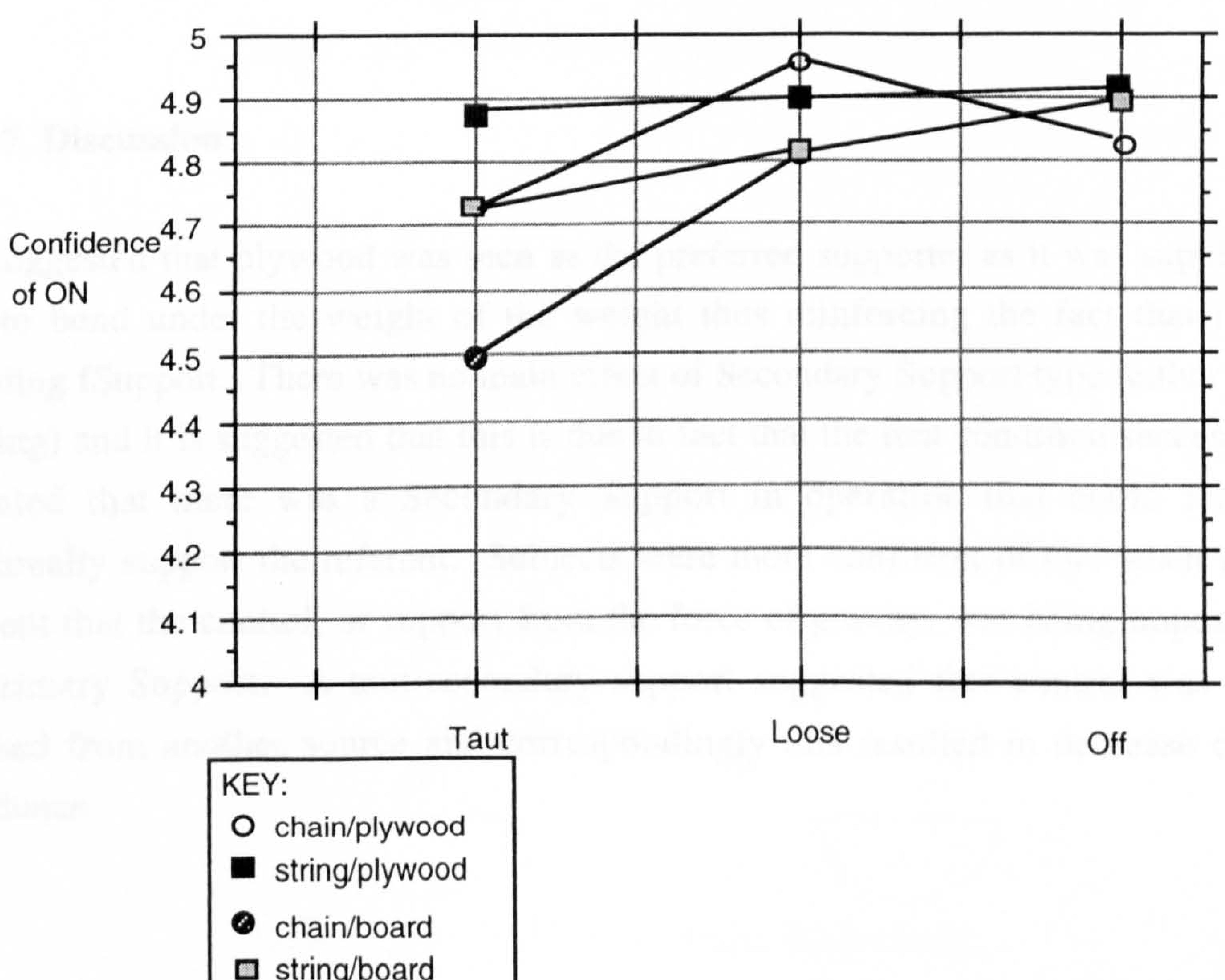


Figure 7.28 - The Combined Effect of Secondary Support, Tension and Primary Support for PREP3 ON Confidence.

The ANOVA revealed a main effect of Primary Support (plywood = 4.876, board = 4.857). The referent weight was judged ON the relatum more often if it was plywood. Plywood was seen as the preferred functional supporter.

The main effect of Tension was also significant. The Tension of the Secondary, Altered Control, Support was varied from taut (4.707) to loose (4.871) to off (4.893). It was found that confidence in ON increased as the secondary support was relaxed. There was a significant increase in confidence of ON between taut scenes and those scenes where the secondary support was either loose or off ($F(1,68) > 5.519$, $p<0.05$ in both cases). There was no main effect of Secondary Support type (chain versus string).

There was a significant interaction between Primary Support and Tension. Means comparisons showed a significant difference between Plywood and Board for the taut scenes ($F(1,68) = 7.843$, $p<0.01$). Subjects were more likely to select ON when the primary support was plywood. It appears that the plywood provided a more visible support (as the plywood was seen to be bending under the weight of the referent).

7.7.2.7 Discussion

It is suggested that plywood was seen as the preferred supporter as it was supple and seen to bend under the weight of the weight thus reinforcing the fact that it was providing fSupport. There was no main effect of Secondary Support type (either chain or string) and it is suggested that this is due to fact that the taut condition successfully indicated that there was a Secondary Support in operation that could feasibly functionally support the referent. Subjects were more confident of ON when it was apparent that the control, or support from the force of gravity, was being imposed by the Primary Support. A taut secondary support suggested that control was being imposed from another source and correspondingly this resulted in decrease of ON confidence.

7.8 General Discussion of the Static Presentations Results

These analyses provide insight into how the mind organises spatial relationships. In this chapter static scenes have been used to elicit confidence judgements about the aptness of various scenes. With regard to **f**Containment and the locative IN it was found that factors such as Containment, Partial Containment, Position, and Altered Control affect confidence. For example, a position 4 scene with containment and no altered control resulted in a higher confidence of in than a Position 4 scene with partial containment and altered control (see Figure 7.29). It is argued that these manipulations alter the control imposed on the referent by the relatum. Basically, the presence of full containment and no altered control at the non-spatial positions provide functional control and result in increased IN judgements. It is more likely that language users can predict the potential for correlated movement when such factors are present.

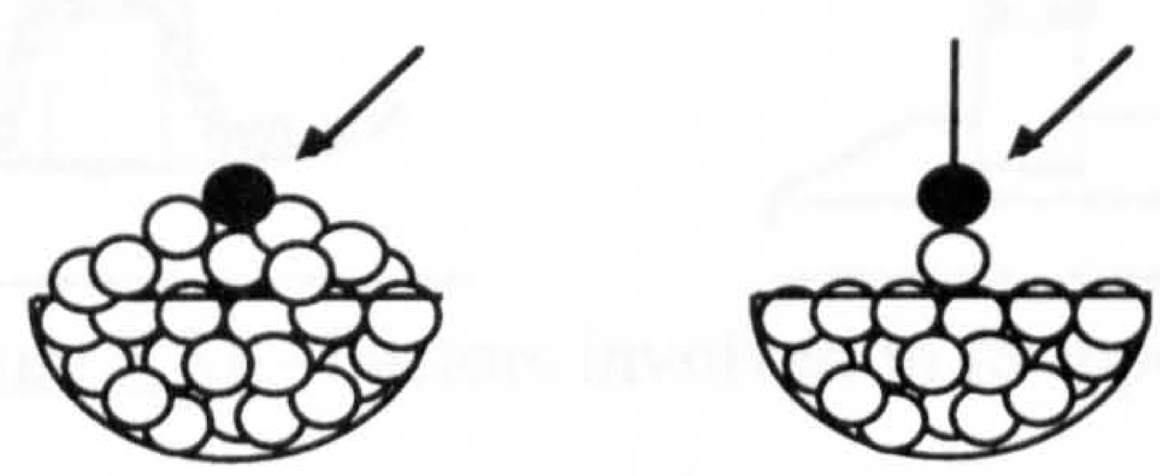


Figure 7.29 - Factors involved in **f**Containment.

With regard to **f**Superiority and OVER evidence was found to support the control relation. Subjects were much more confident in OVER when the ball was in a position to "threaten contact" with the bowl and as the likelihood that the ball could fall into the area of the bowl decreased so too did OVER confidence (see Figure 7.30). Subjects were significantly more likely to select the preposition ABOVE which is less sensitive to functional controls.

Figure 7.30 - Factors involved in **f**Superiority.

Finally, manipulations examining **f**Support and ON showed that when support from the force of gravity by the primary support is threatened by an alternative support subjects are less likely to describe the referent as ON the relatum (primary support). In Figure 7.31 the scene showing the taut chain resulted in reduced confidence of ON as compared to those scenes where the secondary support was loose or off completely. In such a case it is suggested that language users are more likely to predict that the referent weight could stay in position if the relatum board was removed. This is because the relatum does not provide opposition to the force of gravity. It was also found that the supple plywood primary support resulted in a higher ON confidence than the rigid plank of wood support. It is suggested that the plywood provides a more visible support as it is seen to be bending under the weight of the referent.

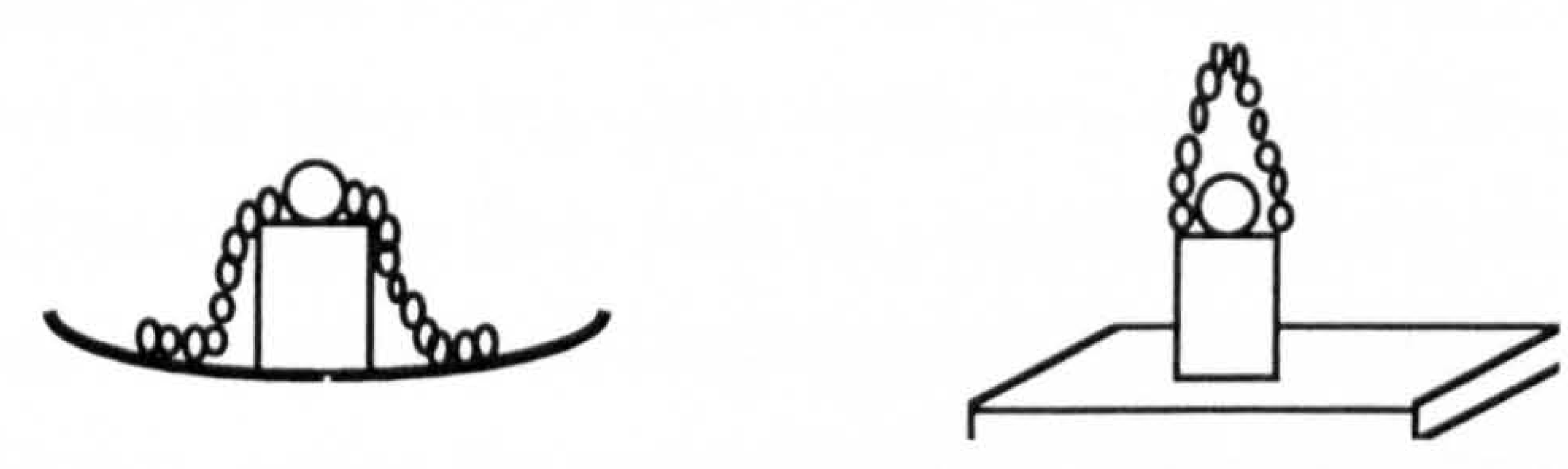


Figure 7.31 - Factors involved in **f**Support.

These manipulations have all involved stationary scenes. However, as has been discussed, the functional controls are inherently dynamic. It is suggested that the factors varied in these static experiments either make it easier or harder for the referent and relatum to be seen as capable of some kind of potential movement and it is suggested that such considerations are taken into account by the language user when selecting an appropriate locative. I turn now to a series of studies which were designed to test how differing dynamic information can alter confidence in the spatial description chosen.

Chapter 8

The Experiments Investigating Functional Geometry: Direct Testing Using Dynamics

8.1 Introduction

In Chapter 7 various factors such as Containment, Partial Containment, Position and Continuity were found to have an affect on Prepositional Confidence. For example, the suggested dynamic prediction of fSuperiority is that the ball should be capable of falling into the area of the bowl when dropped. Altering factors which make this a possibility, such as Horizontal Position, were shown to affect confidence of OVER. This chapter focuses on the scenes which involved dynamic arrangements. These presentations were graded for various factors used in Chapter 7. However, in addition, the suggested dynamic predictions of the theory were either directly strengthened or weakened by including movement in the scenes. The control relations represented by notions of fContainment, fSuperiority and fSupport involve dynamics. As has previously been discussed it is suggested that language users make dynamic predictions and use this information to select the appropriate preposition. The existence of location control, such as "when y moves there will be a correlated movement in x", means that one can predict how the referent and relatum will behave when different forces are applied to them. Indeed, one of the main differences between the functional geometric account and a spatial account is the assumption that functional relations are connected to inherently dynamic mental representations (Freyd, 1987). When one refers to a static scene, such as those found in Chapter 7, the functional relations encode dynamic forces that apply between the objects in the scene. It is suggested that language users make dynamic predictions about scenes which is used in order to select the appropriate preposition.

The dynamic presentations taken from the overall prepositions experiments and discussed in the present chapter were designed to test how differing dynamic information about scenes can affect confidence in various spatial descriptions. In this chapter I focus on the dynamic presentations shown in PREP1 and PREP3 and the results from the prepositions experiments coded as PREP4 and PREP5 which involved only dynamic scenes. These dynamic presentations involve the same basic methodology as the static presentations.

8.2 General Design of the Dynamic Presentations

The dynamic prepositions experiments involved the presentation of various scenes graded for factors that were suggested to influence prepositional choice. The dynamic presentations from PREP1 examined the effect of prior vertical dynamics and also the effect of prior context. Firstly, the prior vertical presentations examined the effect of dynamics on the location control involved with fContainment and the locative IN. Counter effects on OVER and ON were also examined. The factors used were Position (P1 and P2) and Prior Vertical Dynamics (stationary referent ball versus referent ball descending into the bowl and stopping). These factors were organised into 2x2 ANOVA designs. A second series of presentations examined the effect of prior context dynamics on prepositional choice. Again the focus was on fContainment and the locative IN. The factors used for this t-test were a stationary Position 4 scene versus a dynamic Position 4 scene. In the dynamic scene the bowl and contents were seen to move to the referent ball prior to judgement. The effects on OVER and ON were also examined using t-test designs.

In the PREP4 presentations ping-pong ball and bowl scenes were shown that involved the entire scene moving. Since it is suggested that language users select IN on the basis of certain dynamic predictions (if moved the objects in the scene will move together in a correlated manner) it is hypothesised that reinforcing those dynamics will strengthen confidence of IN. Focus was mainly on the locative IN and the specific dynamic predictions of fContainment, however, ON and OVER/ABOVE were also examined. The factors used were Continuity (white referent ball versus black referent ball), scene Dynamics (stationary ball/bowl scene or ball and bowl moving together in a correlated manner) and Position (P1-P5). These factors were organised into 2x2x5 ANOVA designs to examine confidence in spatial preposition.

Similarly, the related PREP5 dynamic presentations focused on the specific dynamic predictions of fContainment and the locative IN. Ping-pong ball and bowl scenes were shown where the referent was moving in a horizontal direction whilst the relatum and other contents remained stationary (this type of movement should neither weaken or strengthen the notions of fContainment) and also scenes where the relatum and other balls were dynamic but the referent was stationary (such scenes should weaken IN confidence as the dynamic predictions inherent in fContainment are not being met).

The factors used were Continuity, scene Dynamics (ball moving/bowl stationary, ball stationary/bowl moving, stationary ball/bowl), and Position (P1-P5). These were organised into 2x3x3 ANOVA designs examining confidence of IN and also confidence of ON. A 2x2x3x3 ANOVA design was then applied to the confidence ratings for OVER and ABOVE (the extra factor was Preposition: OVER versus ABOVE).

Finally, the dynamic presentations from PREP3 focused on fSupport and examined the effect of dynamically manipulating a referent ball and relatum plank of wood and examining effect on perceived functional support. The dynamic prediction is that relatum controls the referent with respect to the force of gravity by virtue of some degree of contact between the two. Factors manipulated were Dynamics (stationary ball, ball with altered control and dynamic ball) and Tilt (shallow, medium and high). These factors were organised into a 3x3 ANOVA design examining the subjects' confidence in the preposition ON.

The method sections for the PREP1 and PREP3 presentations were given in Chapter 7. Specific design sections for these presentations will precede the discussion of their results. The method and design sections for PREP4 and PREP5 presentations will be given in this chapter prior to the results. The confidence judgements for the various descriptions were sorted for each scene according to preposition. As before probability levels lower than 0.08 will not be reported. Focus is on the locatives IN, ON and also comparisons between OVER and ABOVE. It should be noted that there are no major differences in general methodology for any of the dynamic presentations discussed in this chapter.

8.3 The PREP1 Presentations: Prior Vertical Dynamics

8.3.1 Introduction

The dynamic presentations taken from PREP1 focused mainly on fContainment and the preposition IN, however counter effects on OVER and ON were also examined. It is suggested that a previously viewed vertical movement that is inconsistent with location control will weaken confidence of IN. The notions of fContainment do predict that correlated movement is possible. However, vertical movement implies that the referent ball is not being controlled by the relatum bowl and confidence of IN should decrease when subjects witness this vertical movement.

8.3.2 Design

These dynamic presentations involved four scenes. Scenes 1 and 34 were identical except that scene 34 involved the ball descending into the bowl and stopping at the stationary scene 1 position (termed position A). Scenes 5 and 37 were also identical except that scene 37 involved the ball descending into the bowl and stopping at the stationary scene 5 position. This was termed position B (see Figure 8.1). Judgements of the dynamic scenes were made by the subjects after the vertical movement had occurred.

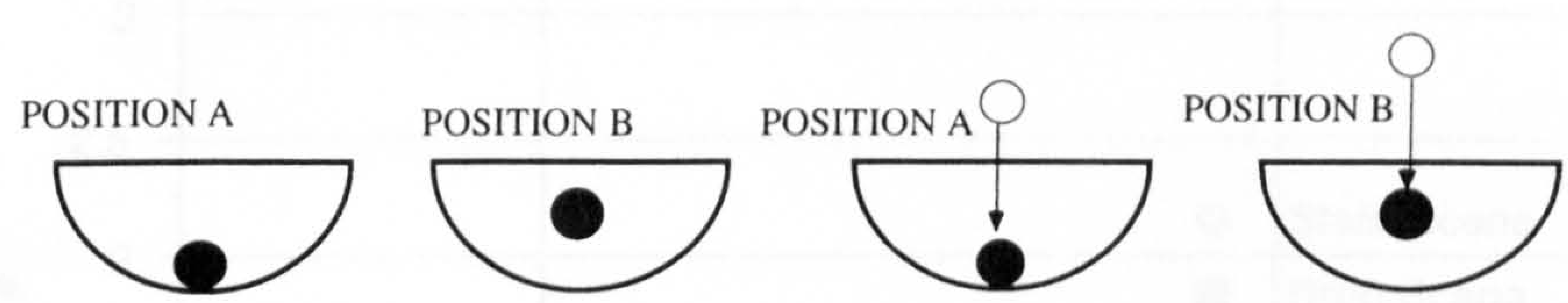


Figure 8.1 - PREP1 Ball Drop 2x2 Scenes.

Two factors that were expected to affect judgements of control were included in this design. Firstly, scenes involving identical spatial configurations were manipulated for Vertical Dynamics. Secondly, the relative Position of ball to bowl was varied.

8.3.3 Prior Vertical Dynamics: Results

The PREP1 scores 1, 34, 5 and 37 for IN confidence were subjected to a 2x2 repeated measures ANOVA (see Appendix B). The reliable main effects are listed in Table 8.1 and the mean values for IN confidence are shown in Figure 8.2.

Reliable Main Effects for IN Judgements - PREP1- Dynamic	
Dynamics	$F(1,29) = 44.43$, $MSe = 0.7$, $p<0.0001$
Position	$F(1,29) = 6.73$, $MSe = 0.91$, $p<0.05$

Table 8.1 - Significant Results for the PREP1 Vertical Dynamics ANOVA Examining IN.

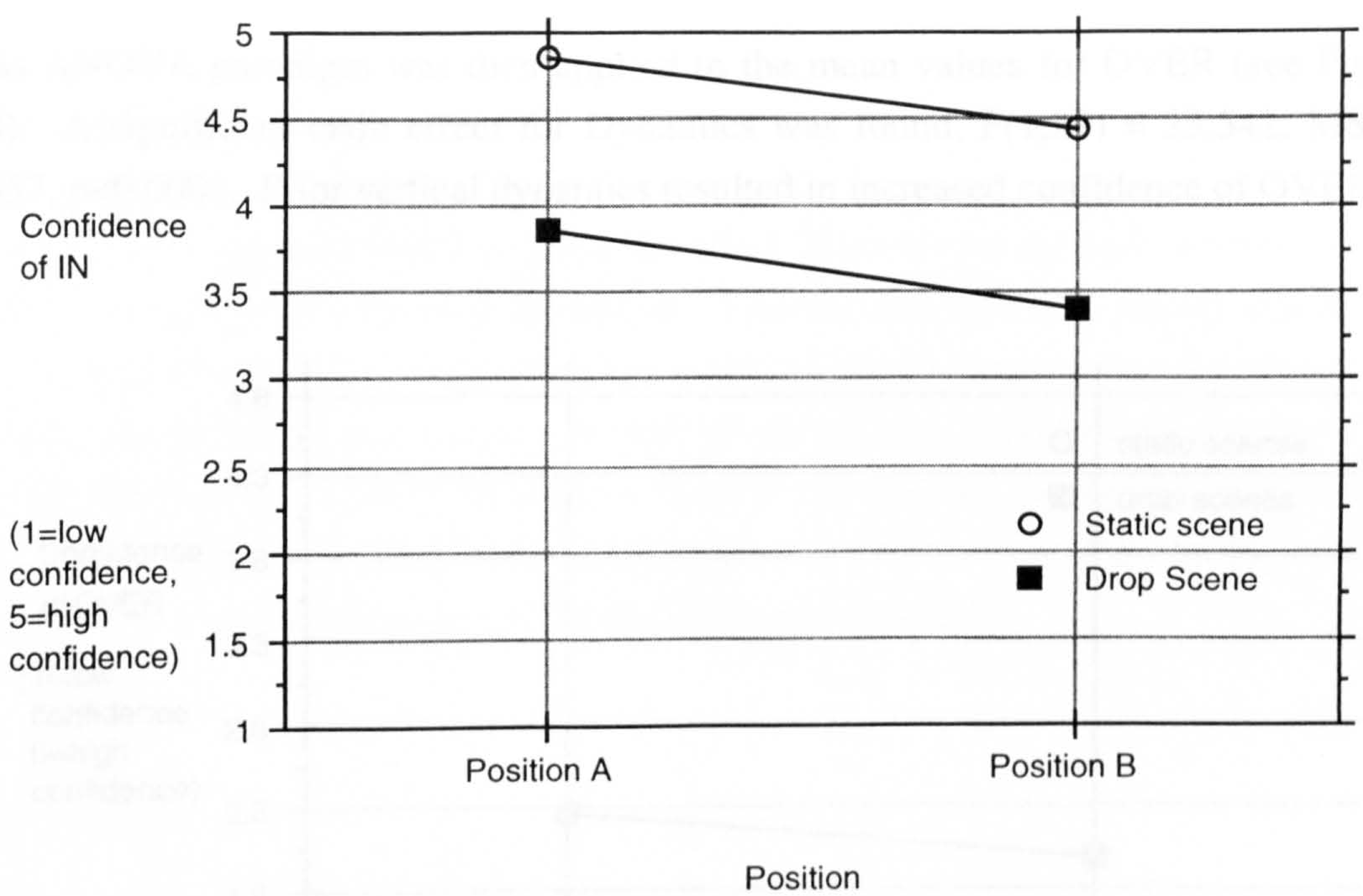


Figure 8.2 - The Combined Effect of Vertical Dynamics and Position for PREP1 IN Confidence.

Considering first the overall effect of Vertical Dynamics (static = 4.65, dynamic = 3.633), further analysis revealed that subjects rated IN more highly for the static scenes at both Positions A and B ($F(1, 29) > 14.38$, $p<0.001$ in both cases). There is an effect of Vertical Dynamics on likelihood of subjects choosing IN. For both positions subjects are more confident of IN for the static manipulations. The main effect of Position revealed Position A (4.367) to rate more highly, overall, for IN than Position B (3.917). However, no significant difference was found between the scores for positions A (4.867) and B (4.433) Static scenes and positions A (3.867) and B (3.4) dynamic (drop) scenes. This finding was unsurprising as both positions A and B can be accounted for by spatial factors and, as has been previously shown in Chapter 7, both positions result in a high confidence of IN.

The ANOVA paradigm examining Vertical Dynamics was applied to ON confidence. There were no significant results. Indeed, all subjects were highly confident that they would not pick ON for any of these scenes (static P1 = 1, static P2 = 1, dynamic P1 = 1.1 and dynamic P2 = 1).

This ANOVA paradigm was then applied to the mean values for OVER (see Figure 8.3). A significant main effect for Dynamics was found, $F(1,29) = 23.542$, $MSe = 1.637$, $p<0.0001$. Prior vertical dynamics resulted in increased confidence of OVER.

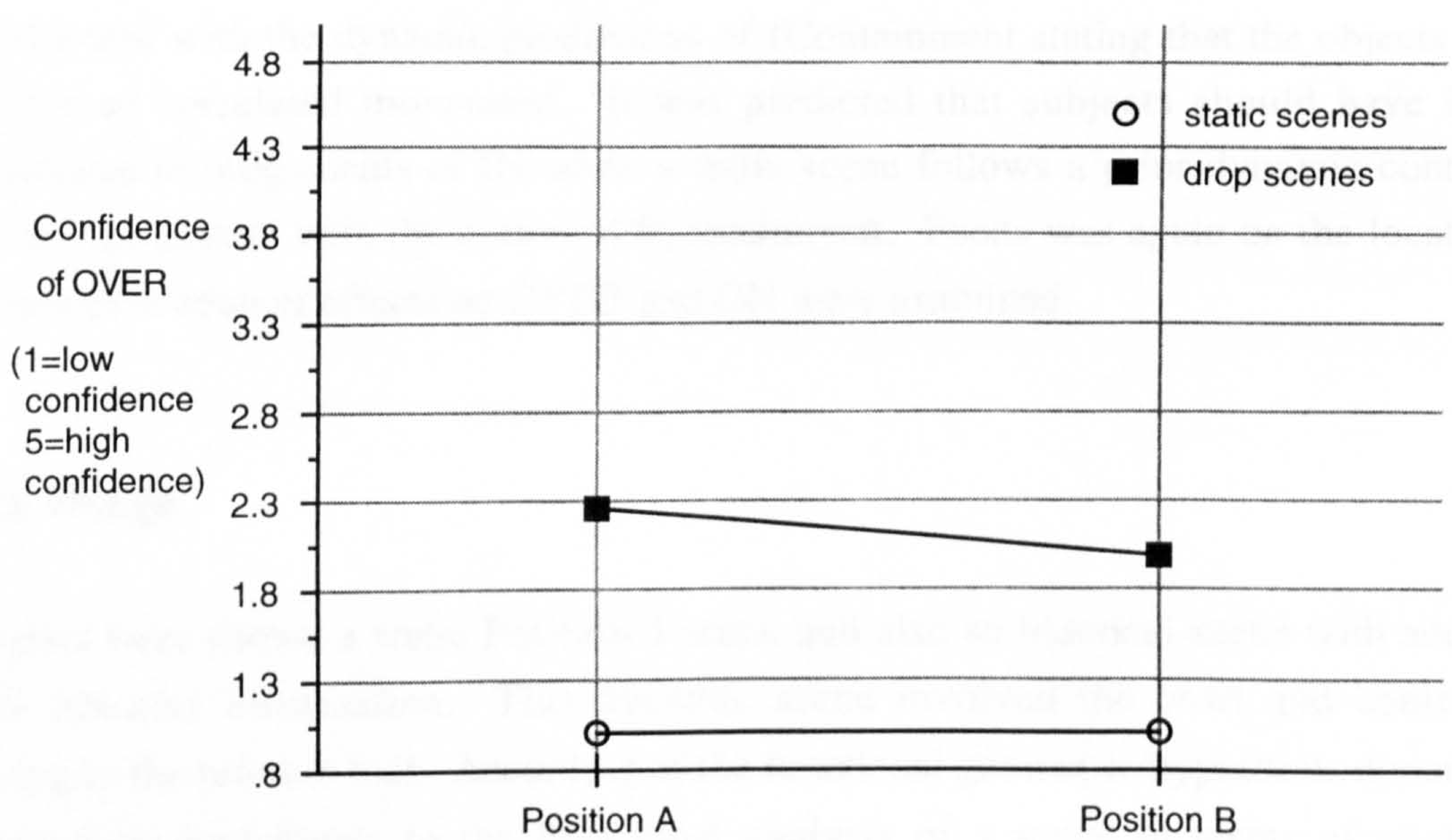


Figure 8.3 - The Combined Effect of Vertical Dynamics and Position for PREP1 OVER Confidence.

8.3.4 Discussion

It is argued that the functional control of fContainment was weakened by the introduction of dynamics. Subjects were less likely to choose IN when they had witnessed previous movement. This dynamic intervention indicated that the ball x could potentially move independently from the bowl y (and outwith the final convex hull representation for the ball and bowl). The functional constraint that x can move with y in a correlated manner is significantly weakened. As a counter effect the vertical descent prior to judgement increased confidence in OVER. It is suggested that this is because threatened contact had been witnessed by the subjects and this contact had subsequently occurred. Notions of fSuperiority will be further investigated later in this chapter.

8.4 The PREP1 Presentations: Prior Context

8.4.1 Introduction

These dynamic presentations examined the effect of additional dynamic information on confidence ratings of various prepositions. Prior information was shown which was inconsistent with the dynamic predictions of fContainment stating that the objects are capable of correlated movement. It was predicted that subjects should have less confidence in judgements of IN when a static scene follows a prior dynamic context that is inconsistent with the notion of fContainment. Focus was again on the locative IN, however counter effects on OVER and ON were examined.

8.4.2 Design

Subjects were shown a static Position 4 scene and also an identical scene with added prior dynamic information. This dynamic scene involved the bowl and contents moving to the referent ball. According to the functional geometric hypothesis dynamic information contributes to the functional analysis of a scene in terms of control relations such as fContainment and fSupport. It should be possible to affect these judgements by manipulating the prior context under which the scene is viewed.

The two scenes used for these presentations (Scenes 15 (position 4) and 38 (position 4)) were identical at point of judgement. However in scene 38 the relatum (containing surrounding balls) was seen to move to the referent x (the black ball) before the requested point of judgement (see Figure 8.4).

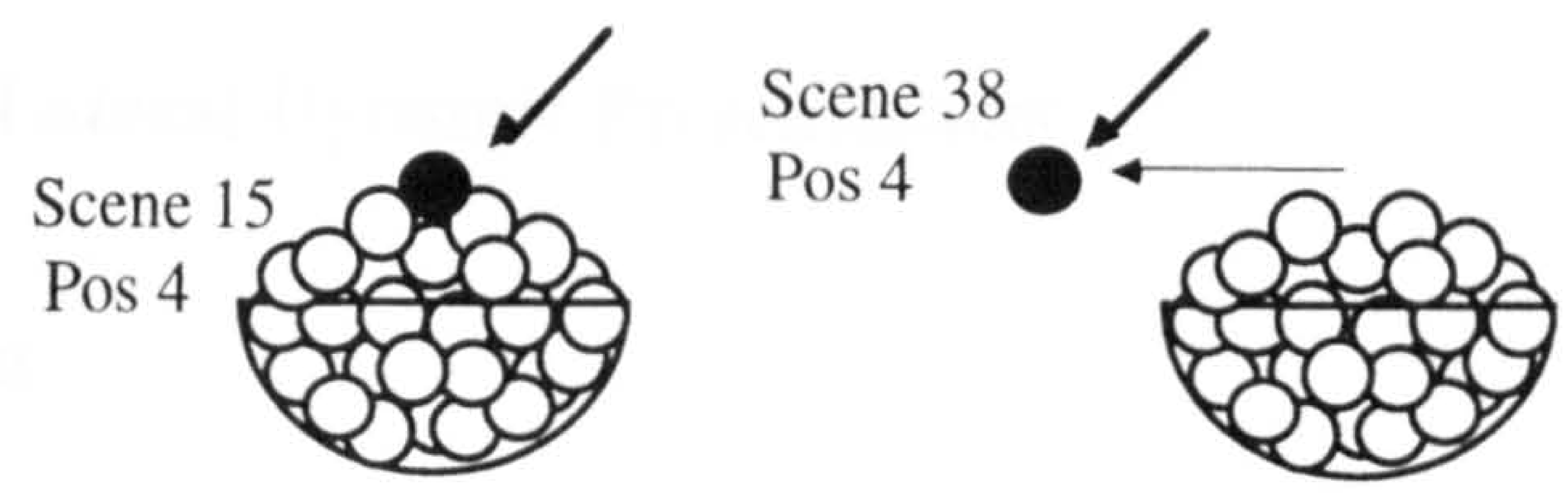


Figure 8.4 - PREP1 Prior Context Scenes.

8.4.3 Prior Context: Results

Confidence judgements were sorted for IN, ON and OVER. A within subjects t-test for IN confidence was performed on this data. The mean values for the two scenes were: prior context = 1.833, no prior context = 3.133. This difference was found to be reliable with t (29) = 5.022, p<0.0001. Judgements for IN decreased when the referent bowl was seen to move to the relatum ball prior to judgement.

This scene also suggested a counter-effect of the relatum y providing a supportive function for the referent ball x. Indeed, a t-test performed on scores for scene 15, no prior context (1.1) and scores for scene 38, prior context (1.83) for ON confidence was significant, t(29) = 2.707, p<0.01. The dynamic manipulation using prior context lead to an increase in subjects confidence of ON.

The mean scores for OVER (context = 2.7, no context = 1.167) were also subjected to a t-test. The result was borderline significant, t(29) = 1.77, p<0.09. This counter-effect presumably resulted from the loss in confidence in the stronger fContainment control relation following the prior context.

8.4.4 Discussion

It is argued that introducing a prior context that is incompatible with the functional interpretation of the preposition IN significantly reduces subjects' confidence in the description. This prior context controls the referents location by supporting it from the force of gravity and therefore an increase in confidence of ON is found. These results reflect the influence of additional functional and physical information on a language user's representation of what is an appropriate situation in which to use the preposition.

8.5 PREP4: The Lateral Dynamic Presentations

8.5.1 Introduction

This series of dynamic presentations focused on fContainment and the locative IN. It is suggested that fContainment states a prediction that object x and object y are capable of potential movement. If the potential for lateral movement is shown to be a fact it is hypothesised that this will reinforce the functional control of fContainment. Basically, it is argued that the Dynamic cases provide additional dynamic information to support the fContainment relation. The dynamic scenes should not increase confidence in ON as it is lateral movement that is shown. It is predicted that scenes with the consistent dynamic information will be rated even more highly IN that their corresponding stationary scenes. Counter effects on OVER and ABOVE were also examined.

8.5.2 Method for PREP4

8.5.2.1 Design

Subjects were shown various graded scenes of ping-pong balls and glass bowls. The dynamic focus of these presentations was the effect of dynamic information consistent with functional controls for IN on prepositional confidence. There were three factors in this design. Firstly, the colour of the referent ball relative to the surrounding balls was varied. This visual Continuity variable involved the ball being either continuous (white) or non-continuous (black) with the surrounding balls. Secondly, scene Dynamics were manipulated. The scene was either stationary or the bowl and target ball were seen to move laterally in a correlated manner. Thirdly, the relative position of ball to bowl was varied (position 1-position 5). The factors of Continuity, Dynamics and Position are illustrated in Figure 8.5.

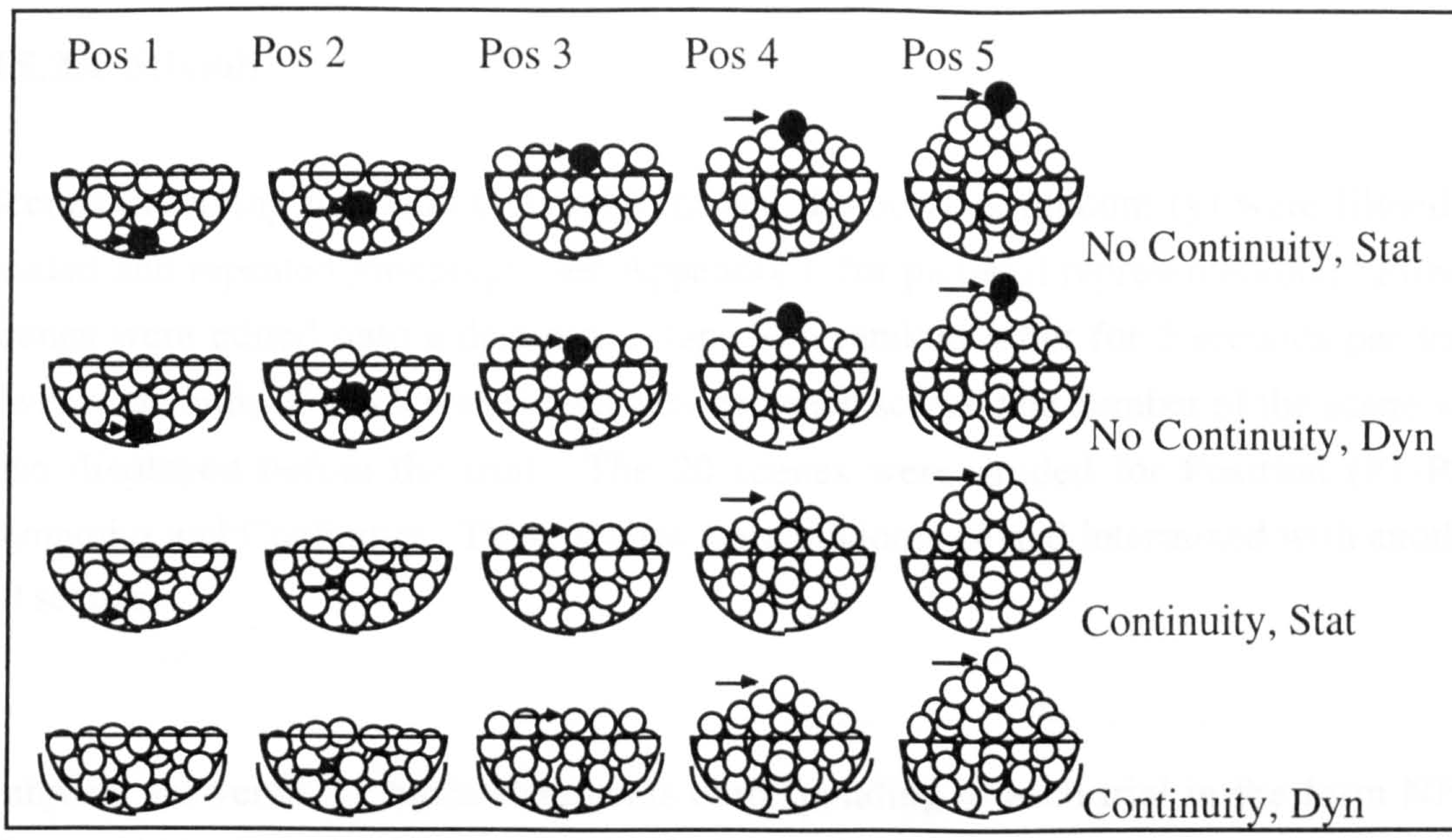


Figure 8.5 - The 2x2x5 ANOVA Design for the PREP4 Presentations.

8.5.2.2 Subjects

The 54 subjects were all undergraduates at the University of Glasgow and were tested in group situations. All subjects were native English speakers.

8.5.2.3 Apparatus and Materials

The materials used consisted of a perspex bowl, transparent thread, one black ping-pong ball and several white ping-pong balls. A black arrow was used as a pointer and green material as the backdrop. The materials were filmed using a Sony DXC M3A television camera, in colour with no sound. After filming the resulting video-tape was edited using an RM-GE 10U editing control unit and a double JVC BR-S610ES VHS video recorder. Questionnaire booklets containing statements corresponding to scenes from the final video and also instructions were compiled (see Appendix K). Spatial arrangements involving the entire scene moving were achieved by gently rocking the table out of camera shot.

8.5.2.4 Stimuli

Scenes involving the ball (x) as referent and the bowl as relatum (y) were filmed in graded and repeated groupings (see Appendix L for pictorial representations). Filmed scenes were edited onto a destination tape in a random order for 5 seconds per trial. Twenty seconds of black was shown between each scene. The number of the scene was also displayed before the trial. The 20 scenes were graded for Position (P1-P5), Dynamics and Continuity. These scenes were randomised and intermixed with another 10 scenes.

Subjects answered six basic statements corresponding to each trial in the form NP + (Prep. + NP) after viewing each trial. Each statement was rated using a corresponding Lickert scale. The scale of 1-5 rated how well subjects thought the statement described the scene from 1 = Highly Unlikely to 5 = Most Likely. The statements were as follows and order of presentation was randomised within statements (see Table 8.2).

The ball is **over** the bowl	1	2	3	4	5
The ball is **in** the bowl	1	2	3	4	5
The ball is **below** the bowl	1	2	3	4	5
The ball is **above** the bowl	1	2	3	4	5
The ball is **under** the bowl	1	2	3	4	5
The ball is **on** the bowl	1	2	3	4	5

Table 8.2 - Statements Presented in PREP4.

8.5.2.5 Procedure

The subjects were tested in a group situation and each received an identical questionnaire which included instructions. These instructions were explained verbally. Subjects were informed that this was a simple language experiment and that they should pay special attention to the ball indicated by the pointer. It was also stressed that the Lickert scale must be rated for each statement per scene and that confidence ratings should be made only after viewing the entire scene. Subjects were instructed that statements should be read prior to the relevant trial appearing on screen. Individuals were able to ask questions to clarify any details. Each scene was preceded by a numbered caption and the number of each scene was called out to the subjects. After the experiment the questionnaires were collected from each subject.

8.5.2.6 Results

These presentations were designed to test how dynamic information about a scene affects confidence in different spatial descriptions. It is proposed that the scenes involving the ball and bowl both moving together will elicit higher confidence of IN than the stationary scenes. PREP4 scores 14, 5, 10, 30, 24, 6, 29, 22, 18, 11, 2, 23, 28, 21, 7, 9, 4, 25, 13, and 16 were subjected to a 2x2x5 repeated measures ANOVA (see Appendix L for pictorial descriptions).

Results will be reported separately for IN and ON. Results for OVER and ABOVE will also be examined. The confidence judgements for IN for both the static and dynamic scenes over the five positions are shown in Figure 8.6. The main effects and interactions are listed in Table 8.3.

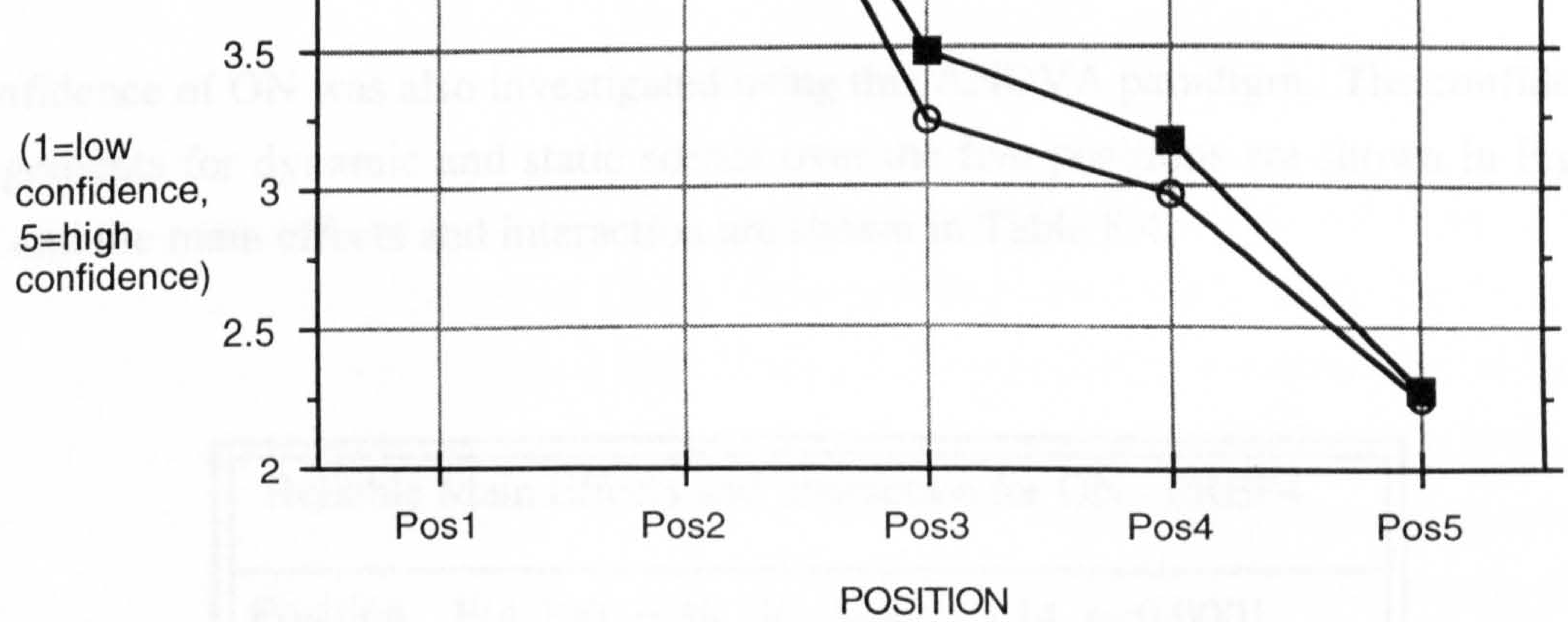


Figure 8.6 - Mean confidence of IN for Dynamic and Static Scenes Across the Five Positions.

Reliable Main Effects and Interaction for IN-PREP4
Scene Dynamics $F(1,50) = 4.434$, MSe = 0.428, $p<0.05$
Position $F(4,200) = 182.288$, MSe = 1.54, $p<0.0001$
Continuity x Pos. $F(4,200) = 3.68$, MSe = 0.395, $p<0.01$

Table 8.3 - Significant Results for the PREP4 Dynamics ANOVA Examining IN.

This ANOVA revealed a main effect for Position. Further analysis revealed that positions 3, 4 and 5 were all significantly different from each other and from position 2 ($F(1,200)>5.73$, $p<0.05$ in all cases). This would be expected given the wide range of positions of ball to bowl. A main effect of scene Dynamics revealed that the ball and bowl moving scenes resulted in a higher confidence of IN than the stationary scenes (dynamic scenes = 3.737 and stationary scenes = 3.661). Again this result was expected. The effect of scene Dynamics was most apparent for positions 3 and 4. For position 3 the stationary scenes had a mean value of 3.245 and for dynamic scenes a mean value of 3.49. A comparison of these means resulted in $F(1,200) = 6.83$, $p<0.01$. Similarly for position 4 the stationary scenes had a mean value of 2.98 and the dynamic had a mean value of 3.17. A comparison of these means revealed $F(1,200) = 3.95$, $p<0.05$. The interaction between Continuity and Position was entirely due to an increase in confidence of IN found for no continuity, position 3 scenes (($F(1,200) = 10.43$, $p<0.01$).

Confidence of ON was also investigated using this ANOVA paradigm. The confidence judgements for dynamic and static scenes over the five positions are shown in Figure 8.7 and the main effects and interaction are shown in Table 8.4.

Reliable Main Effects and Interaction for ON - PREP4
Position $F(4,200) = 48.797$, MSe = 3.14, $p<0.0001$
Continuity x Pos. $F(4,200) = 3.15$, MSe = 0.656, $p<0.05$

Table 8.4 - Significant Results for the PREP4 Dynamics ANOVA Examining ON.

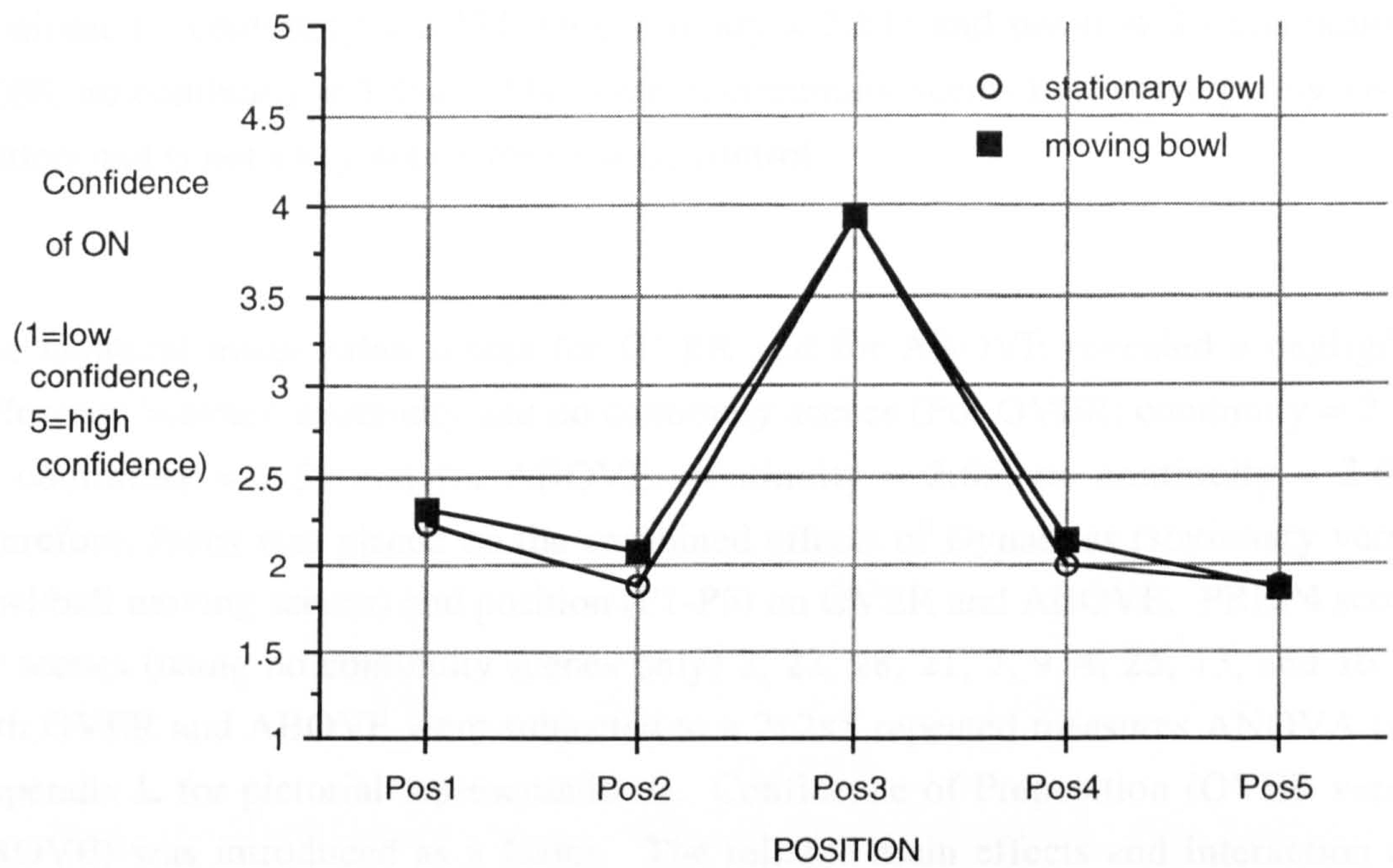


Figure 8.7 - Mean confidence of ON for Dynamic and Static Scenes Across the Five Positions.

This ANOVA revealed only one main effect, that of Position. Further analysis revealed that this was the result of high confidence of ON for position 3. Confidence increased between position 2 and 3, $F(1,200) = 126.68$, $p<0.001$ and also between position 4 and 3, $F(1,200) = 116.22$, $p<0.001$. This occurs because subjects perceive the referent ball to be in contact with the rim of the bowl and therefore supported by the bowl itself.

There was a weak interaction between Continuity and Position. This occurred due to a slight increase in judgements of ON in the continuity cases for position 1 ($F(1,200) = 5.05$, $p<0.05$) and also position 3 ($F(1,200) = 5.861$, $p<0.05$). Position 1 involved the ball sitting on the bottom of the bowl and position 3 involved the ball sitting on the rim of the bowl. In both cases the subjects perceived the continuity scenes to be slightly more ON than the no continuity scenes. The counter-effect at position 3 was found in the previous 2x2x5 IN ANOVA where no continuity scenes at this position slightly increased confidence of IN.

It should be noted that continuity effect found in the present analysis is very small (position 1 - continuity = 2.392, no continuity = 2.137 and position 3 - continuity = 4.088, no continuity = 3.814). The issue of continuity seems to involve purely visual matters and is not a key notion for location control.

The identical mean value scores for OVER and for ABOVE revealed a negligible difference between continuity and no continuity scenes (For OVER: continuity = 2.54, no continuity = 2.59 and for ABOVE: continuity = 2.65, no continuity = 2.65). Therefore, focus was placed on the combined effects of Dynamics (stationary versus bowl/ball moving scenes) and position (P1-P5) on OVER and ABOVE. PREP4 scores for scenes (using no continuity scenes only) 2, 23, 28, 21, 7, 9, 4, 25, 13, and 16 for both OVER and ABOVE were subjected to a 2x2x5 repeated measures ANOVA (see Appendix L for pictorial representations). Confidence of Preposition (OVER versus ABOVE) was introduced as a factor. The reliable main effects and interaction are listed in Table 8.5 and the mean values for prepositional confidence across the five positions are shown in Figure 8.8.

Reliable Main Effects and Interaction - PREP4	
Preposition	$F(1,48) = 4.27$, $MSe = 0.31$, $p<0.05$
Position	$F(4, 192) = 210.45$, $MSe = 1.76$, $p<0.0001$
Prep x Positon	$F(4,192) = 3.409$, $MSe = 0.376$, $p=0.01$

Table 8.5 - Significant Results for the PREP4 Dynamics ANOVA Examining OVER and ABOVE.

Subjects rated ABOVE more highly than OVER for these scenes. Further analysis showed that this was slightly more apparent for the static scenes ($F(1,48) = 4.018$, $p = 0.051$. As expected, there was a large effect of Position. Positions 3, 4, and 5 were all significantly different from each other and from position 2 ($F(1,192) > 19.17$, $p<0.0001$ in all cases).

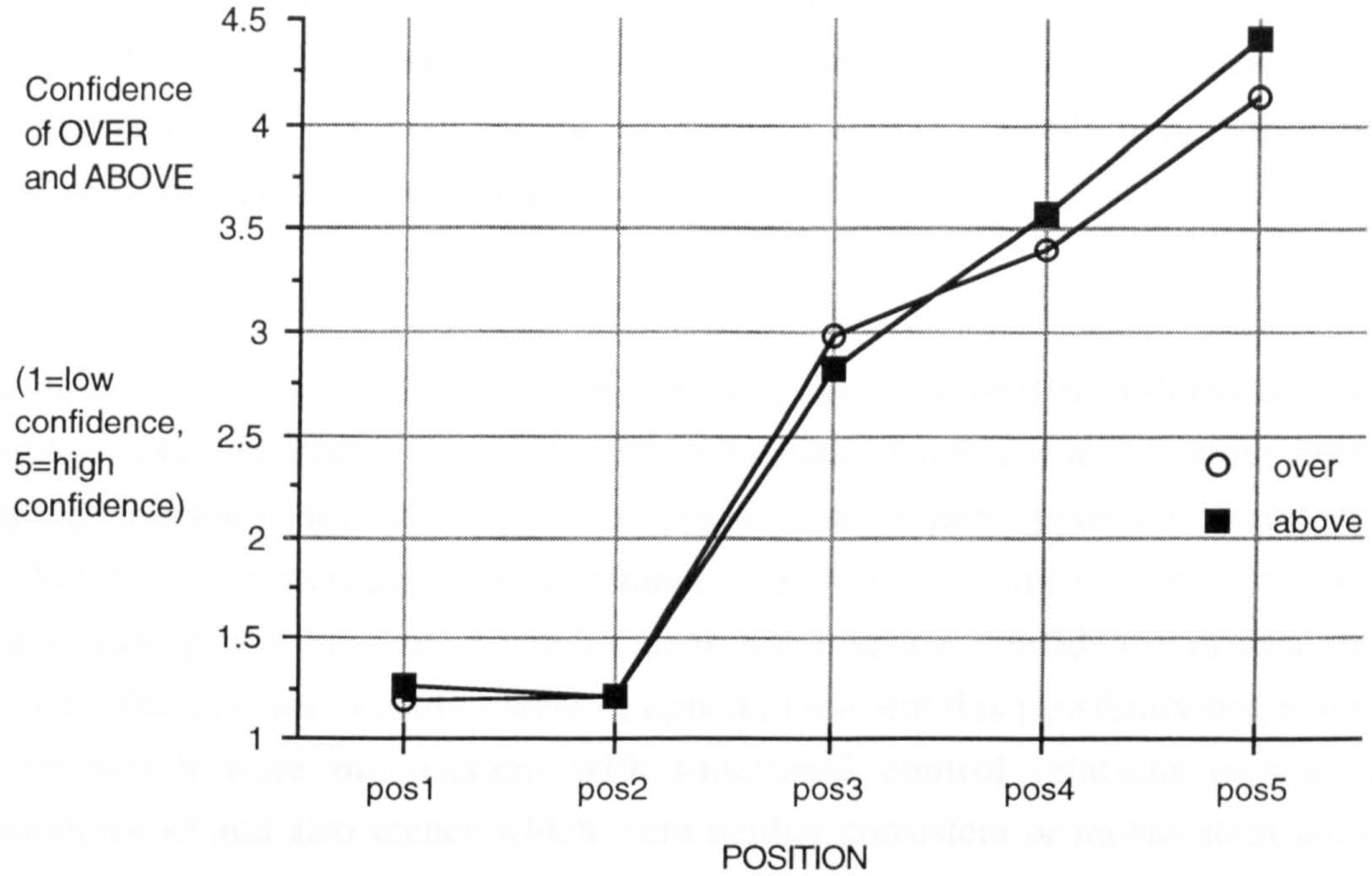


Figure 8.8 - Mean Confidence of OVER and ABOVE Across the Five Positions.

The significant interaction between Preposition and Position was due to the increase in confidence for ABOVE at Positions 4 ($F(1,192) = 3.923$, $p<0.05$) and 5 ($F(1,192) = 9.895$, $p<0.01$). Mean values for ABOVE and OVER across the five positions are shown in Figure 8.6. Basically, as the height of ball relative to bowl increases confidence of OVER decreases as compared to confidence in ABOVE.

8.5.2.7 Discussion

These presentations have shown that the introduction of dynamic information into the scene influences subjects' confidence in the use of the preposition IN but not ON or OVER. This is consistent with the functional geometric account: additional dynamic information from the combined and correlated movement of referent ball and relatum bowl should reinforce the functional control relation assumed to underlie the locative IN but not the locative ON.

The non continuous scenes were then used to investigate any counter-effects on the prepositions OVER and ABOVE. It was found that subjects were more confident of ABOVE than OVER for positions 4 and 5. It is suggested that this may be due to the fact that subjects become less sure that fSuperiority can hold. It becomes less certain whether the ball x is threatening to come into contact with y as a consequence of gravitational force. In contrast the preposition ABOVE needs only a directional meaning which relates to verticality.

The type of dynamics in these studies are suggested to give extra information to the language user. Basically, the correlated movement of referent and relatum provides language users with the information that potential movement <u>is</u> possible and therefore we should see an increase in IN confidence. However, it must be proved that just simply adding any kind of dynamics does not increase confidence in this spatial relation. The next set of studies were designed to rule out this possibility by presenting scenes which were inconsistent with functional control relations (specifically fContainment) and also scenes which were neither consistent or inconsistent with the control.

8.6 PREP5: Inconsistent Dynamic Information

8.6.1 Introduction

This series of dynamic presentations focused on fContainment and the locative IN. Dynamic information that was inconsistent with the dynamic notions of functional control were presented and it is hypothesised that this will weaken the control and thus decrease confidence of IN. The control for fContainment states that the relatum (in this case a bowl) must control the location of the referent (in this case a ball) and it is proposed that movement of the relatum should predict a correlated movement in the referent. Indeed, language users actually take this dynamic information into account when selecting a locative.

So, the functional geometric account predicts that movement of a relatum bowl and contents whilst the ball remains stationary (bowl move scenes) should provide results that are inconsistent with notions of fContainment and thus weaken confidence of IN. In the converse situation a referent ball moving relative to a stationary bowl (ball move scenes) and contents should not affect the conditions of fContainment. It is suggested that this is because the referent ball remains within the bounds of the rim of the container.

This kind of lateral movement is not expected to greatly affect the fSupport relation although it is predicted that lateral movement of the bowl relative to a stationary ball may increase ON confidence at position 3. This is because the movement may reinforce the information that the bowl is supporting the ball (which is touching the rim of the bowl) from the force of gravity. Counter effects on OVER and ABOVE will also be examined.

8.6.2 Method for PREP5

8.6.2.1 Design

Subjects were shown 18 graded scenes of ping-pong balls and glass bowls and asked to make a confidence rating for various spatial prepositions. The presentations involved scenes where the ball moved laterally back and forth relative to a stationary bowl and contents (ball move scenes) and also scenes where the bowl and contents moved laterally relative to a stationary referent ball (bowl move scenes). As noted in the introduction the functional account makes different predictions for these two dynamic representations. There were three factors in this design. Firstly, Continuity (black referent ball versus white referent ball) was varied. Secondly, scene Dynamics were manipulated (ball moving/bowl stationary, bowl moving/ball stationary and both stationary). Thirdly, relative position of ball to bowl was varied (P3, P4, P5). All the differential effects for the lateral Dynamics PREP4 studies related to Positions 3, 4 and 5 therefore only these three positions were used. These factors are shown graphically in Figure 8.9.

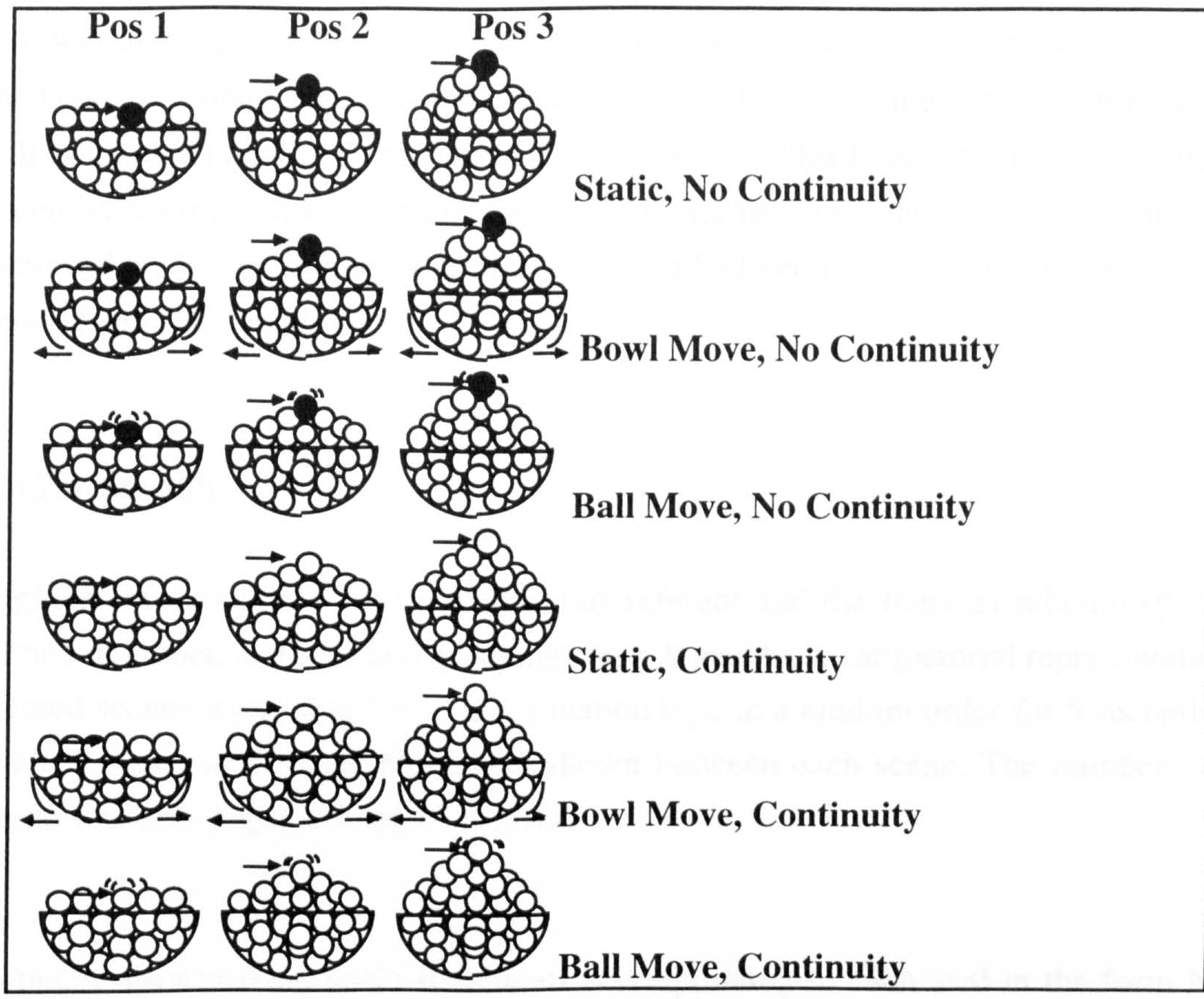


Figure 8.9 - The 2x3x3 ANOVA Design for the PREP5 Presentations.

8.6.2.2 Subjects

The 50 subjects were all undergraduates from the University of Glasgow and were tested in group situations. All subjects were native English speakers.

8.6.2.3 Apparatus and Materials

The materials used consisted of a perspex bowl, transparent thread, a long nail, a piece of wood, one black ping-pong ball and several white ping-pong balls. A black arrow was used as a pointer and green material as the backdrop. The materials were filmed using a Sony DXC M3A television camera, in colour with no sound. After filming the resulting video-tape was edited using an RM-GE 10U editing control unit and a double JVC BR-S610ES VHS video recorder. Questionnaire booklets containing statements corresponding to scenes from the final video and also instructions were compiled (see

Appendix N). Transparent thread was attached to the referent ball for scenes where the ball was moving. Certain scenes involved the referent ball remaining stationary whilst the bowl and contents moved and this was achieved by attaching the referent ping-pong ball to a hidden long nail hammered into in a board. This board was hidden behind the green back-drop. Spatial arrangements involving the bowl and contents moving were achieved by pulling transparent plastic (which had been taped to the underside of the bowl) from side to side.

8.6.2.4 Stimuli

Eighteen scenes involving the ball (x) as referent and the bowl as relatum (y) were filmed in graded and repeated groupings (see Appendix L for pictorial representations). Filmed scenes were edited onto a destination tape in a random order for 5 seconds per trial. Twenty seconds of black was shown between each scene. The number of the scene was also displayed before the trial.

Subjects answered six basic statements corresponding to each trial in the form NP + (Prep. + NP) after viewing each trial. Each statement was rated using a corresponding Lickert scale. The scale of 1-5 rated how well subjects thought the statement described the scene from 1 = Highly Unlikely to 5 = Most Likely. The statements were as follows and order of presentation was randomised within statements (see Table 8.6).

The ball is **over** the bowl	1	2	3	4	5
The ball is **in** the bowl	1	2	3	4	5
The ball is **below** the bowl	1	2	3	4	5
The ball is **above** the bowl	1	2	3	4	5
The ball is **under** the bowl	1	2	3	4	5
The ball is **on** the bowl	1	2	3	4	5

Table 8.6 - Statements Presented in PREP5.

8.6.2.5 Procedure

The subjects were tested in a group situation and each received an identical questionnaire which included instructions. These instructions were explained verbally. Subjects were informed that this was a simple language experiment and that they should pay special attention to the ball indicated by the pointer. It was also stressed that the Lickert scale must be rated for each statement per scene and that confidence ratings should be made only after viewing the entire scene. Subjects were instructed that statements should be read prior to the relevant trial appearing on screen. Individuals were able to ask questions to clarify any details. Each scene was preceded by a numbered caption and the number of each scene was called out to the subjects. After the experiment the questionnaires were collected from each subject.

8.6.2.6 Results

PREP5 scenes 4, 11, 17, 8, 18, 5, 13, 2, 10, 1, 14, 7, 16, 3, 12, 9, 6, and 15 for IN were subjected to a 2x3x3 repeated measures ANOVA (see Appendix O for pictorial descriptions of these scenes). Mean confidences for IN are shown in Figure 8.10. The main effects and interactions are listed in Table 8.7.

Reliable Main Effects and Interactions - PREP5 - IN	
Dynamics	$F(2,98) = 145.86$, $MSe = 1.79$, $p<0.0001$
Position	$F(2,98) = 18.49$, $MSe = 1.35$, $p<0.0001$
Continuity x Dyn	$F(2,98) = 5.16$, $MSe = 0.565$, $p<0.01$
Continuity x Pos	$F(2,98) = 3.22$, $MSe = 0.704$, $p<0.05$
Dyn x Pos	$F(4,196) = 21.47$, $MSe = 0.773$, $p<0.0001$

Table 8.7 - Significant Results for the PREP5 Dynamics ANOVA Examining IN.

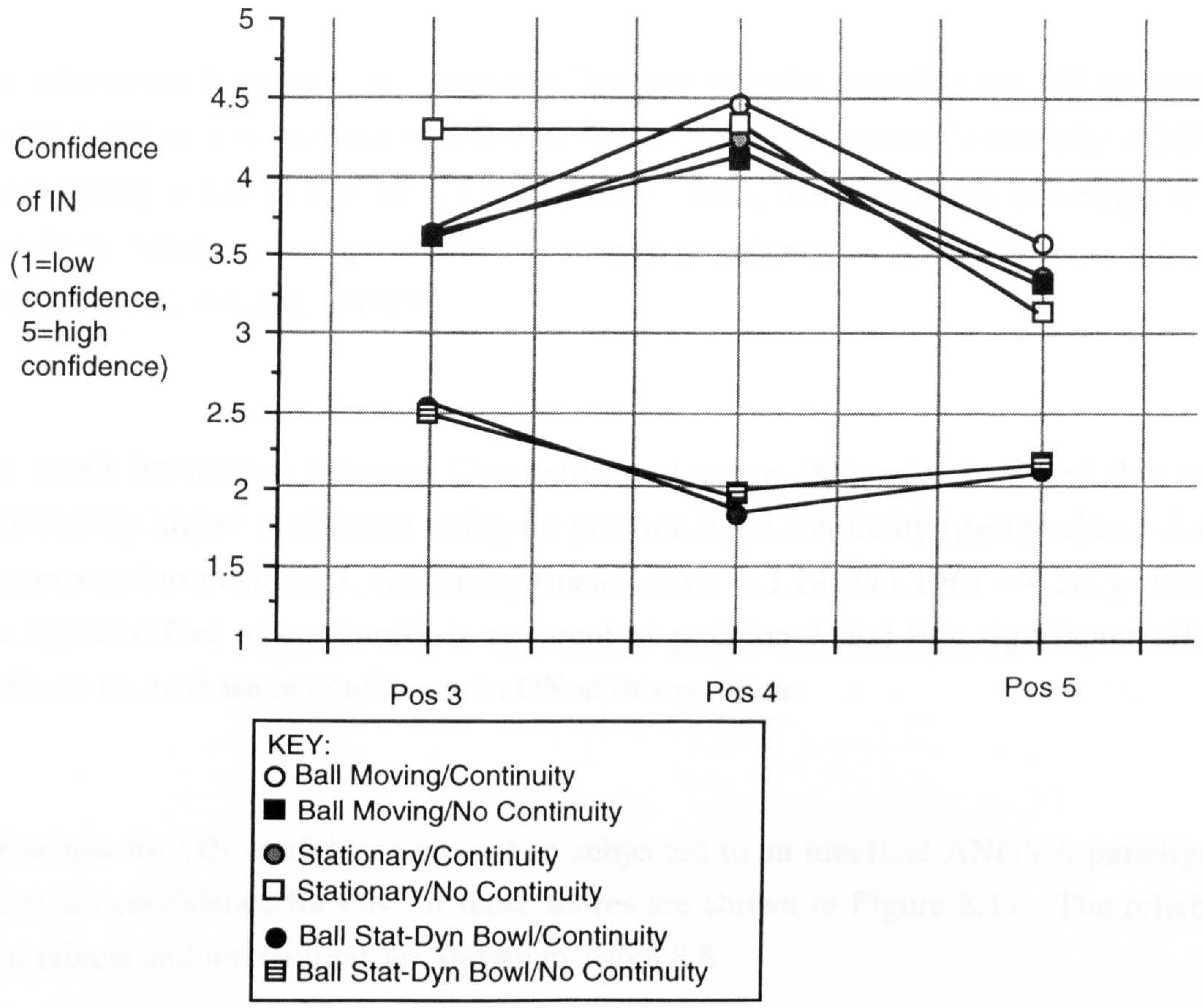


Figure 8.10 - The Combined Effect of Continuity, Dynamics and Position for PREP5 IN Confidence.

There is an extremely strong effect of scene Dynamics on confidence of IN. This effect is due to the contrast between scenes where the bowl and contents move and the ball remains stationary (bowl move scenes = 2.2) and scenes where the ball moves and the bowl and contents remain stationary (ball move scenes = 3.79) or where both referent ball and relatum bowl are stationary (stat scenes = 3.84). Bowl move compared to ball move scenes resulted in $F(1,98) = 212.4$, $p<0.0001$ and bowl move compared to stat scenes resulted in $F(1,98) = 225.02$, $p<0.0001$. The results follow the predictions exactly for the dynamic manipulations.

Turning now to the effect of Position further analysis revealed that this effect was due to differences between position 5 (mean value = 2.95) and positions 3 (mean value = 3.38) and 4 (mean value = 3.497). Indeed, for both contrasts $F(1,98) > 20.62$, $p<0.0001$. Reduction in confidence was only found for the extreme height position.

The interaction between Continuity and Dynamics can be traced to a small advantage of continuity over no continuity referents for the ball move scenes (continuity = 3.893, no continuity = 3.687), $F(1,98) = 5.667$, $p<0.05$. Also, there is a small advantage of no continuity referents for the stationary scenes (continuity = 3.747, no continuity = 3.927), $F(1,98) = 4.299$, $p<0.05$.

The small interaction between Continuity and scene Dynamics is found due to a significantly higher confidence rating for position 3, no continuity (mean value = 3.48) as compared to position 3, continuity (mean value = 3.28, $F(1,196) = 4.26$, $p<0.05$). The visual effect of continuity is apparent at position 3 and this significant effect relates to an increase in confidence in ON at this position.

The scores for ON confidence were then subjected to an identical ANOVA paradigm. The mean confidence for ON for these scores are shown in Figure 8.11. The reliable main effects and interactions are shown in Table 8.8.

Reliable Main Effects and Interactions - PREP5 - ON - 2x2x3	
Continuity	$F(1,49) = 6.49$, MSe = 0.7, $p<0.05$
Dynamics	$F(2,98) = 5.16$, MSe = 1.18, $p<0.01$
Position	$F(2,98) = 173.96$, MSe = 2.18, $p<0.0001$
Dyn x Pos	$F(4,196) = 8.693$, MSe = 0.77, $p<0.0001$
Cont x Dyn x Pos	$F(4,196) = 5.834$, MSe = 0.79, $p<0.001$

Table 8.8 - Significant Results for the PREP5 Dynamic ANOVA Examining ON.

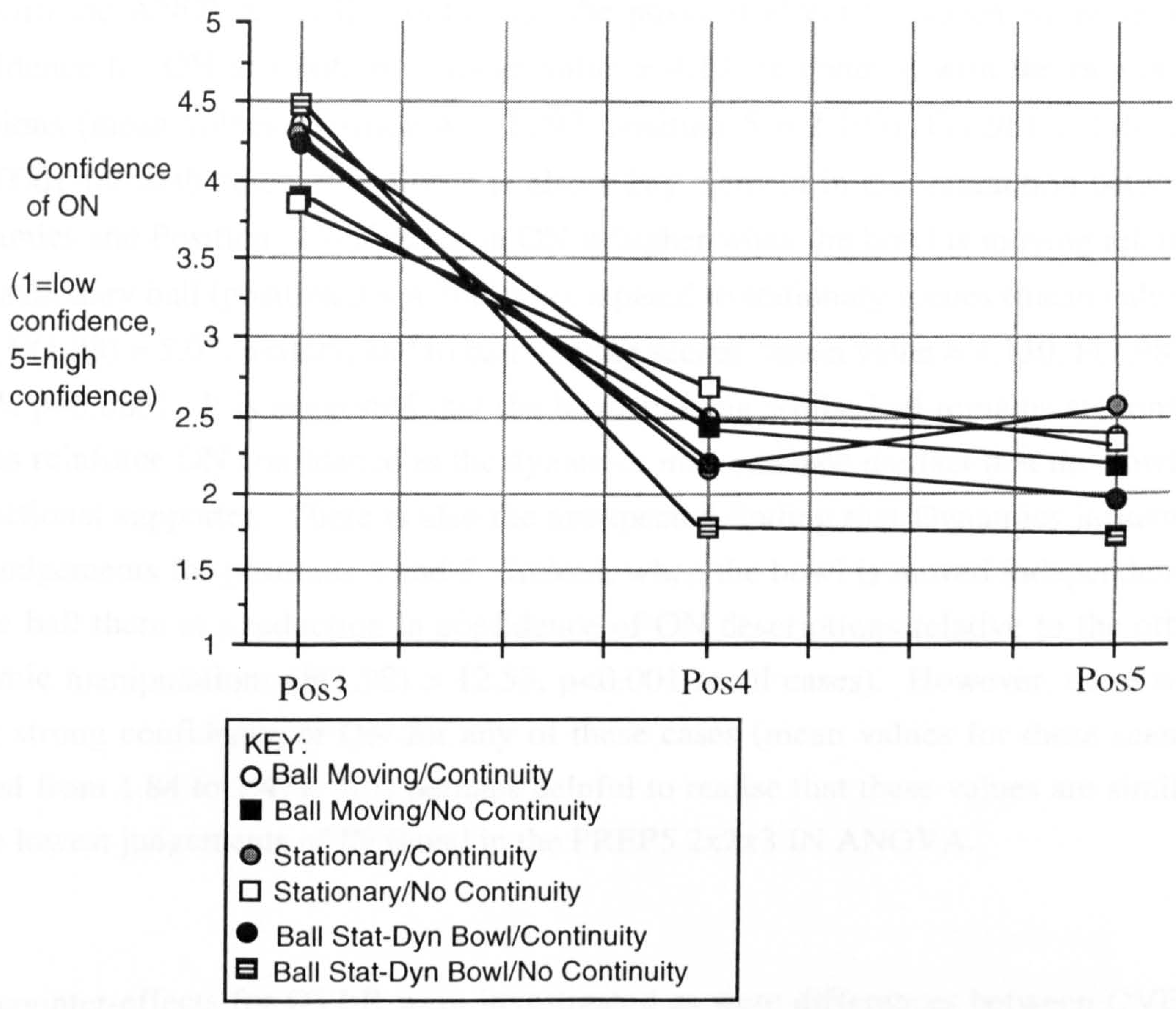


Figure 8.11 - The Combined Effect of Continuity, Dynamics and Position for PREP5 ON Confidence.

There is an effect of Continuity for ON. Confidence of ON increases when the scenes contain continuity (continuity = 2.964, no continuity = 2.822). This is a fairly small difference and is more fully explained by examining the three-way interaction which is due to a small opposite effect of continuity between bowl moving scenes and stationary scenes. Continuity increases judgements of ON for position 3 stationary scenes ($F(1,196) = 6.16$, $p<0.01$) and also for position 3 ball moving scenes ($F(1,196) = 6.737$, p,0.01). Also continuity increases ON judgements for position 4, stationary scenes ($F(1,196) = 9.284$, $p<0.01$). Subjects are more confident of ON for position 4, bowl moving scenes when there is continuity present ($F(1,196) = 5.6$, $p<0.05$). These are relatively small effects and probably reflect slight variations in how the subjects see the spatial relation between the referent ball and the bowl rim. Turning to position 4, it is unlikely to be rated as ON, however, the bowl and white balls moving from side to side whilst the white ball remained stationary may have given the illusion that the bowl was supporting the ball, thus slightly increasing the low ON judgements at this position.

As with the ANOVA for IN confidence the position effect is caused by increased confidence for ON at position 3 (mean value = 4.19) in contrast with the two other positions (mean values: position 4 = 2.297, position 5 = 2.193), $F(1,98) > 246.734$, $p<0.0001$ for both cases. Position 3 is also a key element in the interaction between Dynamics and Position. Confidence in ON is higher when the bowl is moving relative to a stationary ball (position 3 = 4,360) as compared to stationary scenes (mean value = 4.08, $F(1,98) = 5.07$, $p<0.05$) and to ball moving scenes (mean value = 4.130, $F(1,98) = 3.425$, $p=0.065$). It is suggested that the bowl moving whilst ball remains stationary scenes reinforce ON confidence as the dynamics may enhance the fact that the bowl is a functional supporter. There is also the unexpected finding that Dynamics influence ON judgements for positions 4 and 5. Indeed, when the bowl is moved independently of the ball there is a reduction in confidence of ON descriptions relative to the other dynamic manipulations ($F(1,98) > 12.53$, $p<0.001$ in all cases). However, there was not a strong confidence of ON for any of these cases (mean values for these scenes ranged from 1.84 to 2.47). It is perhaps helpful to realise that these values are similar to the lowest judgements of IN found in the PREP5 2x2x3 IN ANOVA.

Any counter-effects for OVER were investigated as were differences between OVER and ABOVE. It is predicted that these prepositions will have a different range and this has been supported by the previous OVER/ABOVE investigation for PREP4 and also by the static investigation reported in section 7.6.6. The spatial preposition OVER will be affected by the controls of fSuperiority, unlike the less functional preposition ABOVE.

In order to compare confidence of OVER and ABOVE the same scenes that constituted the 2x3x3 ANOVAs were used to examine both prepositions. This resulted in a 2x2x3x3 repeated measures ANOVA as Preposition (OVER, ABOVE) was introduced as a factor. The main effects and interactions of this large ANOVA are listed in Table 8.9. The confidence judgements for descriptions containing OVER and ABOVE are shown in Figure 8.12 for all Dynamic manipulations across the three positions.

Reliable Main Effects and Interaction for PREP5 OVER/ABOVE	
Preposition	F(1,49) = 17.88, MSe = 1.146, p<0.0001
Dynamics	F(2,98) = 114.69, MSe = 1.48, p<0.0001
Position	F(2,98) = 124.98, MSe = 1.4, p<0.0001
Prep x Continuity	F(1,49) = 6.49, MSe = 0.42, p<0.05
Prep x Pos	F(2,98) = 10.004, MSe = 0.52, p<0.0001
Dyn x Pos	F(4,196) = 29.45, MSe = 1.24, p<0.0001

Table 8.9 - Significant Main Effects and Interactions for the 2x2x3x3 PREP5 ANOVA.

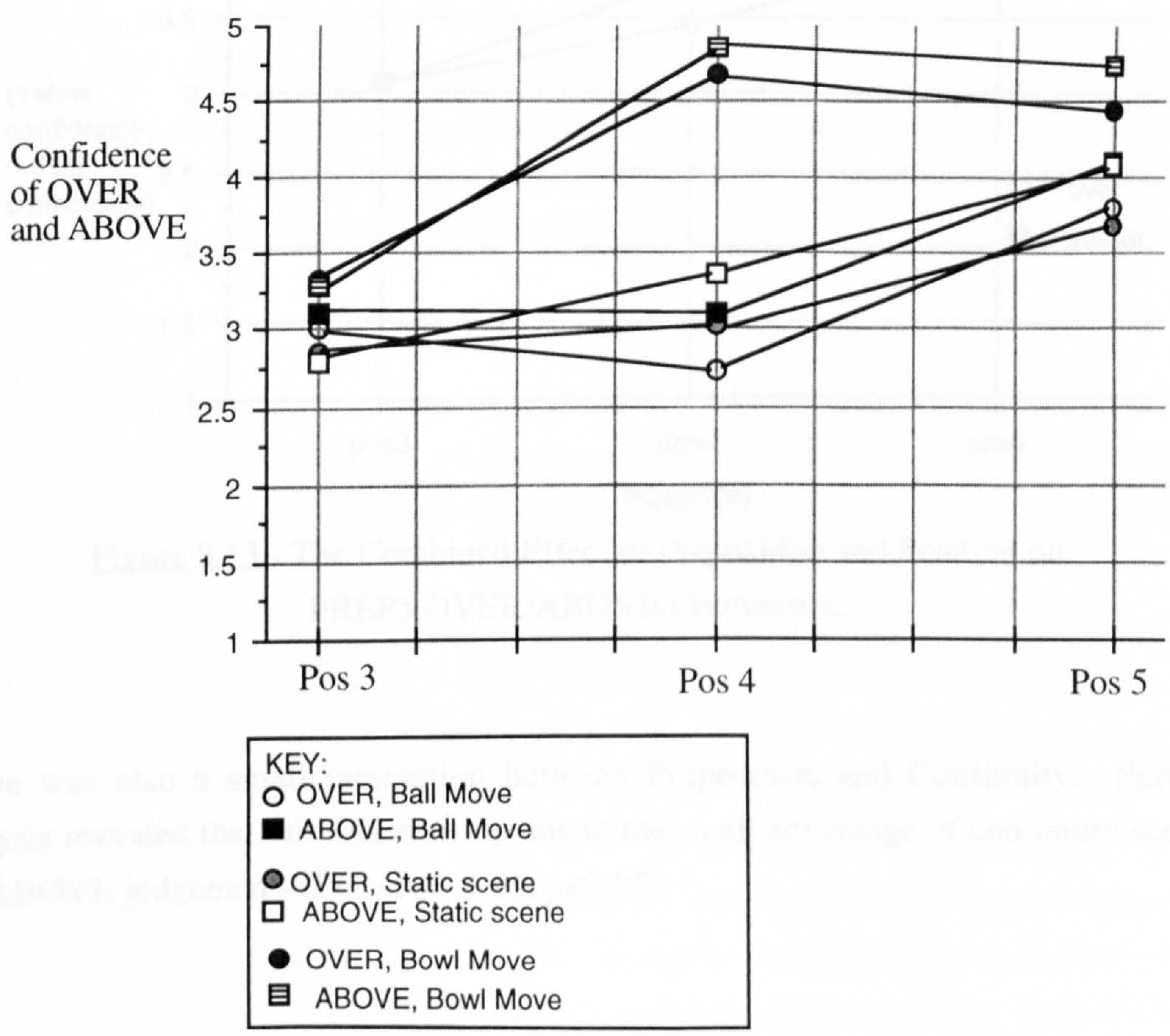


Figure 8.12 - The Combined Effect of Preposition, Position and Dynamics on PREP5 OVER/ABOVE Confidence.

For the main effect of Preposition it was found that, overall, subjects were more confident of ABOVE (mean value = 3.72) than OVER (mean value = 3.51) for these scenes. Further analysis revealed that subjects were more likely to select ABOVE for all three Dynamic manipulations ($F(1,98) > 5.84$, $p<0.05$ in all cases). The interaction between Position and Preposition revealed that subjects were more confident of ABOVE, as opposed to OVER, for both position 4 ($F(1,98) = 26.749$) and position 5 ($F=(1,98) = 32.95$, $p<0.0001$). This was also found to be the case for the PREP4 OVER and ABOVE analysis using similar spatial arrangement scenes. Figure 8.13 presents the mean confidence values for this interaction.

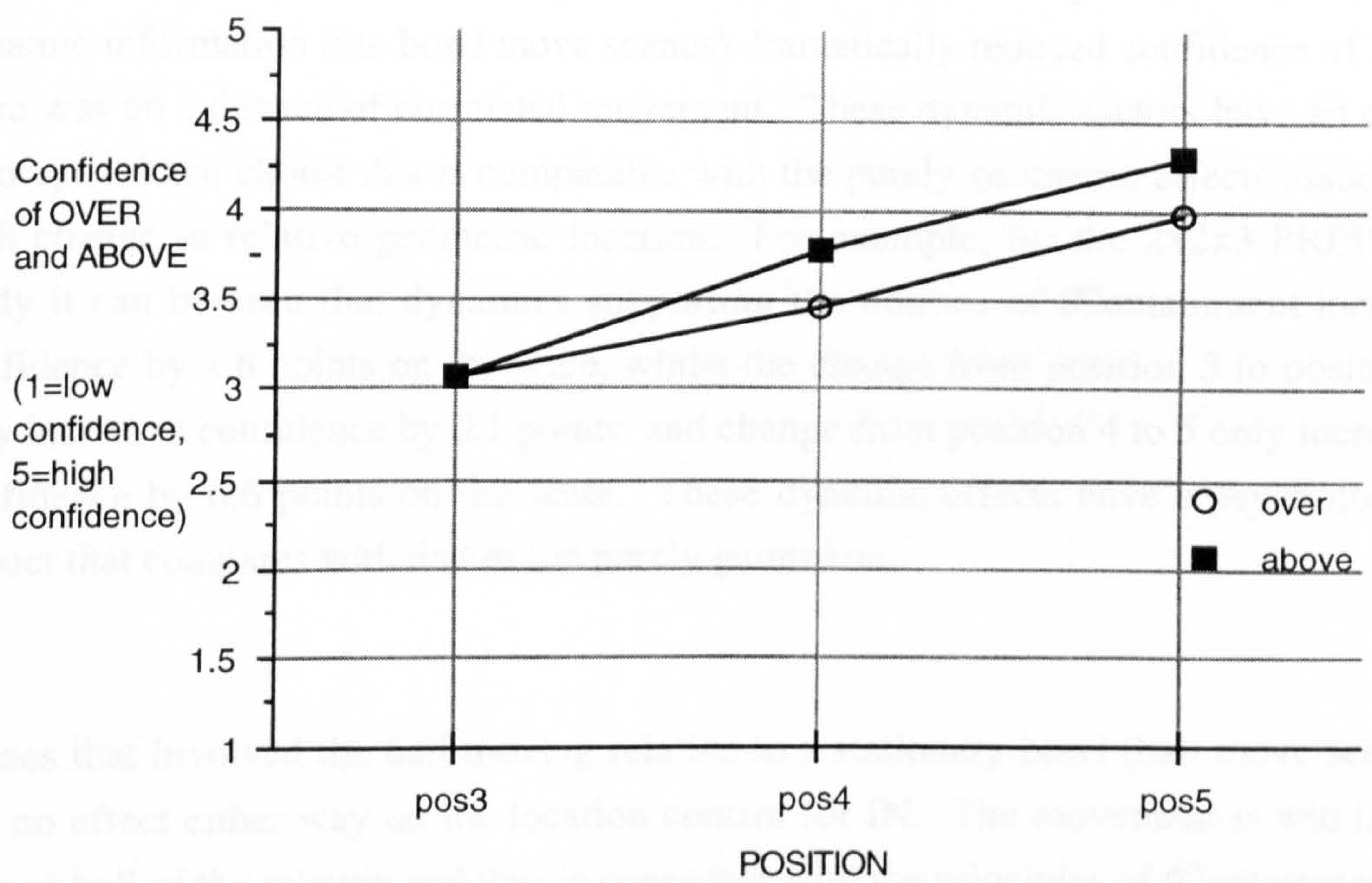


Figure 8.13 - The Combined Effect of Preposition and Position on PREP5 OVER/ABOVE Confidence.

There was also a small interaction between Preposition and Continuity. Further analysis revealed that this was entirely due to the small advantage of continuity scenes for ABOVE judgements ($F(1,49) = 6.62$, $p<0.05$).

For Dynamics it was found that subjects were more likely to rate the bowl move scenes as OVER or ABOVE than either stat or ball move scenes ($F(1,98) > 169.852$,

$p<0.0001$). This counter effect was to be expected. For Position judgements of OVER or ABOVE increased relative to the increase in height of ball to bowl (from P3 to P4 and from P4 to P5, ($F(1,98) > 57.351$, $p<0.0001$). The interaction between Dynamics and Position was reliable. As expected the referent ball was seen as more OVER or ABOVE when the bowl was moving independently to the ball as opposed to the stationary or ball moving scenes ($F(1,196) > 5.44$, $p<0.05$ over all three positions).

8.6.2.7 Discussion

One of the main findings that arise from these presentations relates to the dramatic effects of scene Dynamics on subjects confidence of IN. As predicted inconsistent dynamic information (the bowl move scenes) dramatically reduced confidence of IN as there was no evidence of correlated movement. These dynamic factors have an effect on prepositional choice that is comparable with the purely geometric effects associated with change in relative geometric location. For example, for the 2x2x3 PREP5 IN study it can be seen that dynamics supporting the notions of fContainment increase confidence by 1.6 points on the scale, whilst the change from position 3 to position 4 only increases confidence by 0.1 points. and change from position 4 to 5 only increases confidence by 0.6 points on the scale. These dynamic effects have a psychological impact that compares with that of the purely geometric.

Scenes that involved the ball moving relative to a stationary bowl (ball move scenes) had no effect either way on the location control for IN. The movement is within the convex hull of the relatum and thus is consistent with the principles of fContainment.

It was also found that subjects prefer to describe the configurations at Position 4, and even more so at position 5, as ABOVE rather than OVER. This result was also found for the PREP4 OVER and ABOVE presentations discussed in section 8.5.2.6. It is suggested that this is because the notions of fSuperiority are weakened as the ball moves further in height away from the relatum. Subjects become less confident that threatened contact could be the case. This is especially the case in scenes where the bowl is seen to move from side to side independently of the stationary ball. To use a real world example, although one would say "the bomber is OVER the target" when it is vertical to the target or moving in the area of the target one would be unlikely to say "the bomber is OVER the target" if the plane kept flying miles on either side of the target in a repetitive manner. The preposition ABOVE requires only the verticality factor and is therefore used more often for both position 4 and position 5 scenes and also when the bowl is moving. These findings are supported by the results found in the PREP4 2x2x5 ANOVA examining OVER and ABOVE. Subjects are unlikely to rate these "counter fContainment" bowl move scenes as IN or ON and this accounts for the large increase in OVER and ABOVE confidence for the bowl moving scenes.

8.7 The PREP3 Presentations: Ball Effects and Tilt

8.7.1 Introduction

These presentations focused on the dynamic predictions of fSupport which relate to the spatial preposition ON. It was predicted that manipulating the scene dynamics and altering control for the referent ball would alter notions of functional control concerning support from the force of gravity and thus alter confidence ratings for ON. It was predicted that the string would act as a form of altered control (removing control from the primary supporter) and result in a lowered confidence of ON. Dynamics involving the referent ball moving from side to side and also different tilts of the primary support were also varied to examine effect on prepositional confidence.

8.7.2 Design

The PREP3 dynamic presentations involved 9 graded scenes involving a ping-pong ball as referent and a plank of wood as the primary support. Two factors were used in this design. Firstly, the referent ping-pong ball was manipulated in three ways (Ball Effects). This involved the referent being stationary, the referent moving from side to side (dynamics) or the referent attached to a length of string (altered control). Secondly, the relatum board underwent a Tilt manipulation. The plank of wood was either presented with a shallow tilt, a medium tilt or a high tilt. The 3x3 ANOVA design used to examine confidence of ON is illustrated in Figure 8.14.

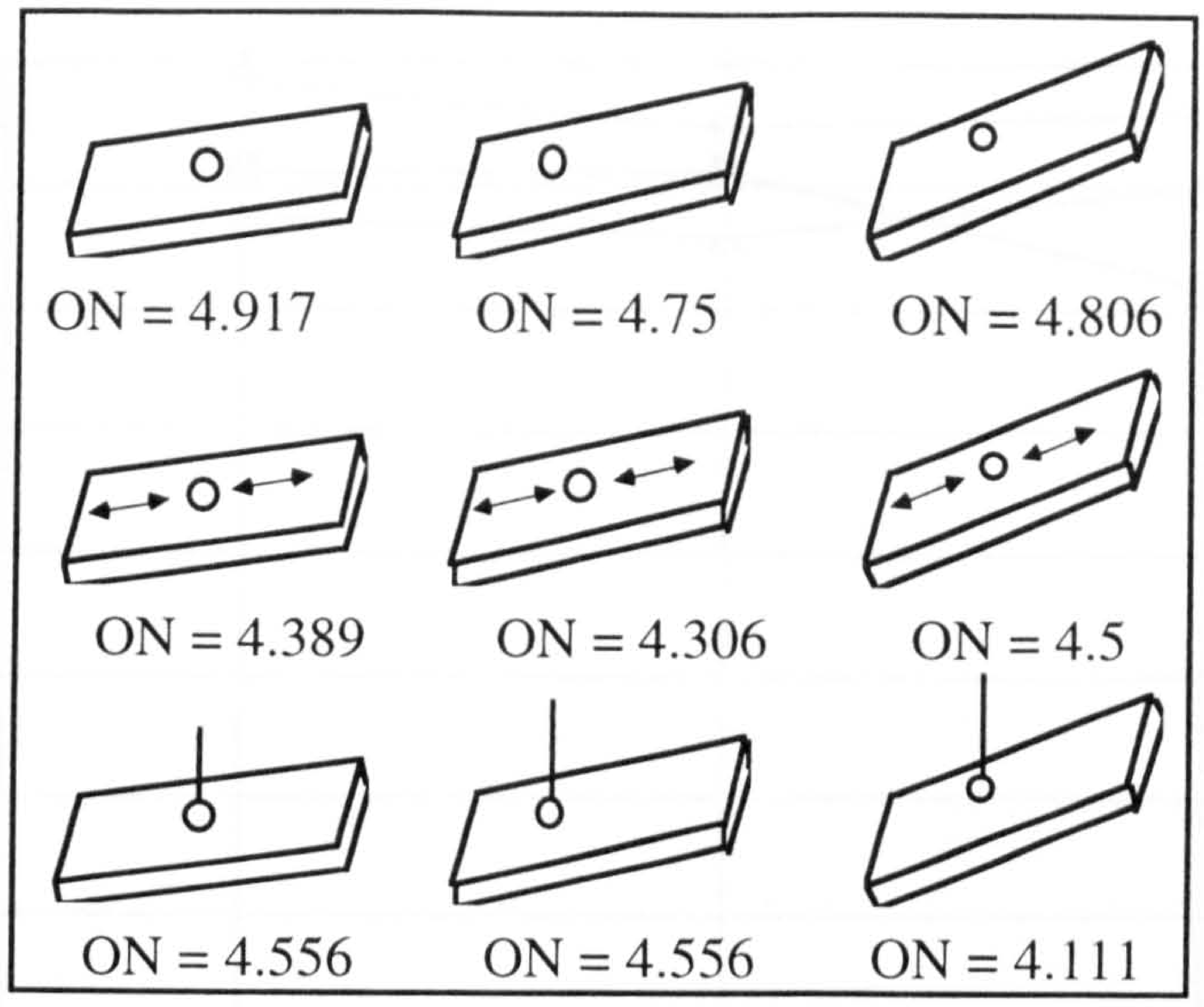


Figure 8.14 - The PREP3 3x3 ANOVA Design and Mean Values.

8.7.3 PREP3: Results

PREP3 scenes 3, 25, 44, 13, 31, 41, 19, 38 and 29 (see Figure 8.12 for pictorial descriptions and mean values) for ON confidence were subjected to a 3x3 repeated measures ANOVA. Confidence ratings for these scores are shown in Figure 8.15. The reliable main effect and interaction are listed in Table 8.10.

Reliable Main Effect and Interaction for ON -PREP3	
Ball Effects	$F(2,70) = 8.07$, $MSe = 0.79$, $p<0.001$
Ball Effects x Tilt	$F(4,140) = 3.54$, $MSe = 0.34$, $p<0.01$

Table 8.10 - Significant Results for the PREP3 Dynamics ANOVA Examining ON.

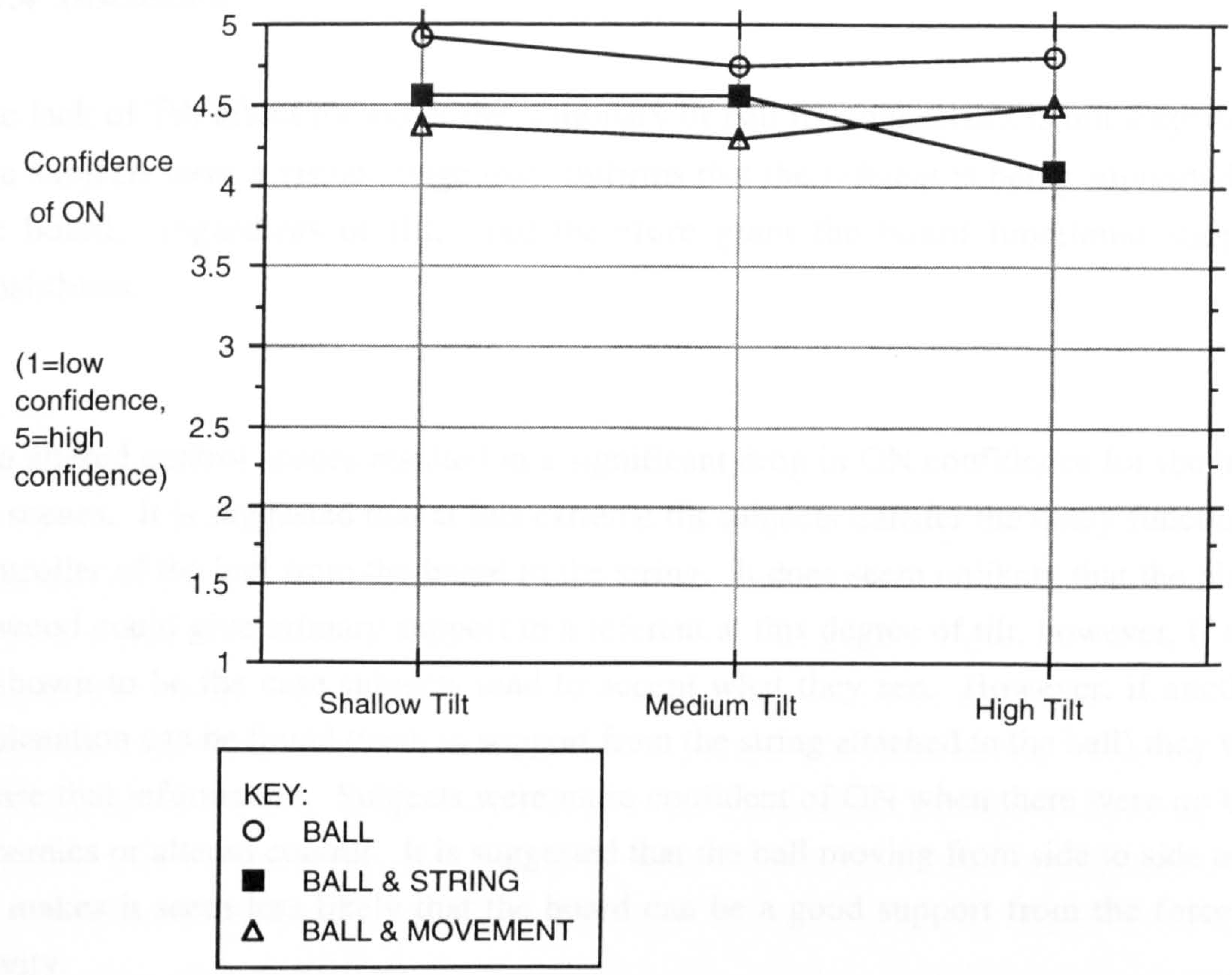


Figure 8.15 - The Combined Effect of Dynamics and Tilt on PREP3 ON Confidence.

When compared to stationary scenes it can be seen that the presence of an altered control (string) and of ball dynamics reduced confidence of ON ($F(1,70) > 11.84$, $p<0.001$ for both cases). There was also a combined effect of Tilt and Ball Effects. Confidence of ON for the altered control scenes drops significantly between a medium and high tilt and shallow and high tilt of the board ($F(1, 140) = 10.59$, $p<0.01$ in both cases).

It was found that there were no significant differences due to Tilt for either stationary or ball moving scenes. However, subjects were significantly more likely to select ON when the ball was stationary as opposed to moving ($F(1, 140) > 5.003$, $p<0.05$ in these cases).

8.7.4 Discussion

The lack of Tilt effect for either the stationary or ball moving scenes is not surprising. The subjects have a visual image that confirms that the referent is being supported by the board, regardless of tilt, and therefore grant the board functional support capabilities.

The altered control scenes resulted in a significant drop in ON confidence for the high tilt scenes. It is suggested that at this extreme tilt subjects transfer the likely functional controller of the ball from the board to the string. It does seem unlikely that the plank of wood could give primary support to a referent at this degree of tilt, however, if that is shown to be the case subjects tend to accept what they see. However, if another explanation can be found (such as support from the string attached to the ball) they will utilise that information. Subjects were more confident of ON when there were no ball dynamics or altered control. It is suggested that the ball moving from side to side on a tilt makes it seem less likely that the board can be a good support from the force of gravity.

8.8 General Discussion of the Dynamic Presentations Results

The experimental manipulations presented in Chapter 7 involved static scenes. It was shown experimentally that various factors such as altered control, position, containment and continuity would influence choice of spatial preposition. It was proposed that these factors are involved in location control.

Although these results support proposals concerning control relations further analyses, in the present chapter, were carried out to investigate the inherently dynamic properties of these relations. Evidence was presented showing that dynamics inconsistent with functional geometric controls inhibit the use of those prepositions that would have been deemed appropriate in the identical static scenes. So, a PREP5 position 4 scene that was stationary was more likely to be rated as IN than the identical position 4 scene where the bowl and contents were moving and the ball was stationary.

Also dynamics consistent with the theory were found to promote the use of the appropriate prepositions. For example, a PREP4 position 4 scene where the ball, contents and bowl were seen to be moving together was rated as more highly IN than the identical position 4 stationary scene. These findings support the dynamic predictions of functional geometry.

It was shown in a PREP1 series of presentations that inconsistent vertical dynamics reduce confidence in the locative IN. For example, a position 1 scene where the referent ball was seen prior to judgement to descend vertically to that position was rated as less IN that the identical, but stationary, position 1 scene. Another series of PREP1 presentations showed that another form of dynamics reduce confidence in the locative IN and increase confidence in the locative ON. A position 4 scene was shown where the bowl and contents moved into place under the referent ball. The subjects were asked to make a confidence rating after the movement. By comparing this dynamic scene with the identical stationary one. It was found that confidence of IN was weakened by the introduction of a prior dynamic context. Such movement indicated that the relatum was not in control of the referent. Indeed judgements of ON increase for the dynamic scene as the movement suggested that the bowl was fulfilling its role as a supporter from the force of gravity.

Finally it was shown that dynamics and altered control can reduce confidence in the spatial preposition ON. Scenes with altered control of the ball resulted in a lower confidence of ON as compared to identical scenes with no altered control. The dynamic prediction is that the referent would alter position if the relatum, supporting it from the force of gravity, were to be removed. The altered control means that if the primary supporter (a plank of wood) was removed it would be less likely that the referent ball would change position. It was also found that dynamics (a moving referent ball) reduced the location control provided by fSupport.

Finally, it must be noted that these results are focused on intuitive theoretical predictions. It is important to discover whether notions of location control are actually in operation when the language user selects a spatial preposition. I now turn to a consideration of the precise nature of this control in a series of Independent Judgement presentations.

Chapter 9

The Experiments Investigating a Functional Geometry: Indirect Testing Using Independent Judgements

9.1 General Introduction to the Independent Judgement Experiments

The experiments reported thus far have shown that inherently dynamic functional controls appear to be in operation. Furthermore, it has been demonstrated that manipulation of these dynamics, vital to the functional control notions, can have a marked effect on subjects' confidence in the use of different prepositions. For example the presence of lateral correlated dynamics reinforces confidence of IN whilst the presence of an uncorrelated movement reduces confidence of IN. This chapter involves indirect experimentation which considers the precise nature of the suggested location controls. These experiments were designed to examine directly whether the dynamic location controls actually influence choice of spatial preposition. Evidence to support the functional geometric theory is gathered not by testing prepositional use directly but rather by examining subjects' independent judgements of how objects will be affected after certain types of movement.

These two final overall experiments address directly the relationship between confidence and control. The dynamic predictions inherent in fContainment, fSuperiority and fSupport are examined directly. If the functional account is correct then the consequence of directly manipulating dynamic functional control predictions (concerning the effect on scenes of various types of suggested movement) should relate to prepositional confidence. The results found for these Independent Judgement presentations can then be correlated with the confidence ratings for IN, ON and OVER found for identical scenes used in the Preposition experiments. Various presentations, previously used in the prepositions experiments, designed at tapping into different prepositional controls were shown. Examples of the Independent Judgement scenes can be viewed on video-tape (see Appendix U for further information).

9.2 General Design of the Independent Judgement Experiments

Two overall experiments are presented in this chapter and these involve various presentations. The experiments are coded as IJ1 and IJ2. Subjects were shown target scenes, previously used in the prepositions experiments, and then shown a suggested type of movement. The subjects then made a binary decision as to the outcome of this suggested movement: either No Change in the scene after movement or a Change in the scene after movement. The general design of these various presentations are now discussed. Specific design factors are presented within the Method sections for both IJ1 and IJ2.

9.2.1 General Design of the IJ1 Presentations

The IJ1 experiment tests dynamic predictions of fContainment using Lateral Groups and predictions of fSuperiority using Vertical groups. The IJ1 Lateral Groups involve presentations which focus on an examination of the dynamic functional control predictions of fContainment (x is capable of correlated lateral movement with y) which relate to IN. Subjects were asked to rate whether a ping-pong ball and bowl scene would stay the same or alter after a suggested lateral movement. The same scenes used in the PREP2 static presentations focusing on the locative IN were used in these Independent Judgement presentations. fContainment dynamic predictions were examined using the following ANOVA designs: Containment, Altered Control and Position (2x2x5), Continuity, Altered Control and Position (2x2x5) and Partial Containment, Altered Control and Position (2x2x3). Correlations were then carried out between ratings of No Change after the suggested movement and confidence of IN found for each of these ANOVA designs. It is predicted that the scenes subjects think will remain the same after a movement (No Change) will also have been rated as highly IN in the Preposition experiments.

The IJ1 Vertical Groups involve a series of presentations which examine the dynamic predictions of fSuperiority (if dropped x will fall into the area of y) which relate to OVER and ABOVE. Subjects were asked to rate whether the referent (a ping-pong ball) would fall into or outwith the area of the relatum bowl if it was dropped. The same scenes used in the PREP2 presentations examining OVER and ABOVE were used in these Independent Judgement experiments. The dynamic predictions of fSuperiority were examined using the following ANOVA design: Horizontal Position and Vertical Height (2x3). Correlations were then carried out between the rating of falling into the area of the bowl and confidence of OVER and ABOVE. It is predicted that scenes where the subjects predict the ball would fall into the bowl if dropped would also have been rated as highly OVER.

9.2.2 General Design of the IJ2 Presentations

The IJ2 presentations focus on an examination of the dynamic functional control predictions of fSupport (involving object y functionally supporting object x from the force of gravity) that are suggested to underpin ON. The IJ2 experiment tests these predictions using Support Groups and Tilt Groups. In the Support Groups subjects were asked to rate whether the referent weight would remain in position or change position if the relatum was removed. In the Tilt Groups subjects were asked to rate whether the referent ball was remain in position or change position after a suggested tilt. The same scenes used in the PREP3 presentations focusing on the locative ON were used in these Independent Judgement presentations. fSupport dynamic predictions were examined using the following ANOVA designs: Secondary Support, Primary Support and Tension of Secondary Support (2x2x3) and Ball Effects and Tilt (3x3). Correlations were then carried out between ratings of No Change after suggested movement and confidence of ON found for each of these ANOVA designs. It is predicted that referents that alter position after the suggested movement will also have been rated as highly ON in the PREP3 experiment.

9.2.3 Data Analysis

Finally in this general design section it should be noted that binary data resulted from these experiments. It is recognised that such data are nominal in nature and therefore non-parametric chi-squares were carried out on the scenes used for these Independent Judgement presentations. On the basis of these highly significant results it was decided to proceed and run Analyses of Variance on the data. This was carried out in order to produce identical ANOVA paradigms to the "sister" data found in PREP2 and PREP3 for these Independent Judgement scenes. It also allowed for the examination of complex interactions. These studies will be reported using parametric statistics but the chi-square results will also be reported at the end of each study to show the non-parametric significance levels. In all these studies ratings of Result A (No Change after movement) were coded as 0 and ratings of Result B (Change after movement) were coded as 1. All repeat scenes (presented to examine consistency over time) resulted in insignificant t-values. This showed that subjects confidence was consistent over time.

9.3 The IJ1 Presentations

9.3.1 Introduction

The IJ1 presentations focus on the inherently dynamic controls suggested to be operating within fContainment and fSuperiority. No direct examination of spatial prepositional usage is involved, rather I am interested in the effect of types of movement on subjects perception of a range of ping-pong ball and bowl scenes previously used to examine prepositional usage in PREP2. Mean values are presented in Appendix R. As should be now familiar it is suggested that the controls operating in the use of spatial prepositions are inherently dynamic and therefore allow one to make various predictions.

In a series of IJ1 presentations which I term the "Lateral Groups" I examined whether subjects thought that various ball and bowl manipulations, originally the scenes used in PREP2, would have the potential to move together in a lateral manner. Put simply the prediction of fContainment is that scenes which are capable of moving together will be rated highly as IN. It is therefore predicted that the scenes which were previously rated as highly IN will be rated as having the potential to move together in the suggested lateral manner. Three separate ANOVA designs were used for the IJ1 Lateral Groups presentations.

Another series of IJ1 manipulations termed the "Vertical Groups" examined whether subjects thought the referent ping-pong ball would fall into the area of the bowl after a suggested movement (in such cases this would be if the ball was dropped). The prediction of fSuperiority is that in cases where subjects perceive that the referent ball would fall into the area of the bowl when dropped, due to the force of gravity, they will rate the scene as highly OVER. In connection with this prediction it is suggested that the less functional ABOVE is not as sensitive to such a prediction: scenes where it is perceived that the ball, when dropped, would not fall into the area of the bowl are more likely to be rated as ABOVE. One ANOVA design was used for the IJ1 Vertical Groups presentations. The Method for IJ1 is now presented and each series of presentations from within this experiment are preceded by a separate Design section.

9.3.2 Method for the IJ1 Presentations

9.3.2.1 Subjects

The 67 subjects were undergraduates at the University of Glasgow. All subjects were native English speakers.

9.3.2.2 Apparatus and Materials

Three perspex bowls of increasing size, transparent thread, one black ping-pong ball and several white ping-pong balls were used as materials in this experiment. A black arrow was used as a pointer and green material as the backdrop. The materials were filmed using a Sony DXC M3A television camera, in colour with no sound. After filming the resulting video-tape was edited using an RM-GE 10U editing control unit and a double JVC BR-S610ES VHS video recorder. Fifty eight groupings were used in this experiment. Questionnaire booklets were compiled containing statements with accompanying pictorial descriptions (see Appendix Q). A checklist was also compiled to ensure that the two-dimensional video images were being viewed in the intended manner (see Appendix F). Four groupings were repeated to test for consistency.

9.3.2.3 Stimuli

Fifty-eight groupings were used in this experiment and they can be divided into two types: Lateral Groups and Vertical Groups. The Lateral Groups consisted of four scenes: a Target Scene, a Type of Movement scene, a Result A scene which depicted No Change after Movement and a Result B scene which depicted Change after Movement (referent has fallen out of the bowl). The Vertical Groups consisted of three scenes: a Target Scene, a Result A scene where the ball is shown within the area of the bowl and a Result B scene where the ball is shown outwith the area of the bowl.

The 58 Target Scenes consisted of the previously filmed scenes shown in PREP2 (see Chapter 7). Transparent thread was used in scenes where no other balls were present and the Type of Movement scene was filmed using an empty bowl. Also, scenes depicting either Change after Movement or the ball in/outside the area of the bowl were filmed for each Target Scene. The Target Scene was also used to depict No Change after Movement. The groupings 1-58 were edited onto the tape in a random order. Ten seconds of black were shown between each grouping.

Subjects answered one of two basic statements after viewing each grouping (1-58) as follows:

Lateral Group: "What do you think would happen to this scene if the bowl was moved to the right?"

Vertical Group: "What do you think would happen to this scene if the ball was dropped?"

The Lateral Groups consisted of:

1. Target scene (5 seconds)
One second of black
2. Suggested type of movement (4 seconds)
Two seconds of black
3. Result A - no change in referent ball position after illustrated movement to the right (5 seconds)
One second of black
4. Result B - a change in referent ball position after illustrated movement to the right (5 seconds)

The Vertical Groups consisted of:

1. Target scene (5 seconds)
Two seconds of black
2. Result A - ball(x) has fallen into the area of relatum (y) (5 seconds)
One second of black
3. Result B - ball(x) has fallen outside the area of relatum (y) (5 seconds)

There were two suggested outcomes for the Target Scene and the subjects had to choose which was the most likely to happen after the suggested movement. A binary judgement was made by ticking either Result A or Result B. A Lateral Group and Vertical Group example is given in Figure 9.1.

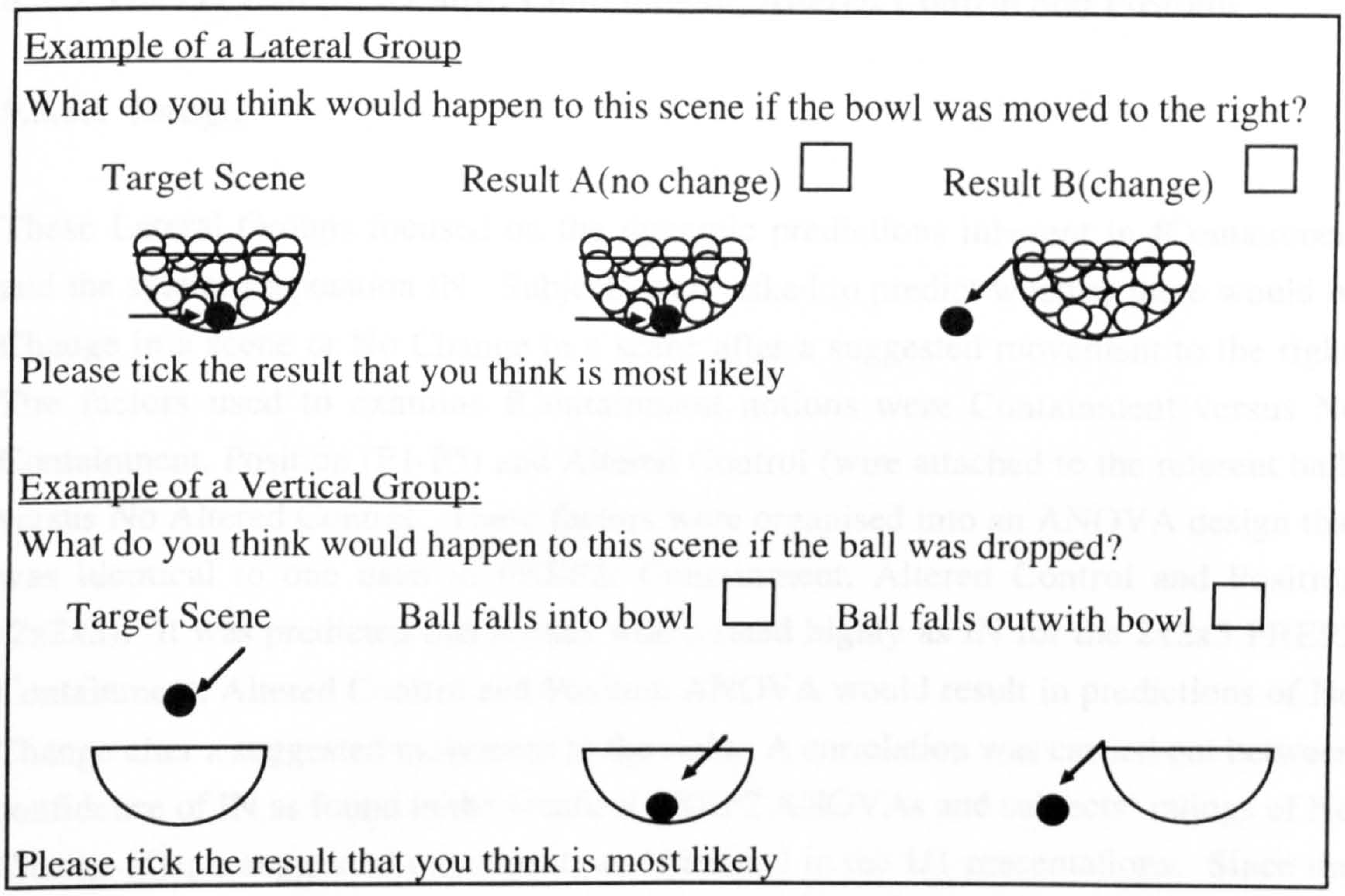


Figure 9.1 - Example of Independent Judgement Groupings from IJ1.

A checklist containing the basic types of scenes was used in this study (see Appendix F). Subjects were asked questions such as "Is the ball touching the rim of the bowl?" or "Is the ball inside the bowl?" in order to check that subjects were viewing the two-dimensional video images in the intended way i.e. the way they would actually appear in a three-dimensional world.

9.3.2.4 Procedure

The subjects were tested in a group situation and each received an identical questionnaire and checklist. The checklist and accompanying video were completed first to make sure that the subjects agreed on what was visually represented on the screen. The instructions on the questionnaire were explained verbally and subjects were able to ask any questions about the procedure. Each grouping was preceded by a numbered caption and the number of each grouping was called out to the subjects. After the experiment the questionnaires were collected from each subject.

9.3.3 The IJ1 Lateral Groups: Containment, Altered Control and Position

9.3.3.1 Design

These Lateral Groups focused on the dynamic predictions inherent in fContainment and the spatial preposition IN. Subjects were asked to predict whether there would be Change in a scene or No Change in a scene after a suggested movement to the right. The factors used to examine fContainment notions were Containment versus No Containment, Position (P1-P5) and Altered Control (wire attached to the referent ball) versus No Altered Control. These factors were organised into an ANOVA design that was identical to one used in PREP2: Containment, Altered Control and Position (2x2x5). It was predicted that scenes which rated highly as IN for the 2x2x5 PREP2 Containment, Altered Control and Position ANOVA would result in predictions of No Change after a suggested movement to the right. A correlation was carried out between confidence of IN as found in the identical PREP2 ANOVAs and subjects' ratings of No Change after a suggested movement, as examined in the IJ1 presentations. Since the basic premise is that scenes rated highly as IN are actually predicted, in part, by the dynamic control that x and y can move together in a correlated way, then it is hypothesised that a strong correlation should be found between high confidence of IN and high ratings of "No Change" in the ball/bowl scene after a suggested correlated movement. A correlation examining the relationship between No Change after movement and the locative ON was also carried out. It is predicted that this will only result in a weak correlation as the dynamic predictions tested were related to IN.

9.3.3.2 Results

The IJ1 scores for groupings 25, 55, 42, 52, 18, 19, 26, 4, 31, 47, 8, 20, 6, 22, 29, 7, 2, 21, 51 and 56 (see Appendix Q for pictorial descriptions) were subjected to a repeated measures 2x2x5 ANOVA. This IJ1 ANOVA focused on the same 20 scenes as the 2x2x5 PREP2 Containment ANOVA. All preposition comparisons relate to this identical paradigm. The mean confidence scores for change after movement are shown in Figure 9.2. The reliable main effects and interactions are listed in Table 9.1.

Reliable Main Effects and Interactions for Indpependent Judgements 2x2x5 Containment	
Wire(altered control)	F(1,66) = 32.57, MSe = 0.41, p<0.0001
Containment	F(1,66) = 98.36, MSe = 0.21, p<0.0001
Position	F(4,264) = 88.91, MSe = 0.16, p<0.0001
WireXCont	F(1,66) = 9.32, MSe = 0.15, p<0.01
WireXPos	F(4,264) = 9.994, MSe = 0.1, p<0.0001
ContXPos	F(2,264) = 20.04, MSe = 0.1, p<0.0001
WireXContXPos	F(2,264) = 10.09, MSe = 0.12, p<0.0001

Table 9.1 - Significant Results for the IJ1 Containment ANOVA.

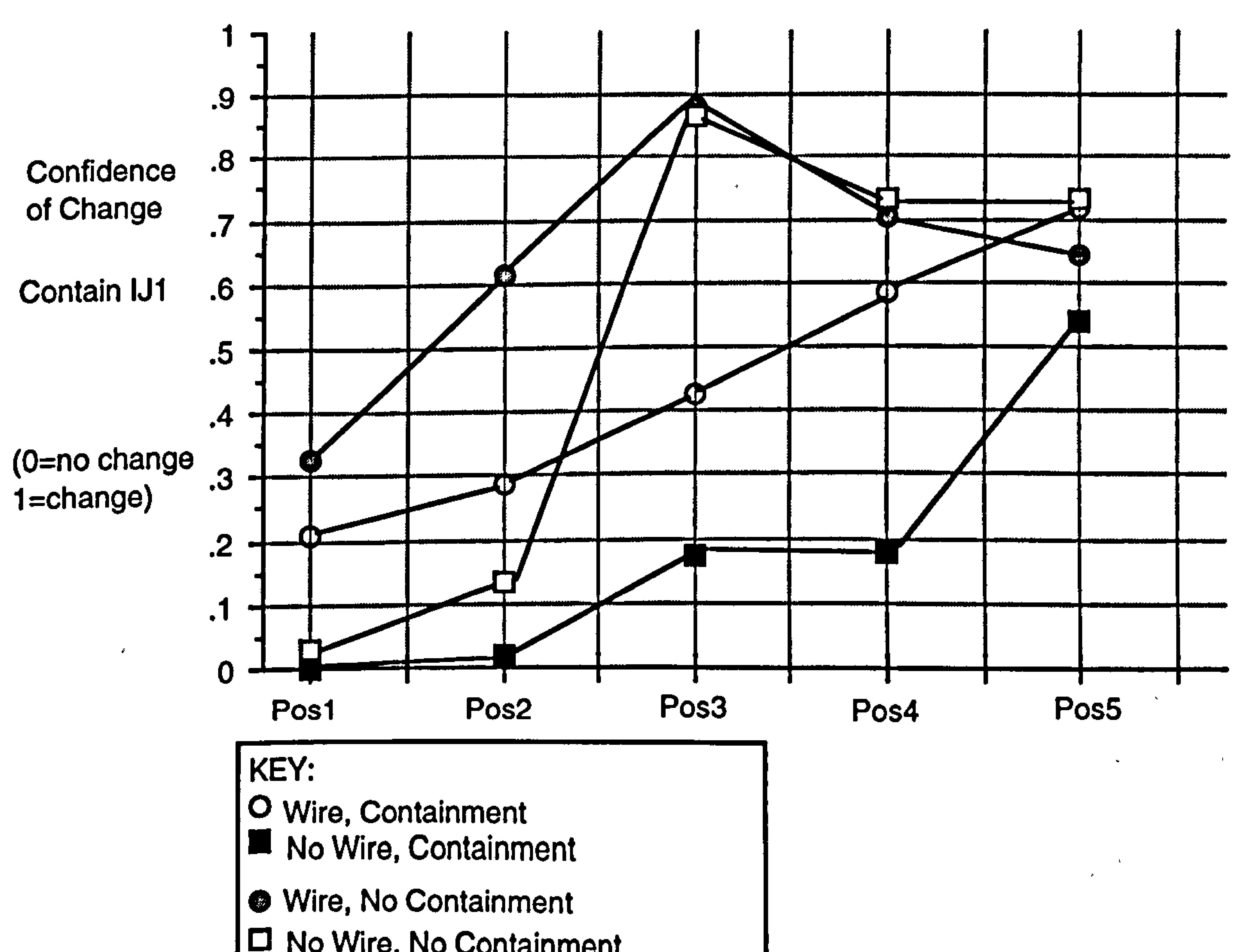


Figure 9.2 - The Combined Effect of Containment, Altered Control and Position on Confidence of Change after Movement for IJ1.

As expected all manipulations had an effect on judgements of potential movement. Having the target ball attached to a piece of wire (altered control) reduced subjects confidence that the ball and bowl could move together (wire = 0.542, no wire = 0.343). This result provides evidence to support the claim that reduced IN confidence found with altered control is because the ball is perceived as less likely to be able to move with the bowl. There is a combined effect of Wire and Position for positions 1 to 4 ($F(1,264) > 11.74$, $p<0.001$ for all four cases). Subjects were increasingly confident of a change after movement as height of ball to bowl increased. As with the corresponding PREP2 ANOVA there is an effect of wire on non-spatial positions 3 and 4, but not on non-spatial 5. Subjects were more confident of a Change for positions 1 and 2 when wire was present.

The main effect of Containment was significant (containment = 0.319, no containment = 0.566). Subjects were more confident of a change after movement when there was no containment present for positions 2, 3 and 4 ($F(1,264) > 25.514$, $p<0.0001$ in all three cases). As expected the presence of an altered control dramatically reduces confidence of No Change for the non-spatial containment scenes ($F(1,264) > 9.06$, $p=0.003$ for all three cases).

The main effect of Position was, not surprisingly, highly significant (P1 = 0.142, P2 = 0.261, P3 = 0.604, P4 = 0.604, P5 = 0.657). Subjects became increasingly more confident of change as position of ball to bowl increased. Change in position from P1 to P2 produced reliable differences in proportion ($F(1,264) = 12.27$, $p<0.0001$), as did the transitions from P2 to P3 ($F(1,264) = 101.4$, $p<0.0001$) and P4 to P5 ($F(1,264) = 10.08$, $p=0.002$).

Non-parametric chi-squares were carried out to check the significance levels for the main effects and were all highly significant where expected. Pooled frequency ratings for Change and No Change after movement for containment and no containment scenes resulted in $X_2(1) = 81.36$, $p<0.0001$. As with the ANOVA subjects rated no change after movement significantly more often for the containment scenes. Pooled frequency ratings for Change and No Change after movement for wire versus no wire scenes resulted in $X_2(1) = 52.708$, $p<0.0001$. There was an overall effect of Position, $X_2(4) = 224.506$, $p<0.0001$. The pooled frequency ratings for position 1 and position 2 revealed that more subjects rated No Change for P1 ($X_2(1) = 11.143$, $p<0.0001$). Pooled ratings for P2 and P3 revealed that more subjects rated no change for P2 ($X_2(1) = 62.93$, $p<0.0001$ and the pooled ratings for P4 and P5 revealed that subjects selected a No Change result more often for position 4.

The pattern of results for judgements of IN seem to match the degree to which subjects perceived the static situations as reflecting location control of the container over its contents. In order to examine the relationship between the two sets of results a correlation between mean confidence of IN and mean confidence of No Change after movement was carried out. A near perfect linear relationship was found between the two variables, $r(19) = 0.832$, $p<0.001$ (see Figure 9.3 for this correlation).

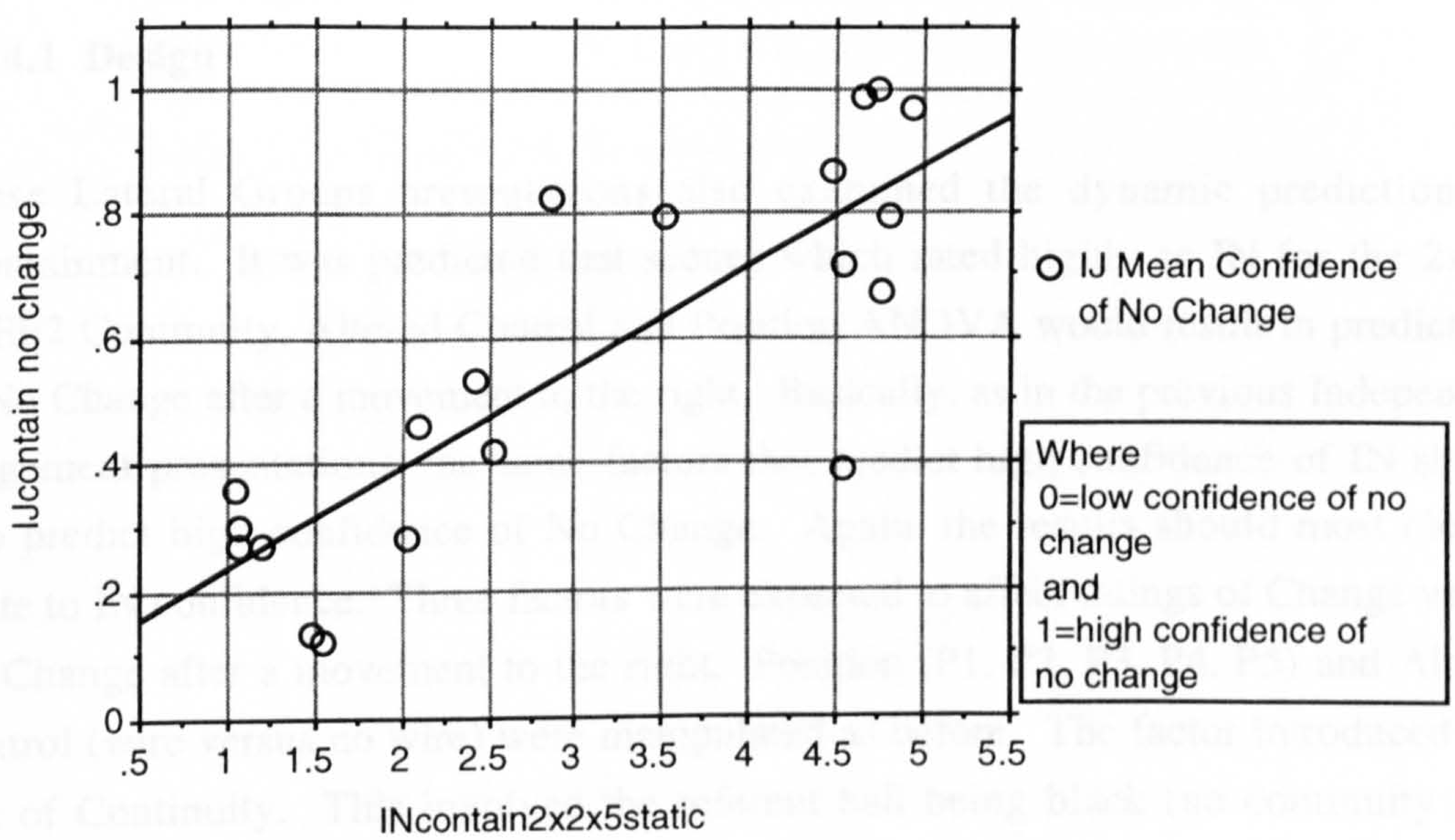


Figure 9.3 - Mean Confidence of IN (PREP2 2x2x5 Containment) Correlated with Mean Confidence of No Change (IJ1 2x2x5 Containment).

Finally, a correlation was carried out between mean confidence of ON for the 2x2x5 Containment ANOVA from PREP2 and the means for confidence of No Change from the independent judgements 2x2x5 for Containment. As would be expected there is no significant correlation ($R(19) = 0.271$ which is not significant at the 0.05 level for critical $R = 0.433$). The potential to move together is not a valid criterion for "on-ness".

9.3.3.3 Discussion

As predicted the main finding was that the more confident subjects were of IN the more likely they would predict No Change after movement. The judgements of location control across a wide range predict confidence in judgements of the use of IN across a wide range. It is argued that this result clearly implicates the notion of location control as part of the representation of the semantics of the spatial preposition IN. As expected there was no correlation between these independent judgements and confidence of ON. The location control that x can move in a correlated manner with y is primarily relevant to the preposition IN. I now turn to further indirect examinations of the factors thought to influence the location control of fContainment.

9.3.4 The IJ1 Lateral Groups: Continuity, Altered Control and Position

9.3.4.1 Design

These Lateral Groups presentations also examined the dynamic predictions of fContainment. It was predicted that scenes which rated highly as IN for the 2x2x5 PREP2 Continuity, Altered Control and Position ANOVA would result in predictions of No Change after a movement to the right. Basically, as in the previous Independent Judgement presentations, the same factors that predict high confidence of IN should also predict high confidence of No Change. Again, the results should most closely relate to IN confidence. Three factors were expected to affect ratings of Change versus No Change after a movement to the right. Position (P1, P2, P3, P4, P5) and Altered Control (wire versus no wire) were manipulated as before. The factor introduced was that of Continuity. This involved the referent ball being black (no continuity with surrounding balls) or the referent ball being white (continuity with other balls). Correlations were then carried out between confidence of both IN and ON and the subjects ratings of No Change after the suggested movement. It was predicted that there would be a strong correlation between IN confidence and high ratings of No Change in the ball/bowl scene after a suggested correlated movement. The correlation involving ON was expected to be weak.

9.3.4.2 Results

The IJ1 scores for groupings 25, 55, 42, 52, 18, 1, 35, 48, 15, 40, 8, 20, 6, 22, 29, 12, 3, 30, 44 and 9 (Appendix Q) were subjected to a repeated measures 2x2x5 ANOVA. This IJ1 ANOVA focused on the same scenes as the PREP2 2x2x5 Continuity ANOVA. All preposition comparisons relate to this identical paradigm. The mean confidence scores for change after movement are shown in Figure 9.4. The reliable main effects and interactions are listed in Table 9.2.

Reliable Main Effects and Interaction for 2x2x5 Continuity IJ1	
Wire(altered control)	F(1,66) = 37.62, MSe = 0.57, p<0.0001
Continuity	F(1,66) = 6.79, MSe = 0.1, p=0.0113
Position	F(4,264) = 57.63, MSe = 0.2, p<0.0001
WireXPos	F(4,264) = 4.21, MSe = 0.14, p=0.003

Table 9.2 - Significant Results for the IJ1 Continuity ANOVA.

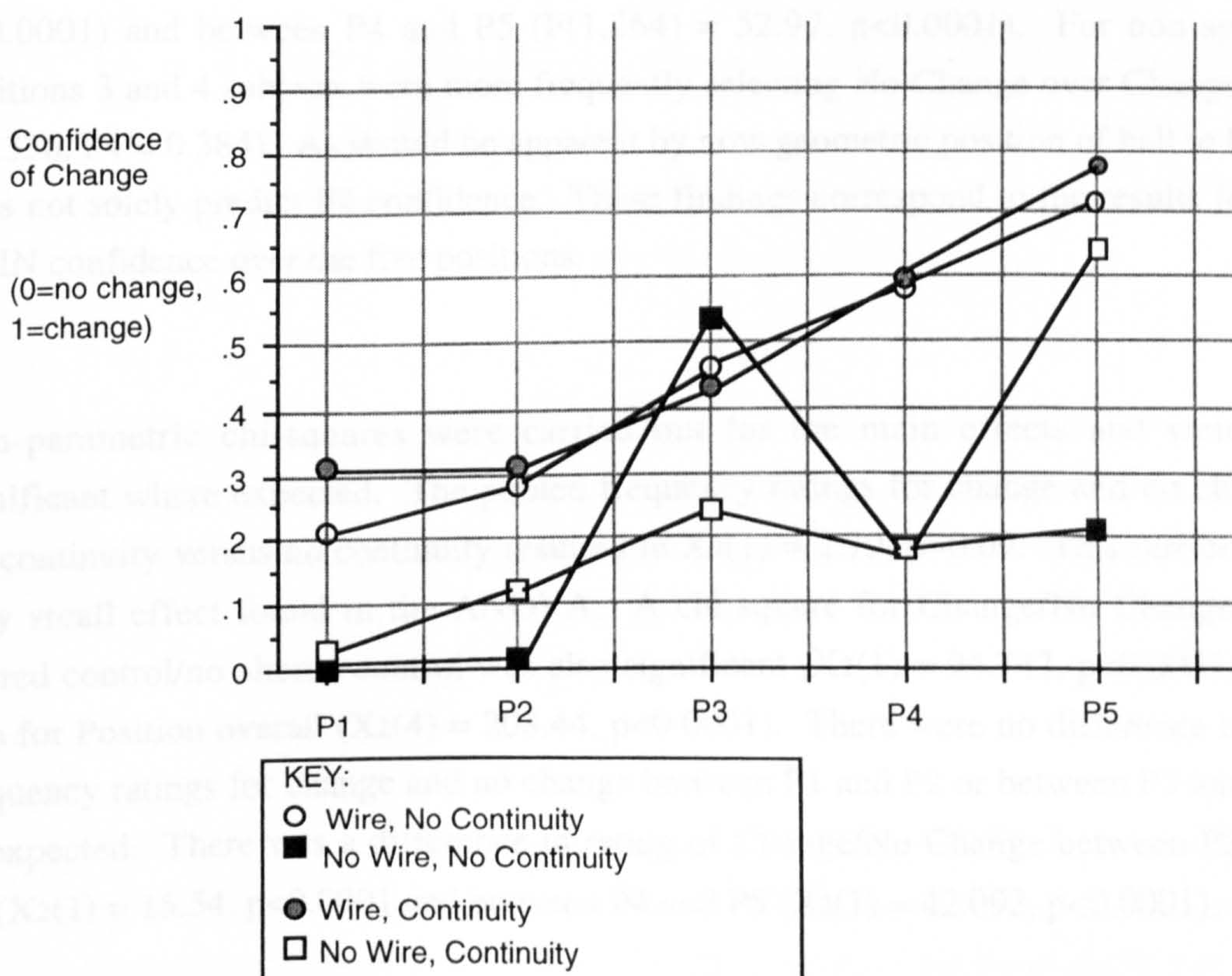


Figure 9.4 - The Combined Effect of Continuity, Altered Control and Position on Confidence of Change after Movement for IJ1.

As in the previous Containment IJ1 ANOVA having the ball secured on a wire (Altered Control) dramatically increases the number of subjects who thought there would be a Change after movement to the right (wire = 0.469, no wire = 0.215). Indeed, the effect of Altered Control is significant over all 5 positions ($F(1,264) = 11.669$, $p<0.001$). This is seen most dramatically for position 4 (wire = 0.590, no wire = 0.179). This non-spatial position depends on functional factors for IN confidence and the altered control significantly weakens the control provided by fContainment.

The Continuity manipulation resulted in increased confidence of change after movement when continuity was present (continuity = 0.364, no continuity = 0.319). This was a small difference and further analysis revealed that this was only the case for the no wire (no altered control) scenes ($F(1,66) = 5.94$, $p<0.05$).

As expected the main effect of Position was significant. Further analyses revealed that confidence of Change after movement increased between P2 and P3 ($F(1,264) = 15.42$, $p<0.0001$) and between P4 and P5 ($F(1,264) = 52.97$, $p<0.0001$). For non-spatial positions 3 and 4 subjects were more frequently selecting No Change over Change (P3 = 0.336, P4 = 0.384). As should be apparent by now geometric position of ball to bowl does not solely predict IN confidence. These findings correspond to the results found for IN confidence over the five positions.

Non-parametric chi-squares were carried out for the main effects and were all significant where expected. The pooled frequency ratings for change and no change for continuity versus no continuity resulted in $X_2(1) = 2.79$, $p=0.09$. This mirrors the very small effect found in the ANOVA. A chi-square for Change/No Change and altered control/no altered control was also significant ($X_2(1) = 94.742$, $p<0.0001$) and also for Position overall ($X_2(4) = 208.44$, $p<0.0001$). There were no difference in the frequency ratings for change and no change between P1 and P2 or between P3 and P4, as expected. There was a difference in rating of Change/No Change between P2 and P3 ($X_2(1) = 15.54$, $p<0.0001$ and between P4 and P5 ($X_2(1) = 42.092$, $p<0.0001$).

Again, the pattern of results found seem to correspond to the degree to which subjects perceive the static situation to reflect location control. In order to examine this relationship a correlation was carried out between mean confidence of IN for the PREP2 2x2x5 Continuity ANOVA and the mean confidence of No Change (the proportion of subjects who predicted that the scene would remain the same after movement). A quantifiable relationship was found where $r(19) = 0.78$, $p<0.0001$. This is a high correlation (see Figure 9.5).

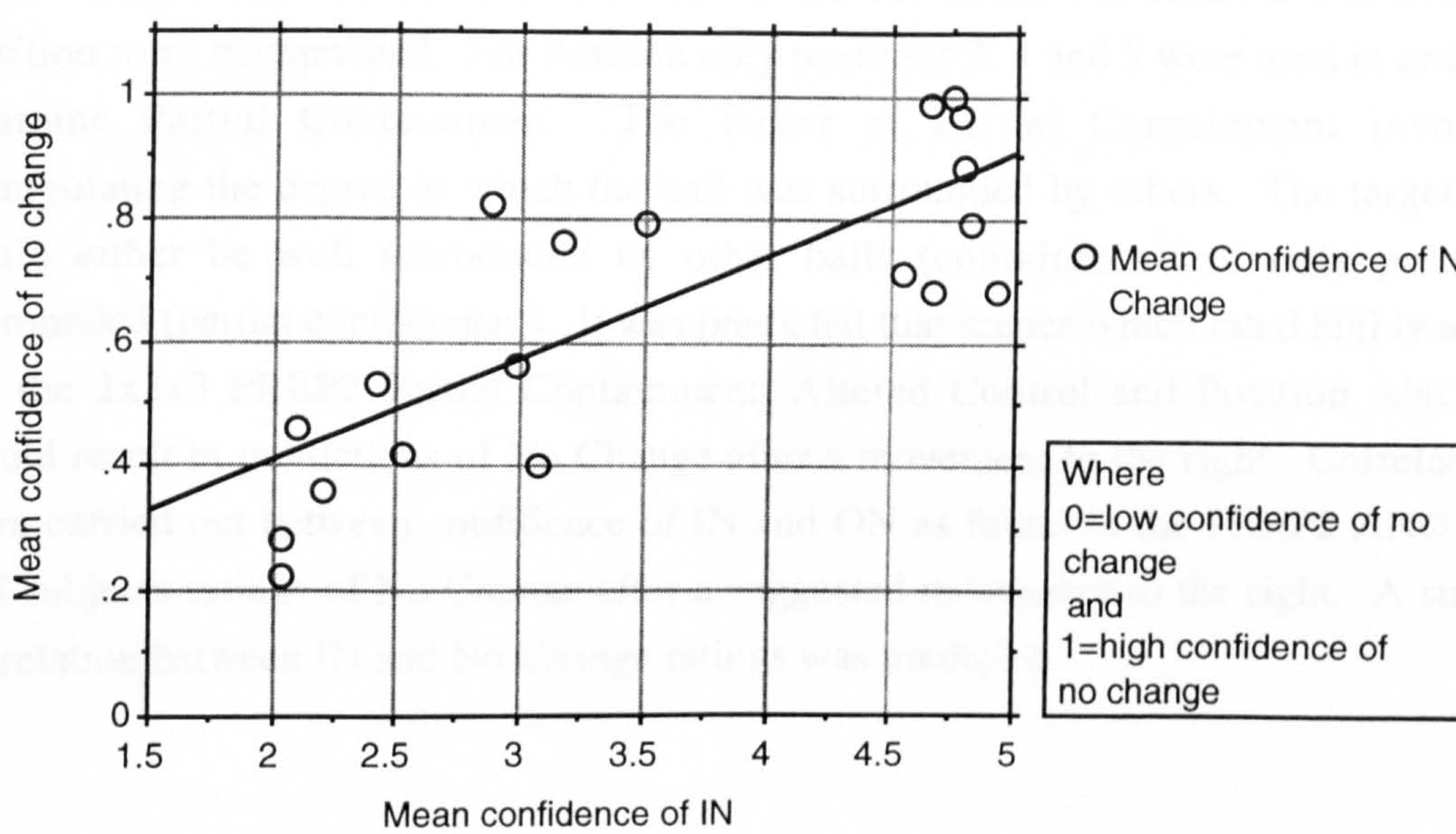


Figure 9.5 - Mean Confidence of IN (PREP2 2x2x5 Continuity) Correlated with Mean Confidence of No Change (IJ1 2x2x5 Continuity).

As expected there was no significant correlation between mean confidence of ON for the 2x2x5 PREP2 ANOVA and confidence of No Change results from the Continuity IJ ANOVA using the same paradigm. $R(19) = 0.412$ and critical $R = 0.433$, $p<0.05$.

9.3.4.3 Discussion

As expected a high correlation was found between confidence of IN and predictions of No Change for these 20 factors. As in the IJ1 Containment, Altered Control and Position presentations the more confident subjects were of IN the more likely they were to predict No Change after a movement to the right. This study provides further evidence that these factors involve the principles of fContainment.

9.3.5 The IJ1 Lateral Groups: Partial Containment, Altered Control and Position

9.3.5.1 Design

These Lateral Groups also focused on the dynamic predictions inherent in fContainment and the locative IN. As before the factors of Altered Control and Position were manipulated. For Position only positions 3, 4 and 5 were used in order to examine Partial Containment. The factor of Partial Containment involved manipulating the degree to which the ball was surrounded by others. The target ball could either be well surrounded by other balls (containment) or only partially surrounded (partial containment). It was predicted that scenes which rated highly as IN for the 2x2x3 PREP2 Partial Containment, Altered Control and Position ANOVA would result in predictions of No Change after a movement to the right. Correlations were carried out between confidence of IN and ON as found in the PREP2 ANOVAs and subjects ratings of No Change after a suggested movement to the right. A strong correlation between IN and No Change ratings was predicted.

9.3.5.2 Results

The IJ mean ratings for groupings 42, 52, 18, 11, 38, 5, 6, 22, 29, 32, 46, and 34 (see Appendix Q for pictorial descriptions) were subjected to a repeated measures 2x2x3 ANOVA. This IJ1 Partial Containment ANOVA focused on the same 12 scenes used for the PREP2 Partial Containment ANOVA. All preposition comparisons related to this identical paradigm. The mean confidence scores for change after movement are shown in Figure 9.6. The reliable main effects and interactions are listed in Table 9.3.

Reliable Main Effects and Interactions for 2x2x3 Partial Containment IJ	
Wire(altered control)	F(1,66) = 37.15, MSe = 0.32, p<0.0001
Containment	F(1,66) = 89.35, MSe = 0.17, p<0.0001
Position	F(2,132) = 67.5, MSe = 0.12, p<0.0001
WireXPos	F(2,132) = 9.18, MSe = 0.13, p<0.001
ContXPos	F(2,132) = 17.48, MSe = 0.1, p<0.0001
WireXContXPos	F(2,132) = 15.464, MSe = 0.1, p<0.0001

Table 9.3 - Significant Results for the IJ1 Partial Containment ANOVA.

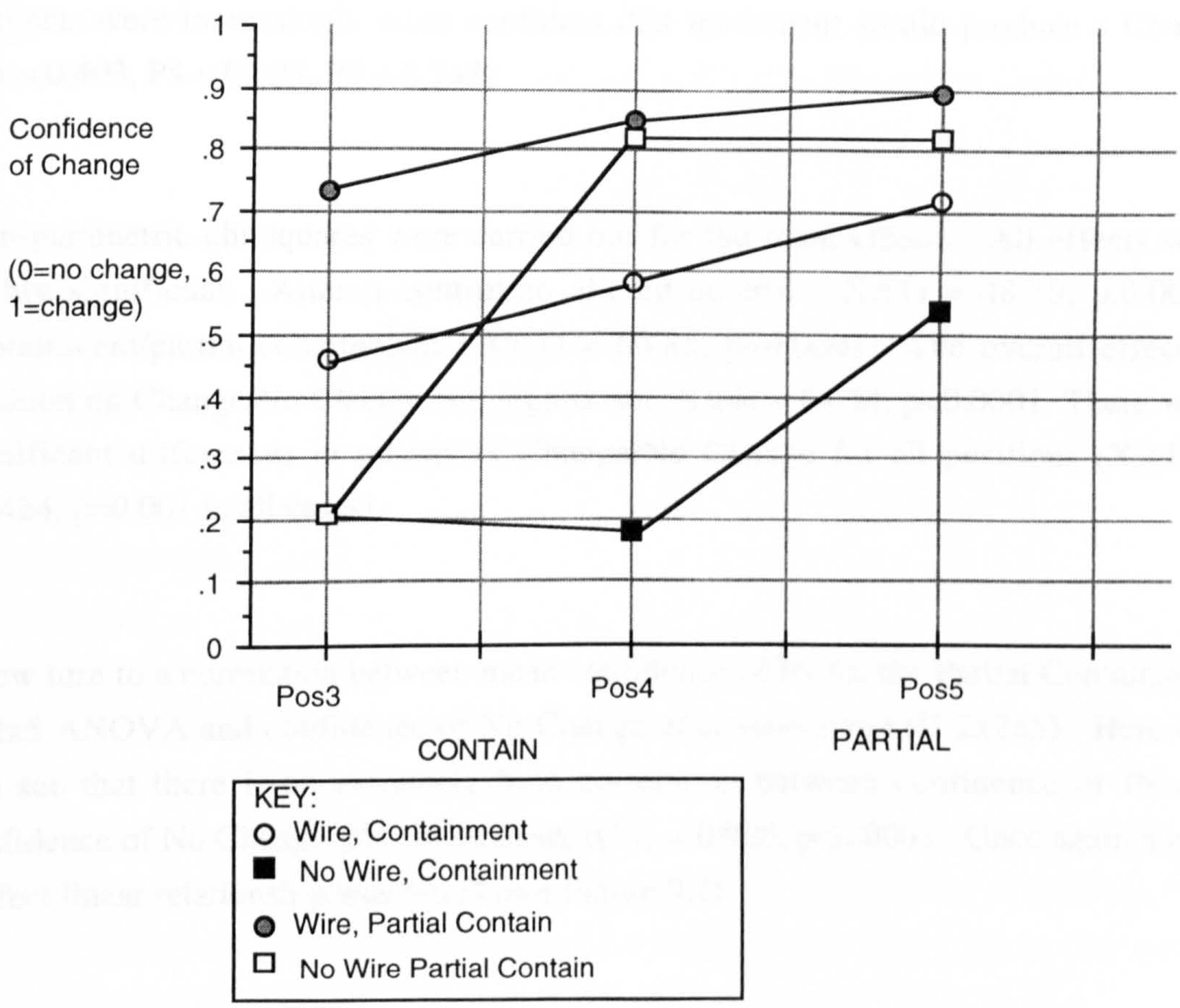


Figure 9.6 - The Combined Effect of Partial Containment, Altered Control and Position on Confidence of Change after Movement for IJ1.

All the expected manipulations produced reliable main effects. Having the ball attached to a piece of wire greatly increased the number of subjects who thought the geometric relation between ball and bowl would alter after the bowl was moved to the right (no altered control = 0.463, altered control = 0.706). This effect of Altered Control was significant over the 5 positions ($F(1,132) > 8.39$, $p<0.01$ for all contrasts). A similar increase was found for the Containment main effect (containment = 0.448, partial containment = 0.721) and further analysis revealed that this effect was for all 5 positions ($F(1,132) > 11.65$, $p<0.001$).

The main effect of Position was significant as expected. A change from position 3 to position 4 produced reliable differences in confidence of Change ($F(1,132) = 48.6$, $p<0.0001$) as did the transition between position 4 and 5 ($F(1,132) = 20.8$, $p<0.0001$). Subjects were increasingly more confident that movement would produce a Change (P3 = 0.403, P4 = 0.608, P5 = 0.743).

Non-parametric chi-squares were carried out for the main effects. All effects were highly significant. Altered control/no altered control - $X_2(1) = 48.19$, p,0.0001, containment/partial containment - $X_2(1) = 60.85$, $p<0.0001$. The overall effect of Position on Change/No Change was significant, $X_2(4) = 64.54$, $p<0.0001$. There were significant differences in ratings of Change/No Change for all positions ($X_2(1) > 10.424$, $p=0.001$ in all cases).

I now turn to a correlation between mean confidence of IN for the Partial Containment 2x2x5 ANOVA and confidence of No Change after movement (IJ 2x2x5). Here one can see that there is an extremely high correlation between confidence of IN and confidence of No Change after movement, $r(11) = 0.926$, $p<0.0001$. Once again a near perfect linear relationship was found (see Figure 9.7).

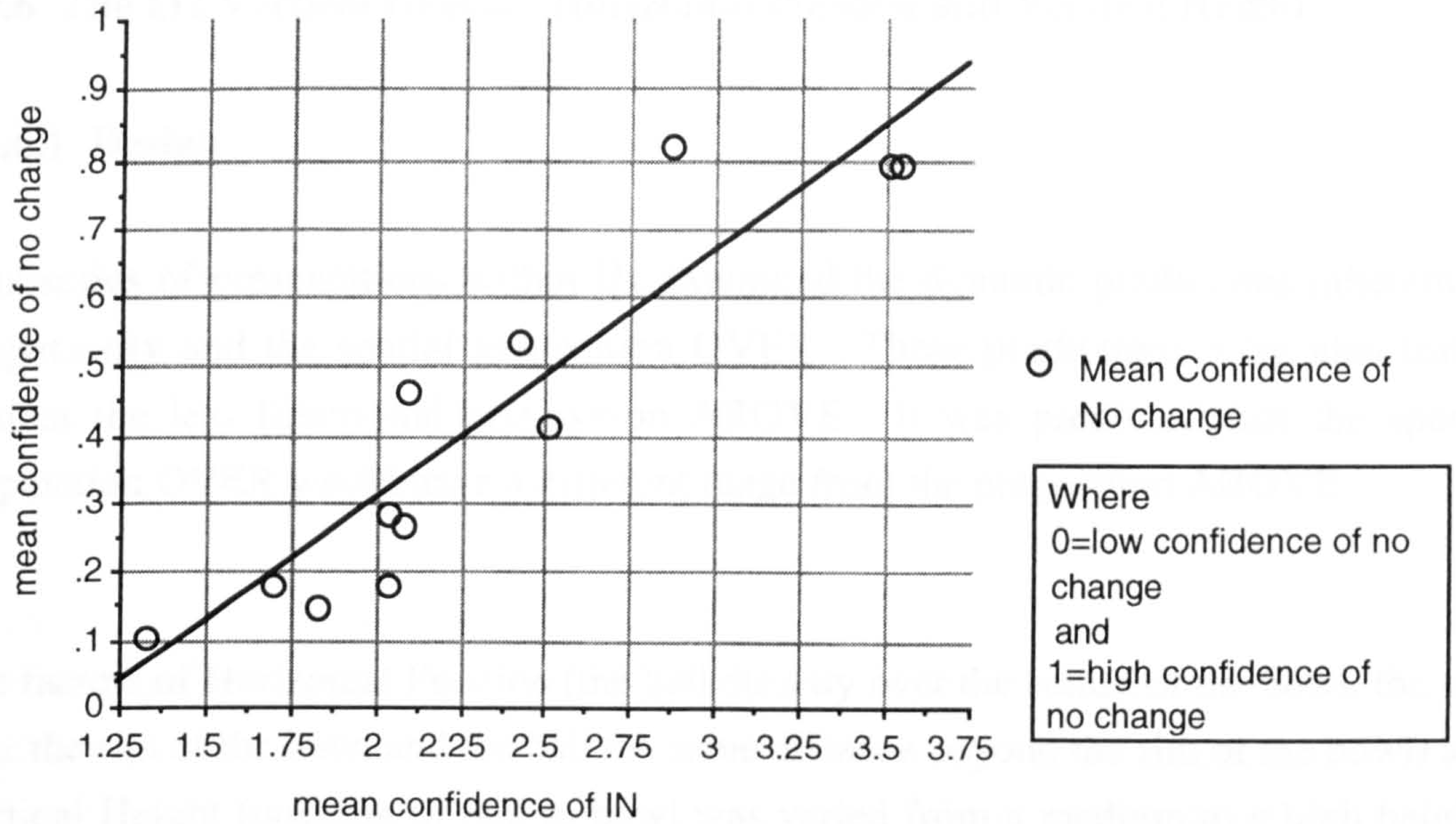


Figure 9.7 - Mean Confidence of IN (PREP2 Partial Containment 2x2x3) Correlated with Mean Confidence of No Change (IJ1 Partial Containment 2x2x3).

The correlation between mean confidence of ON and confidence of No Change after movement was not significant. This was to be expected as ON does not represent such high functional control; functional support does not have to include the potential to move together.

9.3.5.3 Discussion

The Independent Judgement manipulations produced a range of judgements from 18% of subjects predicting change to 90% predicting change across the 12 conditions. The PREP2 ANOVA examining the same scenes found a comparable range of confidence for the use of IN across the 12 conditions. This finding is further understood by the near perfect correlation between confidence of IN and the proportion of subjects who thought there would be No Change after a movement to the right. There is a strong link between the dynamic predictions of fContainment and confidence of IN.

9.3.6 The IJ1 Vertical Groups: Horizontal Position and Vertical Height

9.3.6.1 Design

This series of presentations within IJ1 examined the dynamic predictions inherent in fSuperiority and the spatial preposition OVER. These predictions were also tested against the less functional preposition ABOVE. It was predicted that the spatial preposition OVER would have a different range from the preposition ABOVE.

The factors of Horizontal Position (the ball directly over the centre of the bowl, the ball over the rim of the bowl and the ball the same distance beyond the rim of the bowl) and Vertical Height (position of ball to bowl was varied from a medium to a high height) were varied. These scenes were also used in the PREP2 presentations which directly examined OVER/ABOVE confidence. The factors were organised into a 2x3 ANOVA design. The presentations examined the effect of Vertical Height of the ball and Horizontal Position of the ball on confidence of the ball either falling into the area of the bowl (Result A, coded as 0) or not falling into the area of the bowl (Result B, coded as 1). It was hypothesised that if subjects predict that the referent ball x would fall into the area of the bowl y (Contact), then it will be more likely that the functional preposition OVER will be chosen rather than the less functional spatial preposition ABOVE. ABOVE was chosen more often in the 2x2x3 PREP3 ANOVA (see Chapter 7) and it is expected that this preposition will not be very sensitive to the location control imposed by fSuperiority. Basically, there should be less effect on use of ABOVE, as compared to OVER, when subjects predict that the ball will fall outside the area of the bowl (No Contact).

A correlation was then carried out between subjects confidence in OVER and ABOVE (using identical scenes from PREP2) and ratings of Contact with the bowl after the suggested movement. In this way I was able to examine any differences between OVER and ABOVE relating to these dynamic predictions.

9.3.6.2 Results

Initially a 2x2x3 ANOVA was carried out examining Vertical Height, Horizontal Position and a third factor Sand. This factor of Sand was included because an informal pilot study revealed the possibility that subjects might think that the ball could bounce out of the bowl when released from a height. If this is the case then the addition of scenes with sand in the bowl should prevent any adverse influences on judgements of the ball falling into the area of the bowl. It was found that No Contact with the bowl was found more often when sand was not present. However, this effect was very small and the use of sand really only helped to explain why confidence of the ball falling into the bowl may be slightly higher than expected.

As the effect of Sand was small a 2x3 IJ1 ANOVA examining only Height (medium/high) and Horizontal Position (HP1, HP2, HP3) was used to compare OVER and ABOVE judgements for the 6 basic scenes. These scenes were identical to the 6 scenes repeated in the PREP2 2x2x3 ANOVA examining the effect of these factors on judgements of OVER and also of ABOVE. All preposition comparisons relate to this paradigm. Figure 9.8 shows the proportion of subjects who predicted that the ball would fall outside the area of the bowl for this 2x3 IJ1 ANOVA. The only significant result was for Horizontal Position, $F(2,132) = 71.55$, $MSe = 0.253$, $p<0.0001$. This manipulation was also significant for the OVER and ABOVE ANOVA and, as in the PREP2 2x2x3 ANOVA, the main effect of Height was not significant.

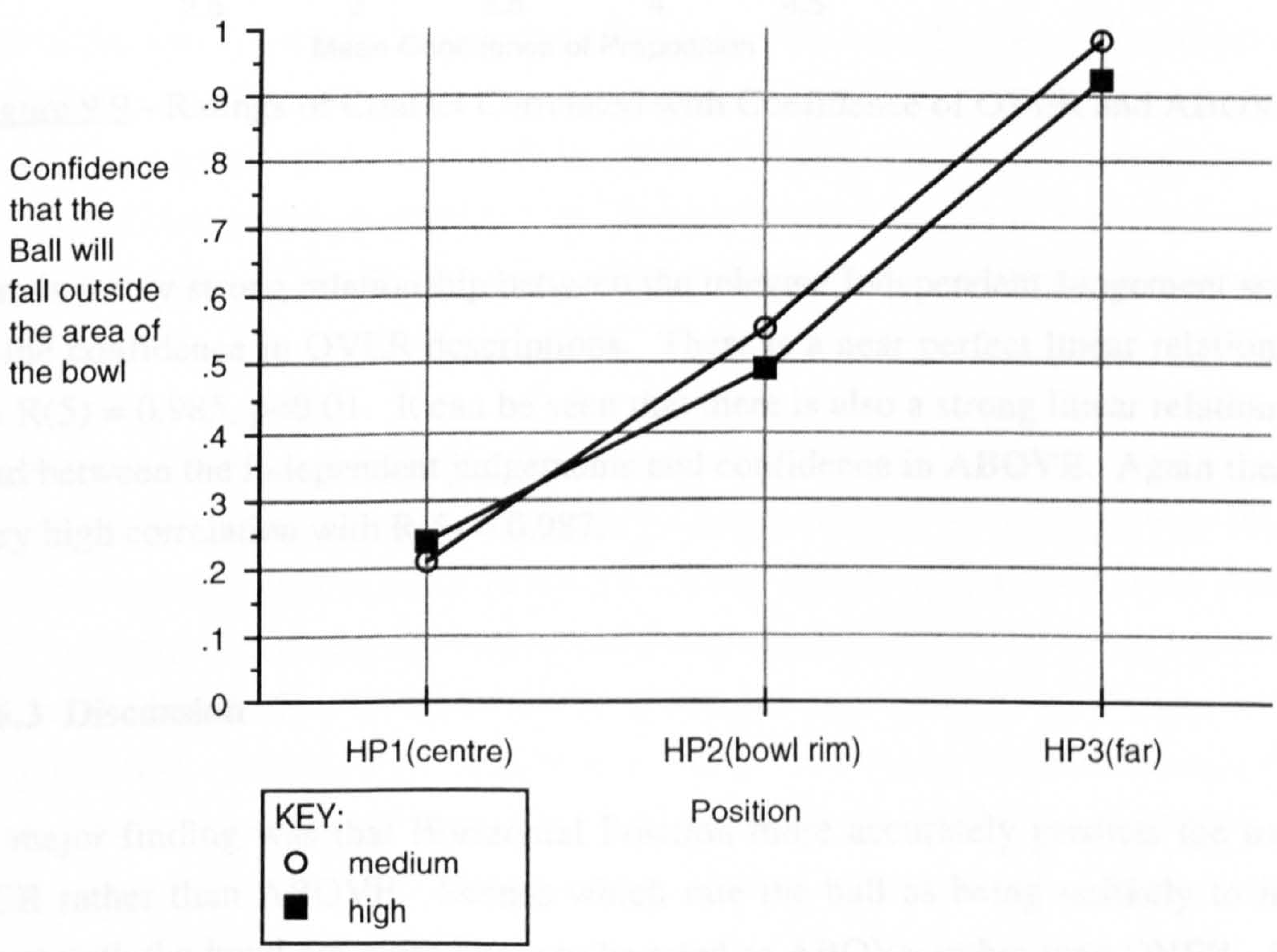


Figure 9.8 - The Combined Effect of Height and Horizontal Position for the IJ1 2x3 ANOVA.

The pattern of results found for OVER and ABOVE judgements seem to reflect the degree to which subjects perceive the static situation to reflect fSuperiority location control. In order to examine this relationship the mean confidence of OVER and also the mean confidence of ABOVE were compared to the proportion of subjects who thought that the ball would fall into the area of the bowl (Contact). The correlation is shown in Figure 9.9.

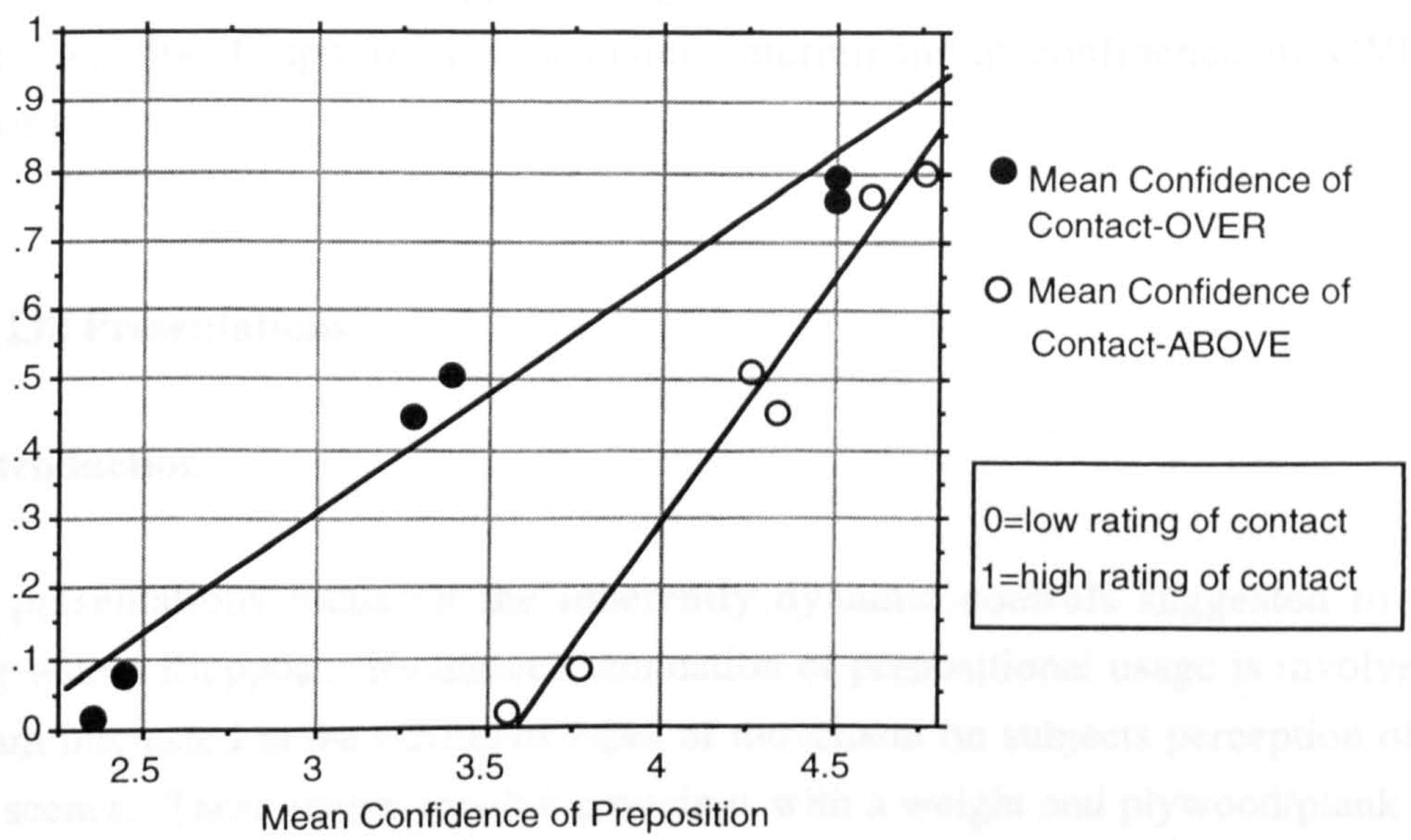


Figure 9.9 - Ratings of Contact Correlated with Confidence of OVER and ABOVE.

There is a very strong relationship between the relevant Independent Judgement scenes and the confidence in OVER descriptions. There is a near perfect linear relationship with $R(5) = 0.985$, $p<0.01$. It can be seen that there is also a strong linear relationship found between the independent judgements and confidence in ABOVE. Again there is a very high correlation with $R(5) = 0.987$.

9.3.6.3 Discussion

The major finding was that Horizontal Position more accurately predicts the use of OVER rather than ABOVE. Scenes which rate the ball as being unlikely to make contact with the bowl are more likely to be rated as ABOVE rather than OVER. High confidence of OVER only occurs when the principle of fSuperiority can be deemed to be in operation.

Both OVER and ABOVE correlate highly with judgements of contact between ball and bowl. This occurs because the judgements are most strongly influenced by position and, as was discussed in Chapter 7, this effects confidence for both OVER and ABOVE. However, it must be noted that the Independent Judgement confidences predict the OVER data across twice the range of the ABOVE data. This is consistent with the idea that fSuperiority is a major determinant in confidence of OVER descriptions.

9.4 The IJ2 Presentations

9.4.1 Introduction

The IJ2 presentations focus on the inherently dynamic controls suggested to be operating within fSupport. No direct examination of prepositional usage is involved, rather I am interested in the effects of types of movement on subjects perception of a range of scenes. These scenes involve groupings with a weight and plywood/plank of wood and grouping with a ping-pong ball and a plank of wood. This series of presentations involved an examination of the dynamic predictions associated with fSupport and the spatial preposition ON. These presentations can be separated into Tilt Groups and Support Groups. Scenes used were identical to those presented in PREP3.

The Support Groups examined whether subjects thought a referent weight would remain in position (No Change) or change position (Change) after the primary support was removed (plywood or plank of wood). In the Tilt Groups subjects were asked to predict whether the ping-pong ball would remain in position (No Change) or change position (Change) after a suggested tilt. Mean values are presented in Appendix T. The prediction of fSupport is that scenes where the subject predicts Change when support from the force of gravity is removed will also be rated as highly ON. Correlations were carried out between No Change after suggested movement and confidence of ON.

9.4.2 Method for the IJ2 Presentations

9.4.2.1 Subjects

The 37 subjects were all undergraduates at the University of Glasgow. All subjects were native English speakers.

9.4.2.2 Apparatus and Materials

Basic materials used were a 2 kilogram weight, a ping-pong ball, transparent thread, wood, plywood, chain, thread, household wire and string. The materials were filmed using a Sony DXC M3A television camera, in colour with no sound. After filming the resulting video-tape was edited using an RM-GE 10U editing control unit and a double JVC BR-S610ES VHS video recorder. Forty-four groupings were presented in this experiment. Four examples were also included to familiarise the subjects with experimental procedure. Questionnaire booklets were compiled containing statements with accompanying pictorial descriptions (see Appendix S). Five groupings were repeated to test for consistency.

9.4.2.3 Stimuli

Of the 44 groupings presented 21 were utilised in two separate designs. The groups used can be divided into two types: Support Groups and Tilt Groups. The Support Groups consisted of three scenes: a Target Scene, a Result A scene which depicted No Change after Primary Support (plywood or board) was removed and a Result B scene which depicted a Change after Primary Support was removed. The Tilt Groups consisted of four scenes: a Target Scene, a Type of Movement scene, a Result A scene which depicted No Change after a suggested tilt and a Result B scene which depicted Change after a suggested tilt (referent ball is no longer in contact with the relatum).

The Target Scenes used consisted of the previously filmed scenes shown in PREP3 (see Chapter 7). Type of movement scenes depicting suggested tilt and scenes depicting Change/No Change after the primary support is removed and No

Change/Change after a suggested tilt were filmed. The groupings were edited onto the tape in a random order and ten seconds of black were shown in between each grouping.

Subjects answered one of two basic statements after viewing each grouping as follows:

Support Group: "What do you think would happen if the plywood/plank of wood [Primary support type] was removed?"

Tilt Group: "What do you think would happen if the plank of wood [Primary support] was tilted, as illustrated?"

For the Tilt Groups the movement was demonstrated before Result A and Result B were presented.

The Support Groups consisted of:

1. Target Scene (5 seconds)
Two seconds of black
2. Result A - No Change in position of the weight after primary support is removed (5 seconds)
One second of black
3. Result B - Change in position of weight after primary support is removed (5 seconds)

The Tilt Groups consisted of:

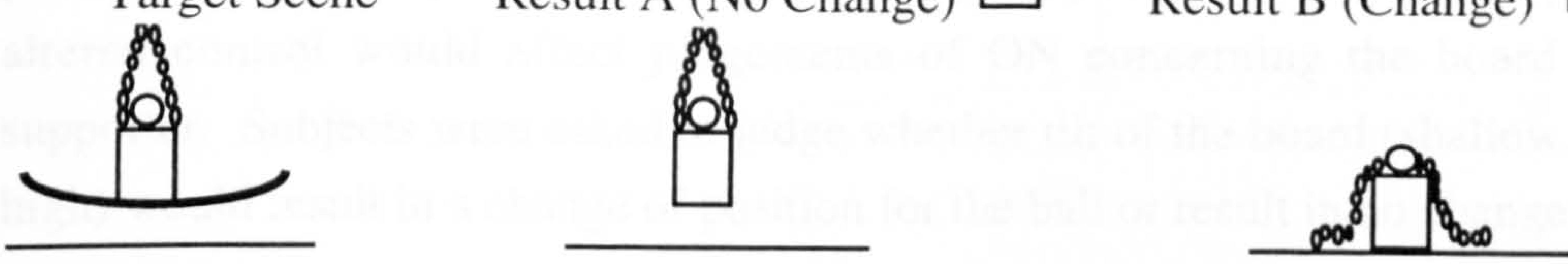
1. Target Scene - (5 seconds)
One second of black
2. Suggested movement (Tilt of primary support) (5 seconds)
Two seconds of black
3. Result A - No change - referent ball remains in position after Tilt (5 seconds)
One second of black
4. Result B - Change - referent ball changes position after Tilt (5 seconds)

There were two suggested outcomes for the Target Scenes and subjects had to choose which was the most likely to happen after the suggested movement. A binary judgement was made by ticking either Result A or Result B. A Support Group and Tilt Group example is presented in Figure 9.10.

Example of a Support Group

What do you think would happen if the **plywood** was removed?

Target Scene | Result A (No Change) ☐ | Result B (Change) ☐



Example of a Tilt Group

(13) What do you think would happen if the **plank of wood** was tilted, as illustrated?

Target Scene | Result A (No change after tilt) ☐ | Result B (Change after tilt) ☐

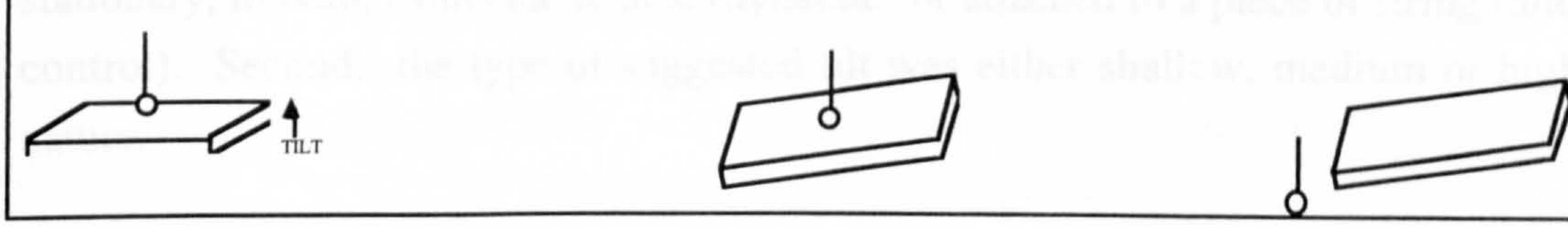


Figure 9.10 - Example of Independent Judgement Groupings from IJ2.

9.4.2.4 Procedure

The subjects were tested in a group situation and each received an identical questionnaire. These instructions on the questionnaire were explained verbally. and subjects were able to ask any questions about the procedure. Each grouping was preceded by a numbered caption and the number of each grouping was called out to the subjects. At the beginning of the tape a scene was shown depicting the types of material used to ensure that subjects were aware of their strength and capacity. Subjects were verbally instructed that the relatums (for example, the board and plywood) were being supported off-camera. After the experiment the questionnaires were collected from each subject.

9.4.3 The IJ2 Tilt Groups: Ball Effects and Tilt

9.4.3.1 Design

The prediction of fSupport is that support is with respect to the force of gravity and that this functional support must be present for a language user to select ON. In this series of Tilt Group presentations is predicted that a suggested tilt of the primary support (a plank of wood) will result in predictions relating to the previous Preposition experiment examining ON (PREP3). Scenes rated as having the referent ball changing position after a tilt will have been rated as highly ON in the PREP3 experiment. It was predicted that manipulation of the referent ping-pong ball involving dynamics and altered control would affect judgements of ON concerning the board as primary supporter. Subjects were asked to judge whether tilt of the board (shallow, medium or high) would result in a change of position for the ball or result in no change in position.

Two factors were expected to have an effect on ratings of Change versus No Change after the suggested movement of the board. First, the referent ball was either stationary, moving from side to side (dynamic) or attached to a piece of string (altered control). Second, the type of suggested tilt was either shallow, medium or high in nature.

9.4.3.2 Results

IJ2 scores 25, 35, 3, 13, 41, 31, 19, 29 and 38 were subjected to a repeated measures 3x3 ANOVA (see Appendix S). This IJ2 Ball Effects ANOVA focused on the same 9 scenes used for the PREP3 Ball Effects ANOVA. All preposition comparisons related to this identical paradigm. The mean confidence scores for change after tilt are shown in Figure 9.11 and the reliable main effect is shown in Table 9.4.

Reliable Main Effect for IJ2 - 3x3	
Ball Effects	$F(2,36) = 73.9$, $MSe = 0.27$, $p<0.0001$

Table 9.4 - Significant Result for the 3x3 IJ2 ANOVA.

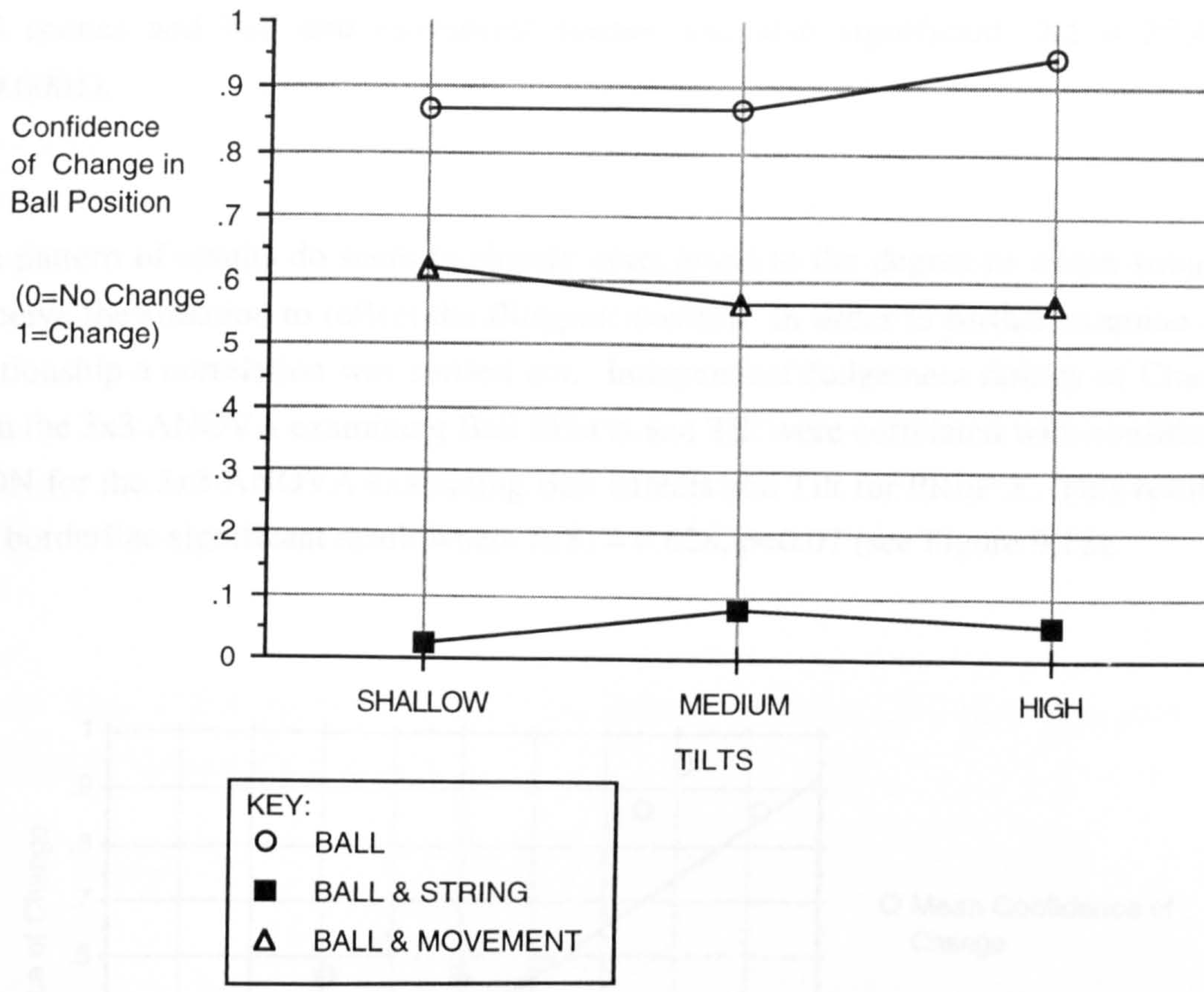


Figure 9.11 - The Combined Effect of Ball Effects and Tilt on Confidence of Change for IJ2.

The only significant result was for Ball Effects. Subjects were most likely to predict a change in position after tilt when the ball was stationary as compared to the ball with altered control and the dynamic ball ($F(1,36) > 19.29$). Subjects were more confident of No Change after a tilt when altered control was present. These results correspond with the ON results found for the 3x3 PREP3 study.

Non-parametric chi-squares were carried on these 9 scenes. As expected the pooled frequency data revealed that there was a significant effect on choice of Change or No Change for stationary ball scenes and ball and string scenes ($X_2(1) = 156.295$, $p<0.0001$). Subjects more frequently selected No Change after a tilt when there was altered control present. Pooled frequency data for ball and string and ball and movement scenes revealed a significant effect on choice of Change or No Change after a tilt ($X_2 = 69.658$, $p<0.0001$). Subjects more frequently selected No Change after a tilt when altered control was present. A chi-square on the pooled data for stationary ball scenes and ball and movement scenes was also significant (X_2 = 25.416, p<0.0001).

The pattern of results do seem to closely correspond to the degree to which subjects perceive the situation to reflect the fSupport control. In order to further examine this relationship a correlation was carried out. Independent Judgement ratings of Change from the 3x3 ANOVA examining Ball Effects and Tilt were correlated with confidence in ON for the 3x3 ANOVA examining Ball Effects and Tilt for PREP 3. This resulted in a borderline significant result where R(8) = 0.628, p=0.07 (see Figure 9.12).

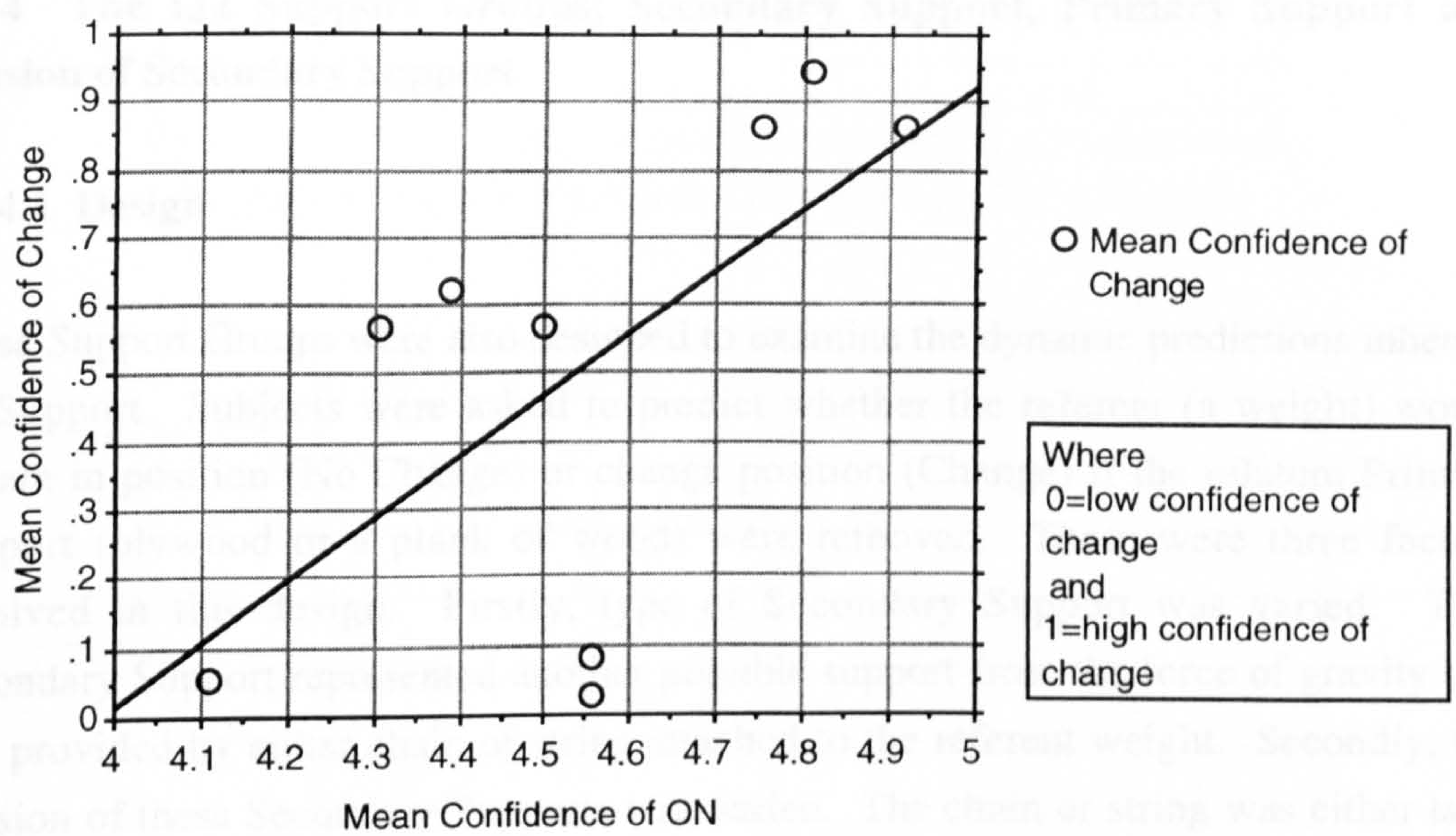


Figure 9.12 - Mean Confidence of ON (PREP3 3x3 Ball Effects) Correlated with Mean Confidence of Change (IJ2 3x3 Ball Effects).

9.4.3.3 Discussion

Only the factor of Ball Effects was significant in the Independent Judgement ANOVA whereas in the PREP3 3x3 ANOVA both Ball Effects and the interaction between Ball Effects and Tilt were significant. It can be seen from Figure 9.12 that, in general, as confidence in ON increases so too does confidence of a Change after the board is seen to tilt. The Stationary ball scenes scored highly for ON and correspondingly were seen as most likely to be affected by a Change when the board was tilted. It is suggested that in such cases perceived functional support by the board is high. It can be seen that in cases where there is altered control (ball and string) that confidence of ON is lower than when there is no altered control (stationary shallow tilt ON = 4.917, Ball and string, shallow tilt ON = 4.556). Correspondingly in the Independent Judgement experiment confidence of a Change after providing altered control is dramatically lower for this scene (stationary, shallow tilt = 0.87; ball and string, shallow tilt = 0.03). It should be noted that the use of dynamic scenes in combinations with indirect testing of judgements of movement somewhat confuses the issue. Subjects are dealing with dynamic information already and are then being asked to further predict what would happen if the scene was tilted.

9.4.4 The IJ2 Support Groups: Secondary Support, Primary Support and Tension of Secondary Support

9.4.4.1 Design

These Support Groups were also designed to examine the dynamic predictions inherent in fSupport. Subjects were asked to predict whether the referent (a weight) would remain in position (No Change) or change position (Change) if the relatum Primary Support (plywood or a plank of wood) were removed. There were three factors involved in this design. Firstly, type of Secondary Support was varied. This Secondary Support represented another possible support from the force of gravity and was provided by either chain or string attached to the referent weight. Secondly, the Tension of these Secondary Supports was varied. The chain or string was either taut, loose or completely off. Subjects were aware that this chain or string was supported off camera in some cases. Thirdly, the type of Primary Support from the force of gravity was either a pliable piece of plywood or a rigid plank of wood. These factors were arranged into a 2x2x3 ANOVA design.

It was predicted that scenes which were rated as highly ON for the identical PREP3 ANOVA would result in predictions of Change after suggested movement. A correlations was carried out between confidence of ON and subjects ratings of No Change after movement. It was predicted that a strong correlation would be found low confidence of ON and ratings of No Change after movement.

9.4.4.2 Results

IJ2 scores 34, 21, 5, 11, 22, 37, 7, 27, 17, 16, 26, 36, 33, 24, 1, 9 and 20 were subjected to a 2x2x3 repeated measures ANOVA (see Appendix S for pictorial representations). This IJ2 Support ANOVA focused on the same 12 scenes used in the PREP3 Support ANOVA. All preposition comparisons related to this identical paradigm. The mean confidence scores for change in position of the weight after the primary support was removed are shown in Figure 9.13. The reliable main effects and interactions are shown in Table 9.5.

Reliable Main Effects and Interaction for 2x2x3 IJ2	
Secondary Support	$F(1,36) = 7.99$, $MSe = 18$, $p<0.01$
Tension of Sec.Sup.	$F(2,72) = 77.22$, $MSe = 0.25$, $p<0.0001$
Sec.Sup.XTension	$F(2,72) = 7.45$, $MSe = 0.14$, $p=0.001$

Table 9.5 - Significant Results for the 2x2x3 IJ2 ANOVA.

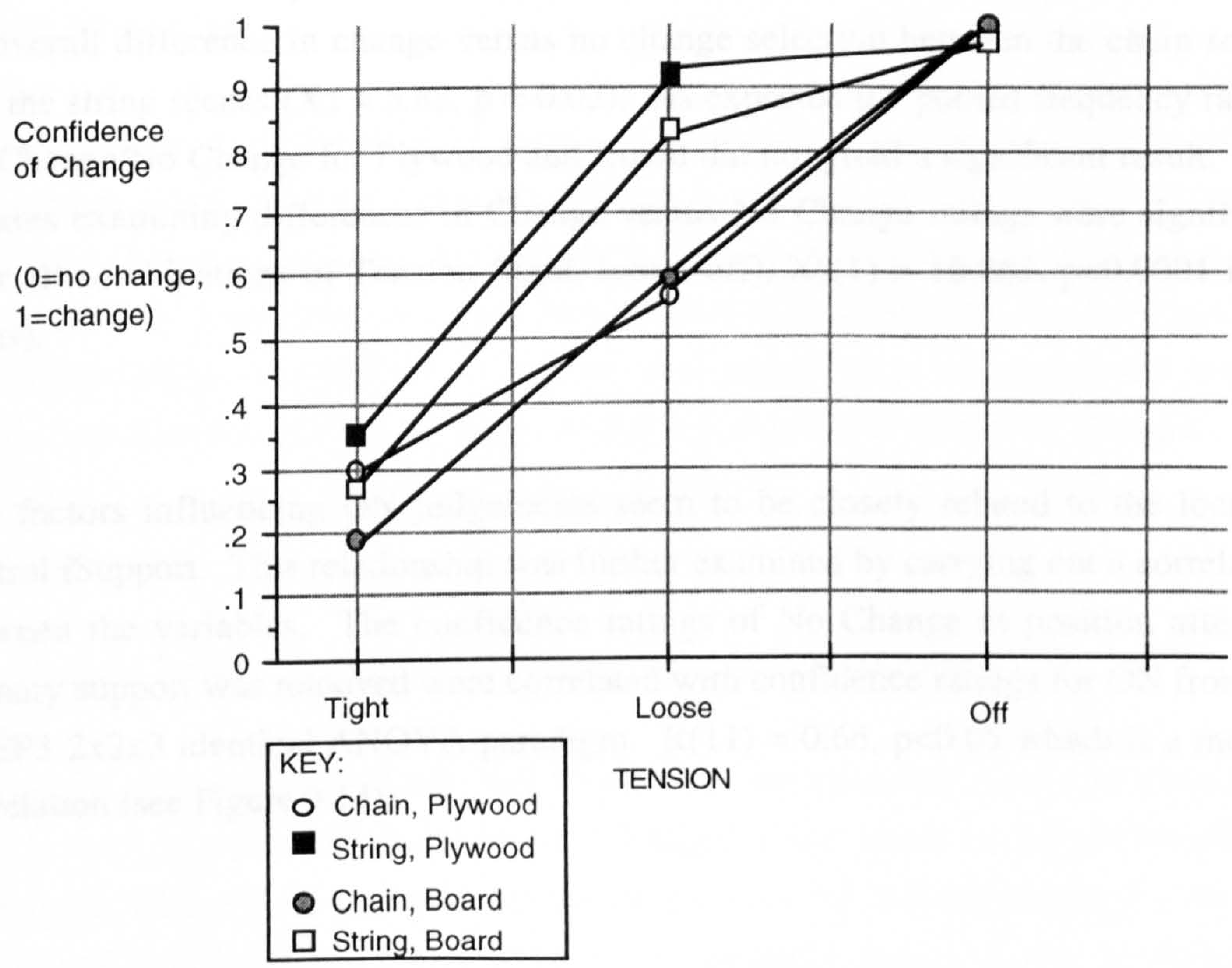


Figure 9.13 - The Combined Effect of Secondary Support, Tension of Secondary Support and Primary Support on Confidence of Change after the Primary Support is Removed.

There was a main effect of Secondary Support. Subjects were more likely to think that the weight (referent) would stay in the same position after the Primary Support (board or plywood) was removed if the Secondary Support was Chain. There was also a main effect of Tension (of Secondary Support). Subjects were more likely to predict that the weight would stay in position if the Secondary Support was taut rather than loose or off ($F(1,72) > 61.32$, $p<0.0001$).

The interaction between Secondary Support and Primary Support revealed that subjects were more confident that the weight would remain in position if chain was the Secondary Support for both types of Primary Support ($F(1,36) > 9.51$, $p<0.01$). However, it is important to note that subjects predict that a change is more likely when string is present versus chain present specifically in the loose condition ($F(1,72) = 23.69$, $p<0.0001$). There are no significant differences between chain and string for the tight and off conditions.

Non-Parametric chi squares were also carried out on this data. As expected there was an overall difference in change versus no change selection between the chain scenes and the string scenes ($X_2 = 5.82$, $p = 0.02$). As expected the pooled frequency ratings for Change/No Change for Plywood and Board did not yield a significant result. Chi-squares examining differences in Change versus No Change ratings were significant over all combinations of Tension (tight, loose, off), $X_2(1) > 16.063$, $p<0.0001$ in all cases).

The factors influencing ON judgements seem to be closely related to the location control fSupport. This relationship was further examined by carrying out a correlation between the variables. The confidence ratings of No Change in position after the primary support was removed were correlated with confidence ratings for ON from the PREP3 2x2x3 identical ANOVA paradigm. $R(11) = 0.66$, $p<0.05$ which is a modest correlation (see Figure 9.14).

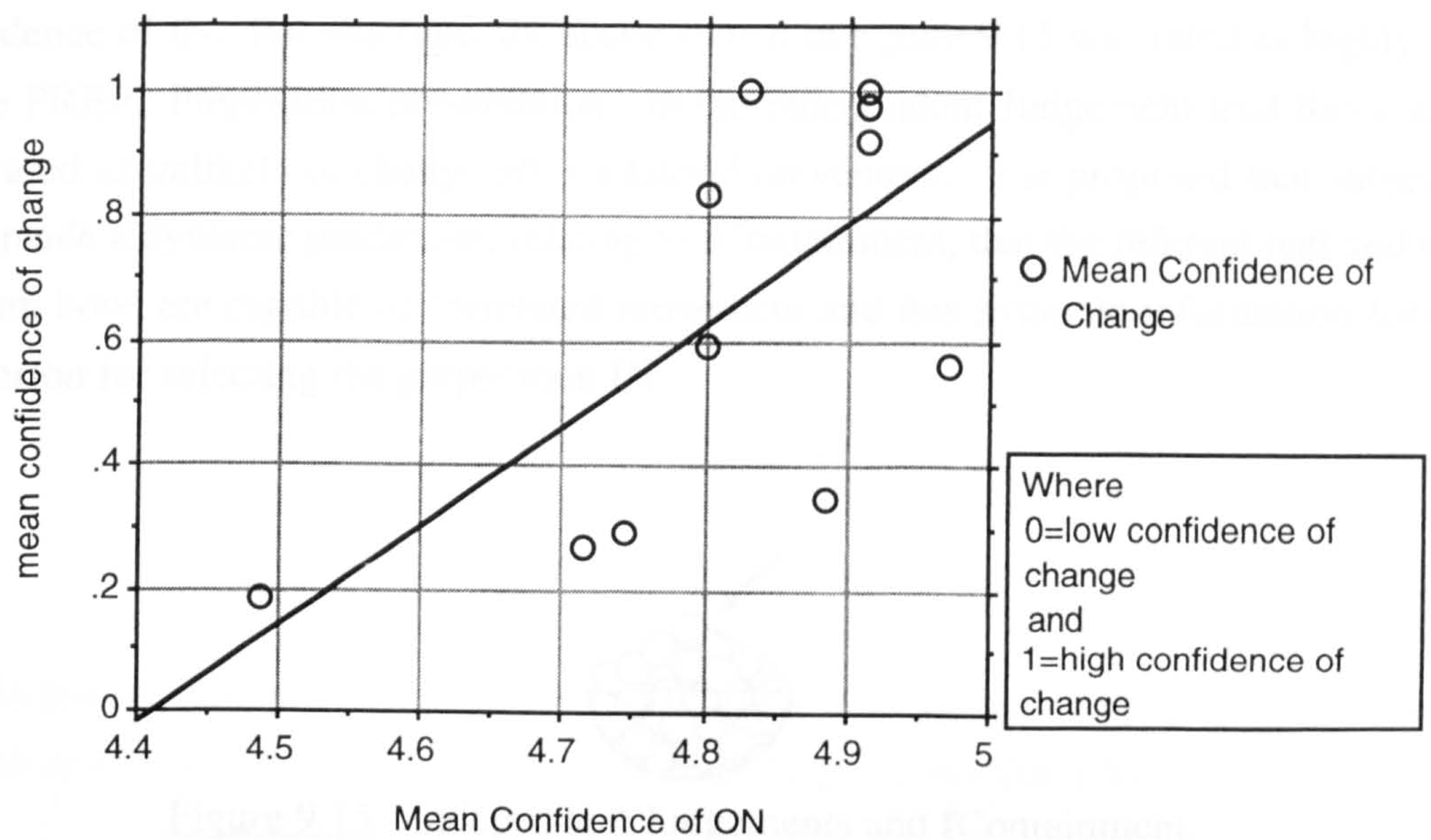


Figure 9.14 - Mean Confidence of ON (PREP3 2x2x3) Correlated with Mean Confidence of Change after Movement (IJ2 2x2x3).

9.4.4.3 Discussion

As can be seen from Figure 9.14 there is a relationship, as predicted, between high confidence of ON and confidence of a Change in position after the Primary Support is removed. If support from the force of gravity can be provided by an alternate source, for example by a taut piece of chain, then subjects will predict No Change in position. Correspondingly, in PREP3 it was found that scenes with taut secondary support reduced confidence of ON. It appears that the functional control of **f**Support is in operation.

9.5 General Summary of the Independent Judgement Results

The range of judgements predicting change for the analysed scenes corresponded closely to a comparable range of confidence for the specific prepositions being examined. This chapter has presented evidence showing that the proposed principles of **f**Containment, **f**Support and **f**Superiority actually appear to be in operation. Manipulation of the various factors that altered preposition confidence correspondingly altered the confidence of the location controls embodied by these principles. I have been able to show that the predictions of correlated movement are closely related to confidence of IN. For example, the scene shown in Figure 9.15 was rated as highly IN in the PREP2 Preposition presentation. In the Independent Judgement trial this scene was rated as unlikely to change after a lateral movement. It is proposed that subjects have made a dynamic prediction, relating to **f**Containment, that the referent ball and the relatum bowl are capable of correlated movement and this dynamic information forms a criterion for selecting the preposition IN.

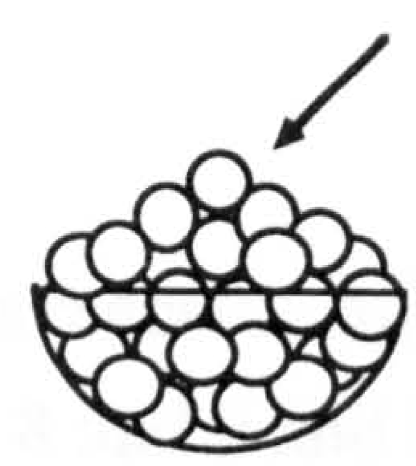


Figure 9.15 - Independent Judgements and **f**Containment.

Similarly predictions of gravitational support are related to confidence of ON. For example, the scene in Figure 9.16 was rated as highly ON in the PREP3 presentation. In the Independent Judgement trial this scene was rated as highly likely to change after the Primary Support (plywood) was removed. It is proposed that subjects have made a dynamic prediction, relating to **f**Support, that the referent weight will no longer be supported by the relatum plywood if this relatum was removed. It is suggested that this dynamic prediction is a criterion for selecting ON.

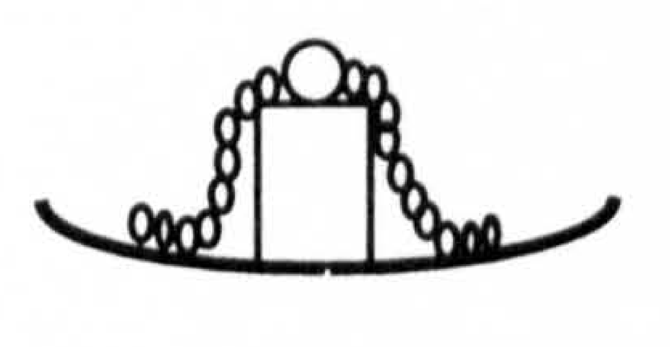


Figure 9.16 - Independent Judgements and **f**Support.

Finally, I have been able to show the dynamic prediction of **f**Superiority is closely related to OVER confidence. For example, the scene shown in Figure 9.17 was rated as highly OVER in a PREP2 preposition presentation. In the Independent Judgement trial this scene was rated as highly likely to fall into the area of the bowl. It is proposed that subjects have made a dynamic prediction, relating to **f**Superiority, that the referent ball would fall into the area of the bowl and this dynamic information forms a criterion for selecting the preposition IN.

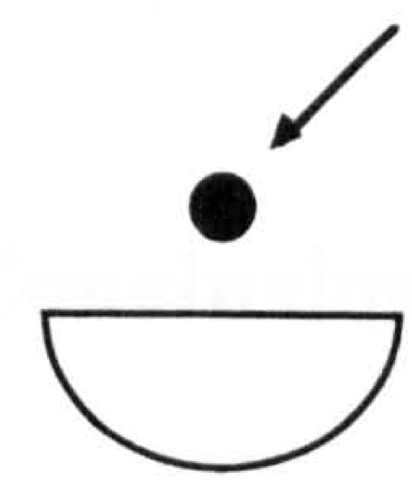


Figure 9.17 - Independent Judgements and **f**Superiority.

The following conclusions chapter presents a summary of the main findings from the experiments discussed in Chapters 7, 8 and 9 and it is to this that I now turn.

Chapter 10

Conclusions

10.1 Introduction

In this final chapter the general goals of the thesis are discussed. I then go on to present the main findings found from direct static and dynamic manipulations examining use of spatial prepositions. Findings concerning indirect testing of independent judgements are also examined. These findings are related to the theory of functional geometry and the cognitive model of space. The analysis presented to account for the semantics of spatial language is also compared to previous approaches and the implications of the present approach are discussed. It is also important to examine the methodological issues that have been raised during the course of this project and propose alternative methodologies for future research into functional control relations. I also suggest future research examining the functional control relations and validity of such controls for the spatial preposition AT.

10.2 General Aims

The main goal of this thesis was to show that the semantics of spatial prepositions are more fully realised within a framework of functionality. Functional relations, rather than geometric relations, were suggested to be of primary importance, moreover, it was suggested that a functional account could be achieved through minimal specification of lexical entries. I now examine the aims that directly lead from these proposals.

10.2.1 A Minimally Specified Functional Account

This thesis aimed to show that <u>functional control relations</u> were in operation and that it was unnecessary to abandon all the claims of a Classically based theory. Factors suggested to contribute to weak or strong control of relatum over referent were examined. The aim was to show that an operational semantic analysis focused on functionality could involve a minimal lexical entry via the use of cognitive mental models of space.

10.2.2 A Psychologically Viable Account

This thesis also set out to show that a functional account using minimal specification was actually psychologically viable. Many of the previous semantic investigations have amounted to little more than philosophical treatises. It was important to experimentally uphold these intuitions about spatial prepositions and also to try and directly test credibility of the theory of functional control relations. This was felt to be important as interpretation of the Preposition results was based on my intuitions of functional control. It was important to discover if dynamic functional control was actually reflected in the language users description of spatial configurations.

10.3 A Geometry Without Angles: The Results

10.3.1 The Major Findings

The experiments reported in chapters 7, 8 and 9 raise problems for any simple spatial account of the meaning of the locatives IN, ON and OVER. Various factors, other than geometric position, were found to influence prepositional choice. These factors or functional control relations affect choice of preposition in association with simple spatial factors and provide a strong argument for the existence of functional control relations. Independent Judgement experiments were also designed to examine whether the suggested functional controls actually influenced language users choice of spatial description. It was found that independent testing of controls corresponded extremely closely with expected prepositional confidence. Examples from the experiments will be used in order to clearly summarise these results. The major findings for fContainment, fSupport and fSuperiority are now presented.

10.3.2 Major Findings for IN and fContainment

The functional control proposed for IN was termed fContainment. This control is as follows:

FContainment -y fContains x if y controls the location of x such that when y moves there will be a correlated movement in x, (or uncorrelated movement within the convex hull of y), by virtue of some degree of enclosure.

This control makes several predictions, which were all upheld experimentally:

1. A language user will be confident of an IN description if the referent (for example a ping-pong ball) has the potential to move with the relatum (for example a bowl).

2. Any physical or functional factors which strengthen or weaken this control will also strengthen or weaken confidence of IN.

3. Uncorrelated movement of the referent within the type of convex hull suggested by Cohn (1996) will provide information that is neither inconsistent or consistent with the control. In other words confidence of IN will not be altered by such movement. Dynamic information that is inconsistent or consistent with the control will weaken and strengthen confidence respectively.

4. Since the dynamic control imposed suggests that the referent can move with the relatum Independent Judgements of this type of movement will correspond with confidence of IN.

The series of experiments carried out as part of this research have provided evidence of these predictions. Some visual examples from studies involving IN and its functional control help to summarise the major findings.

Various factors presented in the glass bowl and ping-pong bowl manipulations were found to strengthen or weaken the control specifying functional containment. It was found that full containment (provided by surrounding balls) for non-spatial positions strengthened functional control in the static scenes. In contrast a total lack of containment or only partial containment and the presence of an altered control (provided by wire attached to the referent ball) was found to weaken the control imposed by the bowl on the ball. So, for example, in Figure 10.1 Scene A graphically represents a non-spatial configuration where full containment and no altered control is present. Scene B represents a non-spatial position with only partial containment and the presence of an altered control. Confidence of IN was higher for Scene A than it was for Scene B. In Scene B the bowl does not impose as strong a functional control, x and y are less likely to have the potential to move together.

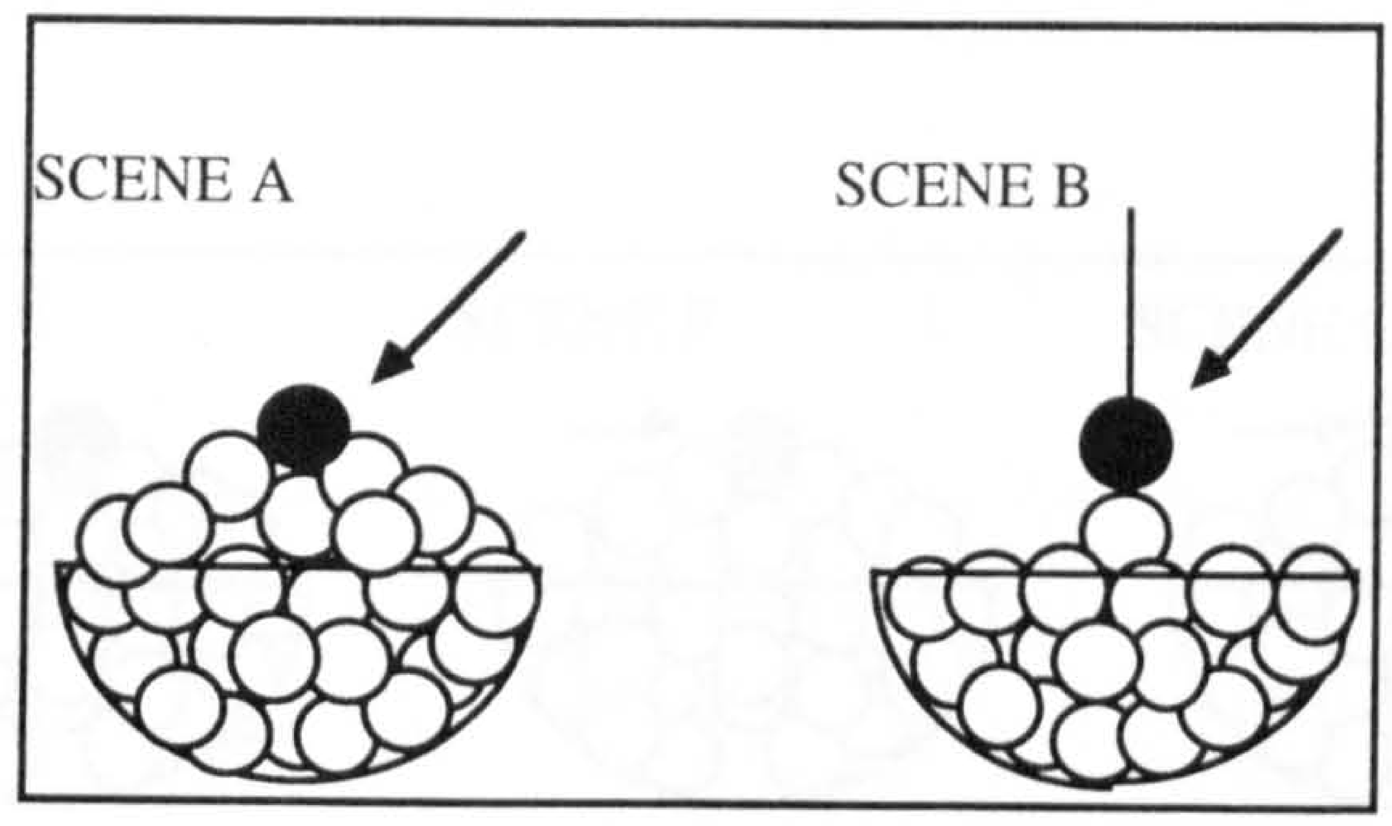


Figure 10.1 - Altering the Functional Control for IN.

The dynamic manipulations provided further evidence to support the fact that suggested dynamic controls operate and predict the use of IN. These manipulations found that dynamic information inconsistent with the functional containment control that "x and y have the potential to move together" reduced confidence of IN. So, in Figure 10.2 Scene C provided inconsistent dynamic information whilst Scene D showed the identical static configuration.

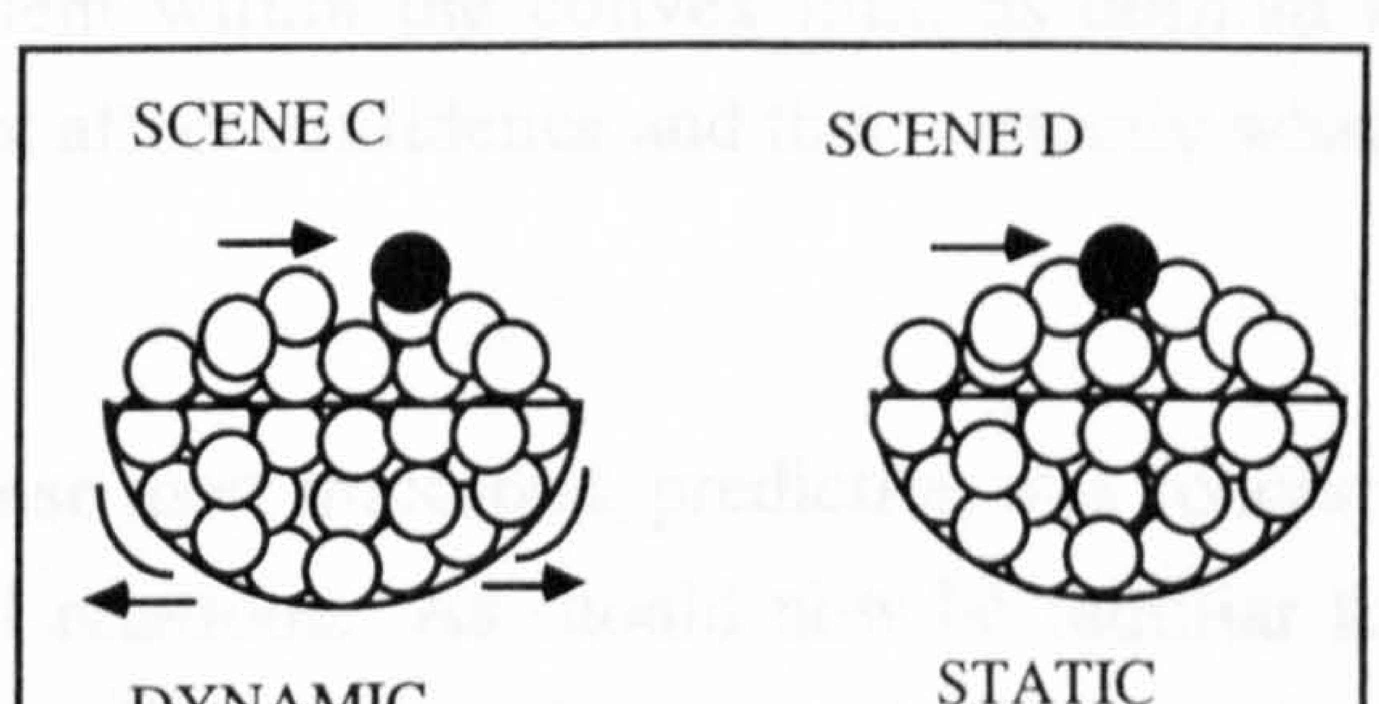


Figure 10.2 - Inconsistent Dynamic Information.

Scenes such as C involved the referent ping-pong ball remaining stationary whilst the relatum bowl and contents moved independently. This is inconsistent with the correlated movement that is predicted by fContainment. Confidence of IN was found to be lower for scenes of type C as compared to the static scenes of type D.

Dynamic information that was consistent with the notions of functional control were found to reinforce confidence of IN. Also dynamic information that was neither consistent or inconsistent with **f**Containment did not alter confidence of IN (as compared to the purely static scenes). These findings can be encapsulated by the following graphical representations given in Figure 10.3.

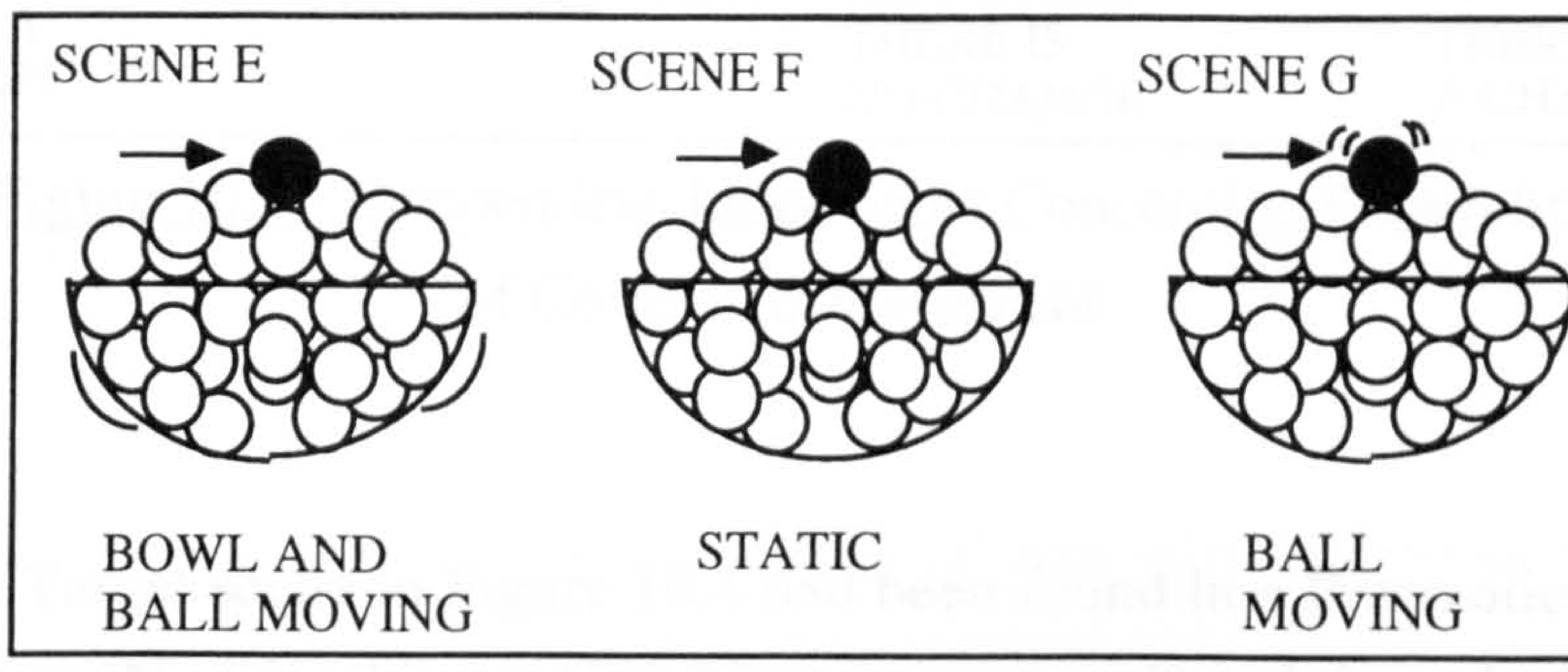


Figure 10.3 - Consistent Dynamic Information.

In scene E a correlated movement of referent and relatum was shown and this information is consistent with the functional control for IN. Correspondingly it was found that such dynamic scenes resulted in a reinforced confidence of IN, as compared to the identical static scenes. However, in type G scenes I presented information that is neither consistent with or inconsistent with the functional control. The definition predicts that movement within the convex hull, as defined by Qualitative Spatial Reasoning, should not affect confidence and this is exactly what was found.

Our final, and in a sense most important, prediction was concerned with the validity of the suggested control relations. As should now be familiar functional and physical factors were found to effect IN confidence and these results were attributed to the control of **f**Containment. Indirect testing using these scenes for Independent Judgements was able to show that the attribution was not misguided; location controls actually appear to influence confidence of IN. In this particular series of studies, subjects were asked to predict whether the bowl and ball would be able to move together. By asking about the predictions of control relations independently I was able to discover that they were actually in operation. The scenes shown in Figure 10.4 further explain these findings.

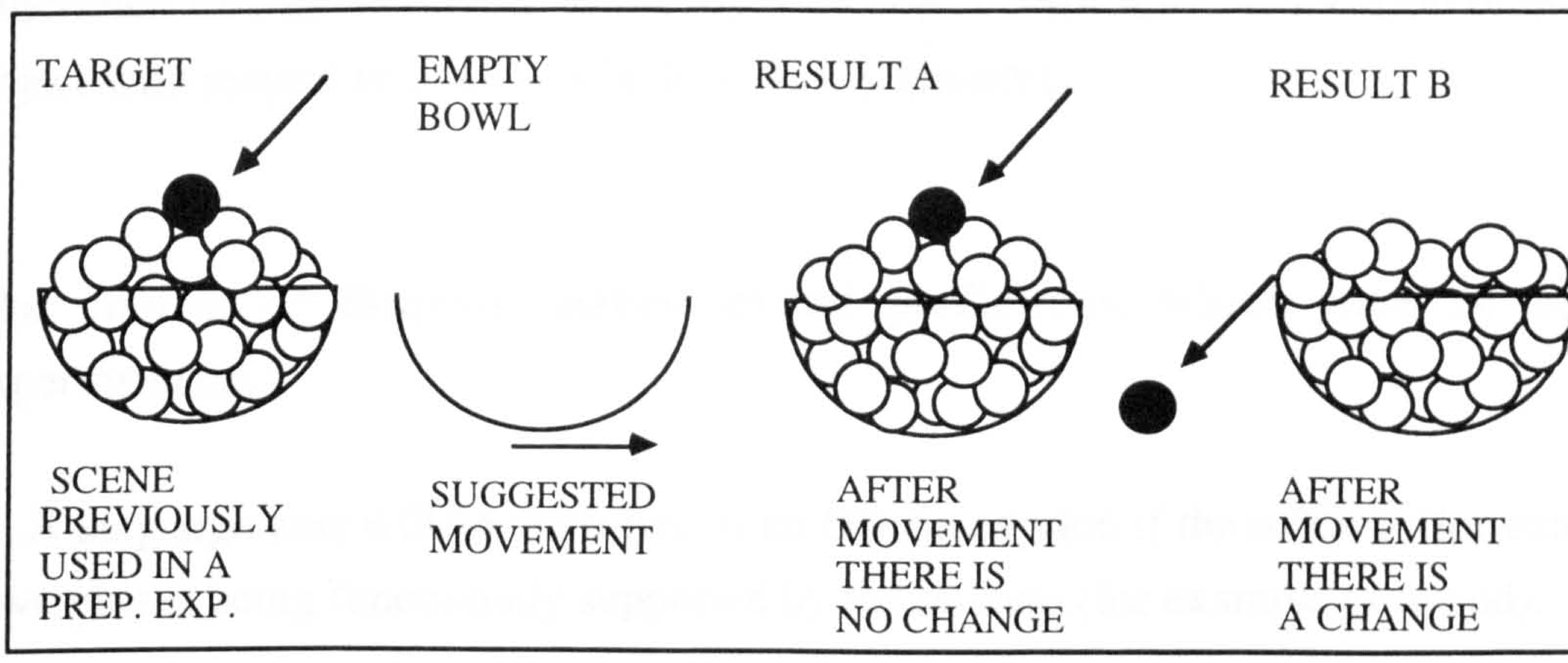


Figure 10.4 - Independent Judgements Concerning Possibility of Correlated Movement.

The example Target scene in Figure 10.4 had been found in a Preposition experiment to rate highly as IN. Was this because **f**Containment predicted that x had the potential to move with y? The Independent Judgement experiment showed that this control actually appeared to be in operation. In this example, subjects were more likely to select Result A which predicted that the target scene would stay the same after a suggested correlated movement. Similarly it was found that subjects would predict a change after movement for a scene such as Scene B in Figure 10.1. The results from independent judgements correlated highly with the results from the comparative prepositional studies. The control imposed on a scene by **f**Containment directly influences confidence in the spatial preposition IN.

10.3.3 Major Findings for ON and fSupport

A functional control was also proposed for ON and this was termed **f**Containment. The control can be defined in the following way:

fSupport - y **f**Supports x if y controls the location of x with respect to a unidirectional force (by default gravity) by virtue of some degree of contact between x and y.

The support provided by this control is functional. As with fContainment there is a functional relation involved. Basically, one object constrains the location of another object with respect to a force (which is usually gravity).

The control of fSupport makes several predictions, which were all upheld experimentally:

1. A language user will be confident of an ON description if the referent (for example a weight) is being functionally supported by the relatum (for example plywood).

2. Any physical or functional factors which strengthen or weaken this control will also strengthen or weaken confidence of ON.

3. Independent Judgements of this location control will correspond to the results found in the prepositions experiment. Since the dynamic control imposed suggests that the relatum must be seen as a functional supporter then judgements of whether the location of the referent will remain unchanged after the relatum is removed will correspond with confidence of ON.

Experiments designed to tap into functional support have provided evidence of these predictions. I will use some visual examples from the studies involving ON and its functional control help to summarise the major findings.

Various factors presented in the weight/ping-pong ball and plywood/plank of wood manipulations were found to strengthen or weaken the control of fSupport. It was found that altered control attached to the referent weight reduced confidence in ON. Subjects were less confident that the primary support (plywood or board) was supporting the weight from the force of gravity. This reduced confidence in ON was magnified if the altered control or secondary support was seen as being taut. It was suggested that the tautness reinforced the idea that functional support was being provided from a source other than the primary support. So, for example, in Figure 10.5 Scene H graphically represents a configuration with no altered control and a pliable plywood primary support. Scene I presents a configuration where there is altered control provided by taut chain and a plank of rigid wood primary support.

Confidence of ON was higher for Scene H than it was for Scene I. In scene I the primary support does not impose as high a level of functional support from the force of gravity as there is a possible altered control providing the support.

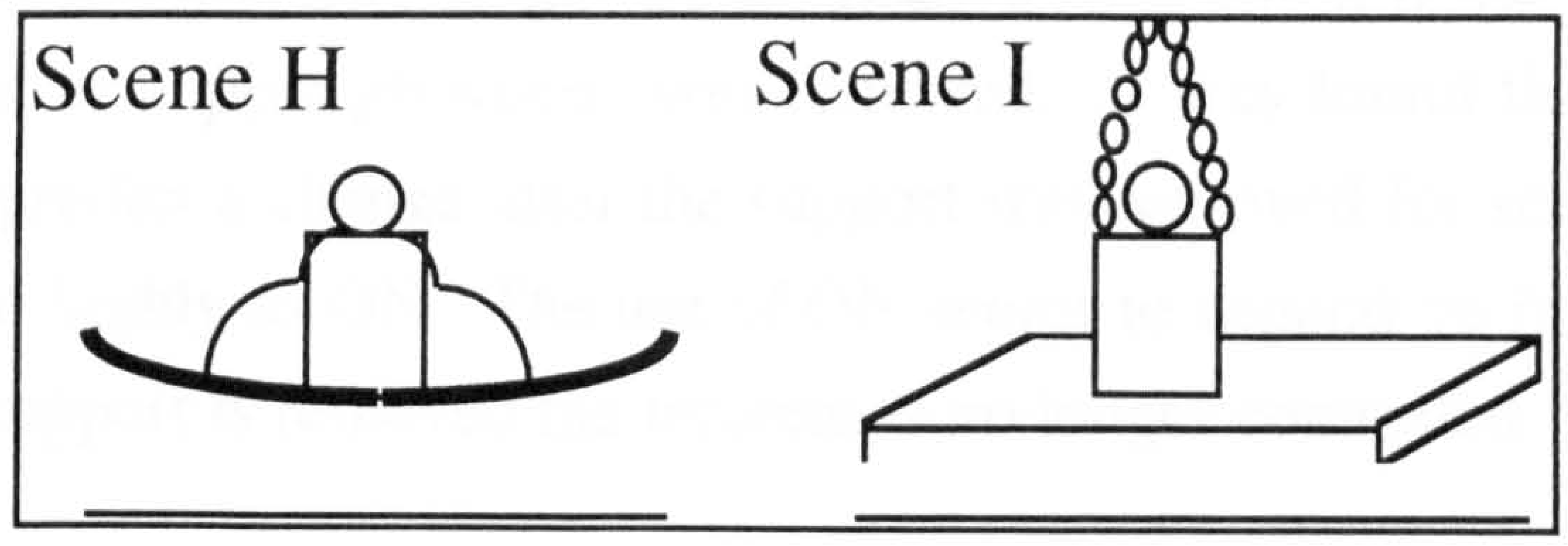


Figure 10.5 - Altering the Functional Control for ON Using the Weight and Wood Manipulations.

It was found, in the ping-pong ball and tilted board manipulations, that dynamics reduced the strength of **f**Support. In contrast the stationary scene strengthened the control. So, for example, in Figure 10.6 Scene J graphically represents a configuration where there are dynamics present and a slightly tilted board. Scene K presents a configuration where the ball is static. Confidence of ON was higher for Scene K than it was for J.

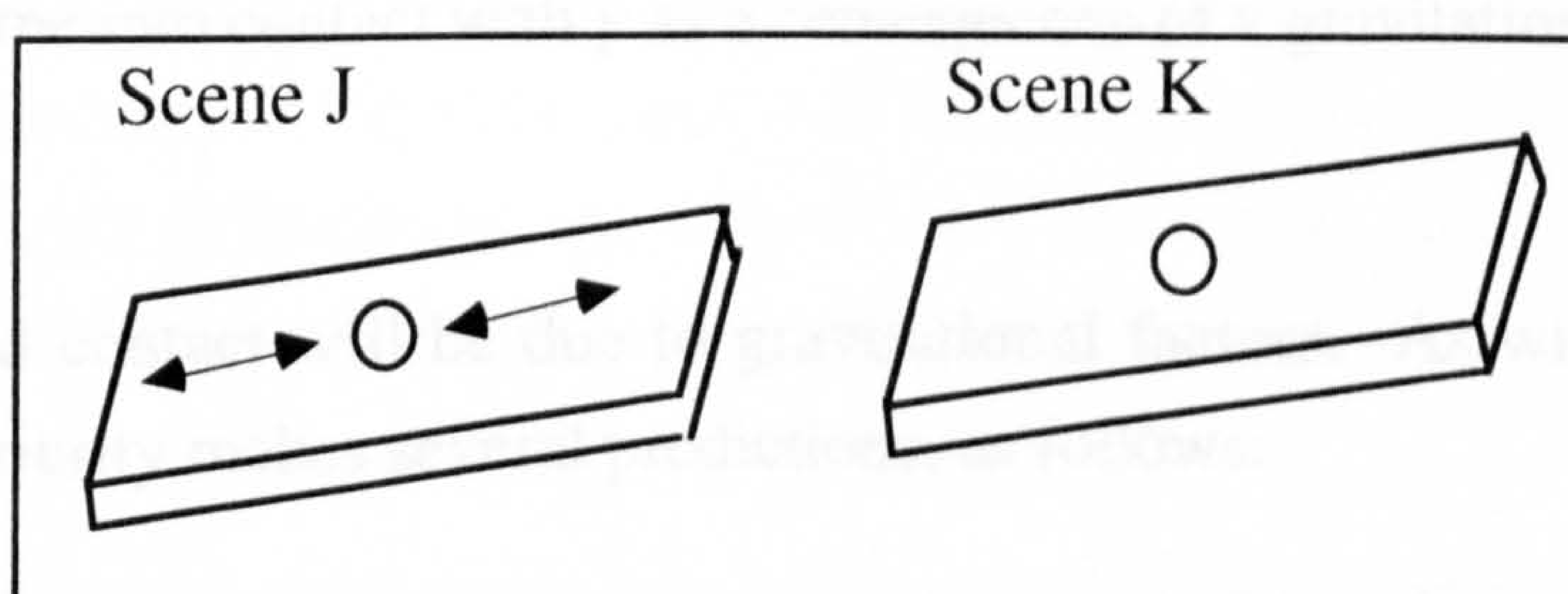


Figure 10.6 - Altering the Functional Control for ON Using the Ball and Tilt Manipulations.

In Scene J the board does not impose as strong a functional control; x (the ball) is less likely to be getting functional support from y (the board).

The validity of the fSupport control relation was examined independently. The physical and functional factors found to affect ON confidence were attributed to fSupport. Indirect testing of these scenes was able to show that support from the force of gravity is the motivating factor in selection of ON descriptions. Subjects were asked to predict whether the weight would remain in position if the primary support (the rigid board or supple plywood) was removed. It was found that subjects were more likely to predict a change after the support was removed for scenes which were previously rated highly as ON. The use of ON seems to depend on functional support and when this support is removed the referent is no longer controlled.

10.3.4 Major Findings for OVER and fSuperiority

Investigations that involved tapping into the location control involved with OVER were also carried out. This was the most complicated preposition examined and it is recognised that the functional control does not cover all uses of OVER. However, it does show that a functional account of OVER is viable. The functional control for OVER was suggested to be as follows:

fSuperiority - x is fSuperior to y if x, or something intrinsically associated with x, threatens to come into contact with y as a consequence of a gravitational force.

This threatened contact will be due to gravitational factors. As with the other two controls fSuperiority makes several predictions, as follows:

1. A language user will be confident of an OVER description if the referent (for example a ping-pong ball) has the potential, or threatens, to fall into the area of the relatum (for example the bowl).

2 Any physical or functional factors which strengthen or weaken this control will also strengthen or weaken confidence of OVER.

3. This functional locative will have a different range of uses from the less functional locative ABOVE. The range of uses for OVER can be directly predicted by the nature of the location control imposed by fSuperiority.

4. As with the other controls independent judgements of this control will correspond to the confidence ratings of OVER.

The investigations carried out have provided evidence of these predictions and I now present a summary of the results with some visual examples.

Manipulations using glass bowls and a single ping-pong ball were found to strengthen and weaken the control specifying functional superiority. In an investigation of OVER and ABOVE it was found that the referent ball positioned directly over the centre of the bowl strengthened the control predicted for fSuperiority. In contrast when the ball was horizontally positioned directly over the rim of the bowl the functional control was weakened. This weakened control was even more pronounced when the ball was seen to be horizontally positioned beyond the rim of the bowl. So, for example, in Figure 10.7 Scene L graphically represents a configuration where the referent ball is directly over the bowl. Scene M represents a configuration where the ball is over the rim and scene N represents a Scene where the ball is positioned beyond the rim. Confidence of OVER (and ABOVE) was highest for Scene L. For configurations such as Scenes M and N ABOVE was the preferred locative; the use of OVER dropped dramatically as the ball moved away from the centre of the bowl.

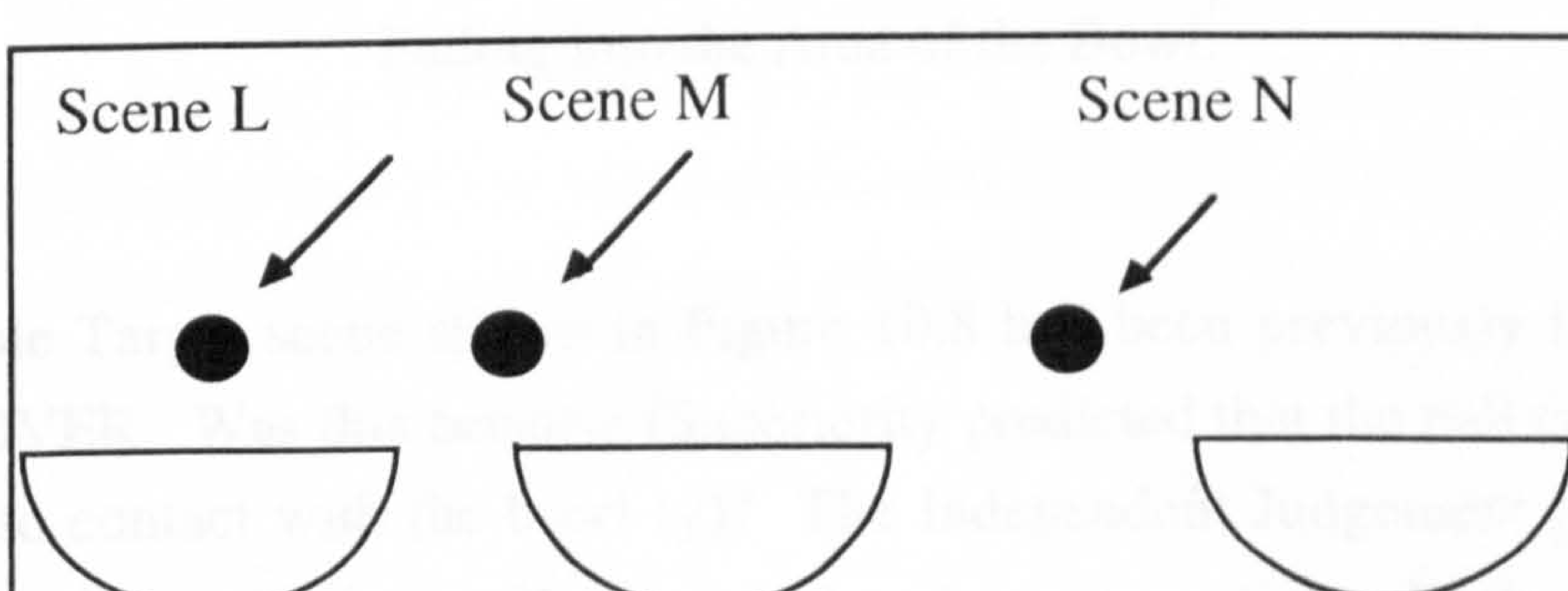


Figure 10.7 - Altering the Functional Control for OVER.

Scene M and, even more so, Scene N do not impose as strong a functional control. In other words the ball is less likely to fall into the area of the bowl. The preposition ABOVE is less sensitive to this control and this is why subjects preferred to use this preposition.

I also examined the validity of these control relations by examining movement predictions independently. Functional factors that were found to affect OVER confidence and these results were attributed to the control imposed by fSuperiority. Indirect testing was able to show that this attribution was in no way misguided. By asking about the predictions of location control independently I was able to discover that they were actually in operation: location control does appear to influence confidence of OVER. In the Independent Judgement presentations subjects were asked to predict where the ball would fall if it were to be dropped. The scenes shown in Figure 10.8 further explain these findings.

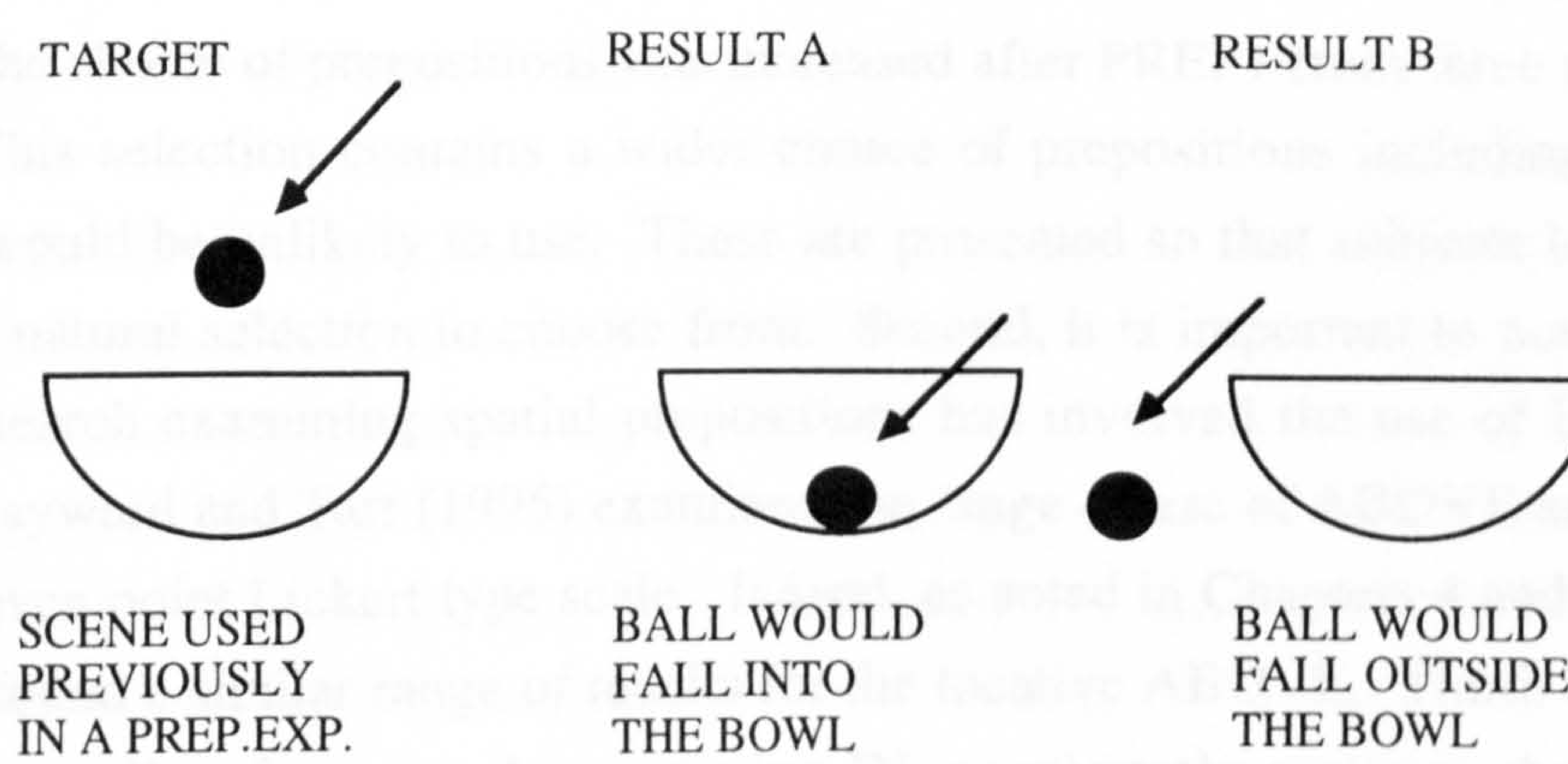


Figure 10.8 - Independent Judgements Concerning Possibility of the Ball Falling into the Area of the Bowl.

The example Target scene shown in Figure 10.8 had been previously found to rate highly as OVER. Was this because fSuperiority predicted that the ball (x) threatened to come into contact with the bowl (y)? The Independent Judgement presentations showed that this control actually appeared to be in operation. In the Figure 10.8 example subjects were more likely to select Result A which predicted that if the ball was dropped it would fall into the area of the bowl. Similarly it was found that subjects were more likely to select Result B for a scene such as Scene M and even more likely to select Result B for a scene such as Scene N. The results from this experiment correlated highly with the results from the comparative Preposition experiment. The control imposed on the scene by fSuperiority directly influences confidence in OVER and has a much smaller effect on the non-functional locative ABOVE.

10.4 Methodological Issues

10.4.1 The Lickert Type Scale

The method used to directly test prepositional usage relies on the use of a Lickert type scale. Coventry (1992) argued that using such a scale may result in subjects making artificial distinctions between various prepositions. I now present some arguments against this statement including work carried out by Coventry et al (1994).

First, in order to reduce the likelihood of artificial distinctions being made by the subjects the choice of prepositions was increased after PREP1 from three prepositions to six. This selection contains a wider choice of prepositions including some that subjects would be unlikely to use. These are presented so that subjects have a fuller and more natural selection to choose from. Second, it is important to note that other recent research examining spatial prepositions has involved the use of Lickert type scales. Hayward and Tarr (1995) examined the range of use of ABOVE and BELOW using a seven point Lickert type scale. Indeed, as noted in Chapters 4 and 9 Hayward and Tarr found a similar range of results for the locative ABOVE. Third, the findings of various studies, for example examining IN, consistently replicate the same core findings. For example, containment increases judgements of IN at position 4 throughout the different experiments. Fourth, Coventry, Carmichael and Garrod examined identical scenes using two experimental measures: the Lickert scale that I designed and the sentence completion method designed by Coventry (1992) (as described in Chapter 6). Both paradigms are valid and it was found that both methodologies appear to support one another. As Coventry, Carmichael and Garrod (1994) note the Lickert scale taps graded responses for certain features whilst the free-recall taps aspects of language production. The use of a Lickert scale allows for results that are more statistically robust as graded degrees of the appropriateness of a preposition can be uncovered. Further investigations using both the available methodologies available is certainly desirable.

10.4.2 The Binary Data

It is important to note that Analyses of Variance were used to analyse the binary Independent Judgement data. Technically I should have used Chi Square procedures but it would have been impossible to examine interactions using this method. It is argued that the significant values were so highly significant that the data was robust enough to undergo the ANOVA procedure without producing significant results where there should have been none. I also suggest that future research could avoid the use of binary judgements. For example, an alternative methodology could ask subjects to rate a Lickert type scale for how likely they think it would be that there would be No Change in the scene after movement. It may also be interesting to ask subjects to make a free response of what they think would actually happen if they were highly confident of a change occurring after movement.

10. 5 Suggestions for Future Research

I feel that further research should focus on functional controls that may operate on other spatial prepositions such as BETWEEN and AT. Certainly this would provide further evidence that control relations characterise spatial descriptions. A good candidate for such analysis would be the spatial preposition AT. Garrod and Sanford (1989) present some interesting suggestions concerning the functional control. They note that the "ideal meaning" suggested by Herskovits (1986) for AT is as follows:

AT: for a point to coincide with another.

Use types are specified by Herskovits and these include "Spatial entity at location", "Person at institution", "Person using artefact" and "Spatial entity at generic place". However, the ideal meaning captures a purely spatial relation and these use types suggest full specification. Garrod and Sanford note the use of AT does involve functional factors. It is suggested that there must be "functional coincidence". This means that x and y must be able to interact with one another. It does seem that a language user is more likely to say some one is "AT the desk" if they are facing the desk rather than if they have their back turned to the desk, and are therefore not interacting with it.

Carlson-Radvansky and Radvansky (1996) in an investigation of spatial relations show that subjects are more willing to adopt an object centred reference frame when there is a functional relation between the objects, for example, a postman facing, and thus interacting, with a mailbox. Intrinsic spatial terms such as IN FRONT OF are preferred in such a case over deictic-extrinsic terms such as TO THE LEFT OF. Intrinsic spatial terms focus attention on object function. For example, in the sentence "Gillian is AT the desk" the assignment of intrinsic sides will depend on functional factors which involve the seat and person facing the front of the desk. It is suggested that these findings and intuitions provide the basis for future Functional Geometric investigations examining the spatial preposition AT.

10.6 Research Implications and Issues

The results found during the course of this project give further evidence that we use our language for space on a highly functional, interactive level. Of course one should not ignore spatial factors, but any geometry employed must be consistent with how we interact with the physical world. Previous accounts such as those given by Cooper (1968), Leech (1969), Bennett (1975) that employ geometric notions as their main focus are not sufficient to explain the complex uses of spatial prepositions.

A psychologically plausible theory with psychological validity was required. This has been achieved through experimentation and has avoided the error of simply making the intuitive judgements presented by Herskovits (1986) and Brugman and Lakoff (1988). More than just a theory of language was required and the present investigation recognises that it is important that distinctions made by language users are represented. It is also important to note that previous accounts did little more than assume the kind of cognitive geometry that would be required. I suggested that such a geometry must take into account regions rather than points, lines and planes.

This work is a step forward in the effort to provide a solution to the encoding/decoding problem. The final aim must surely be to have a computer with a natural language front end, able to understand when one asks it, for example, to "Put the missile IN the carrier and detonate it when we are OVER that hill" (or perhaps something a little more friendly).

I suggest that the semantics of spatial prepositions are best analysed within the framework of a Functional Geometry as it has been found that notions of location control such as fContainment, fSupport and fSuperiority do appear to be operating when language users choose spatial prepositions.

Appendices

Appendix A: PREP1 Questionnaire Booklet

Language Experiment

You will be shown scenes of bowls and ping-pong balls on a video. We want judgements of where the ball is in relation to the bowl. You **must** circle a rating (1 to 5) for how well you think a statement describes a scene (1 = Not very well to 5 = Very well). Please read each set of questions before the relevant scene appears.

Some question groups are divided by a series of asterisks. In such cases the relevant scene will be shown twice to allow time to answer both sections.

(1)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(2)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(3)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(4)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(5)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(6)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5
	******************************					
	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5

(7)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5
	******************************					
	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5
(8)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5
	******************************					
	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5
(9)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5
	******************************					
	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5
(10)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5
	******************************					
	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5
(11)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(12)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5

(13)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5

(14)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5

(15)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5

(16)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5

****

	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5

(17)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5

****

	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5

(18)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5

****

	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5

(19)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5

****

	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5

---

(20)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5

****

	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5

PLEASE TAKE A 5 MINUTE BREAK HERE

---

(21)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(22)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(23)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(24)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(25)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(26)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5

(27)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5
	******************************					
	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5
(28)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5
	******************************					
	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5
(29)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5
	******************************					
	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5
(30)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5
	******************************					
	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5
(31)	The ball is **in** the small bowl	1	2	3	4	5
	The ball is **on** the small bowl	1	2	3	4	5
	The ball is **over** the small bowl	1	2	3	4	5
	******************************					
	The ball is **in** the big bowl	1	2	3	4	5
	The ball is **on** the big bowl	1	2	3	4	5
	The ball is **over** the big bowl	1	2	3	4	5

(32)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(33)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(34)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(35)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(36)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(37)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(38)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(39)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
(40)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5

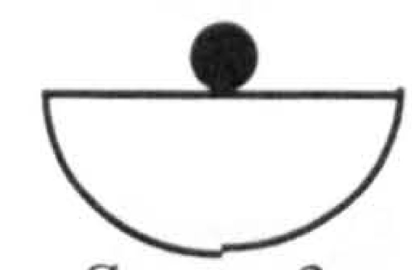
END

Appendix B: PREP1 Pictorial Representations

These scenes are in the randomised order in which they were shown to subjects.

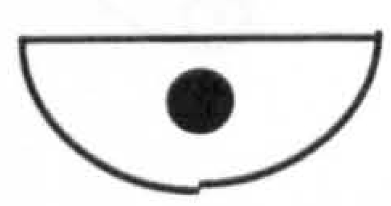
Scene 1

Scene 2

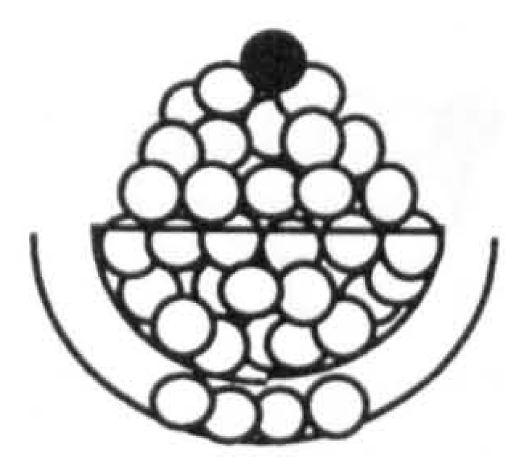


Scene 3

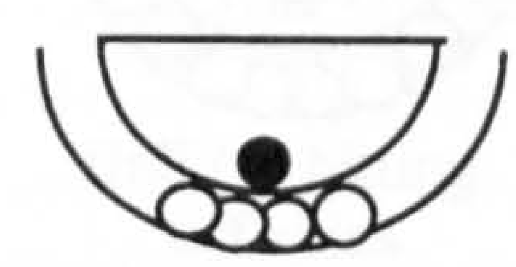
Scene 4



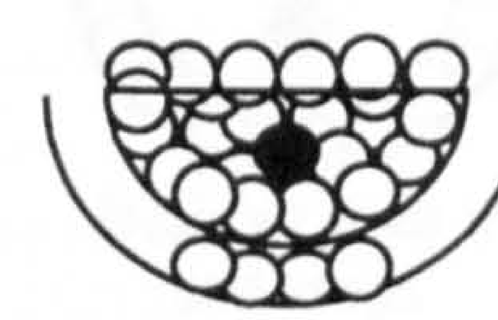
Scene 5



Scene 6



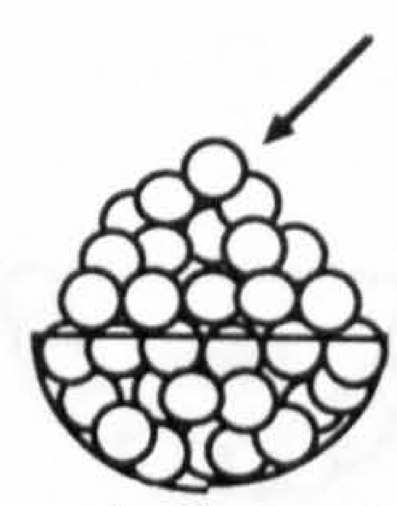
Scene 7



Scene 8

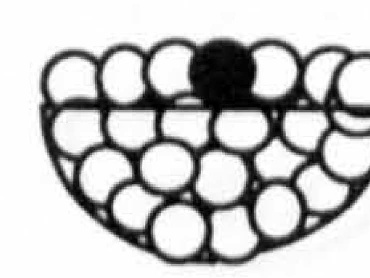
Scene 9

Scene 10

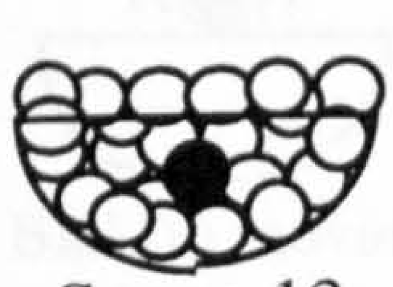


Pointer indicates ball (x)

Scene 11



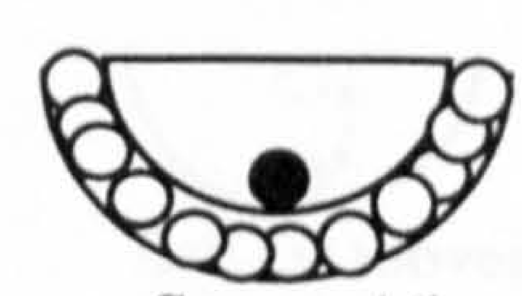
Scene 12



Scene 13

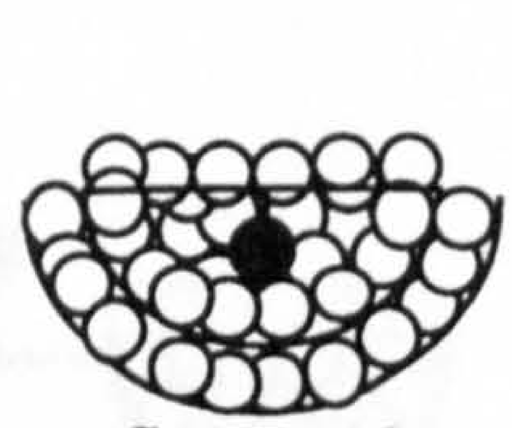
Scene 14

Scene 15

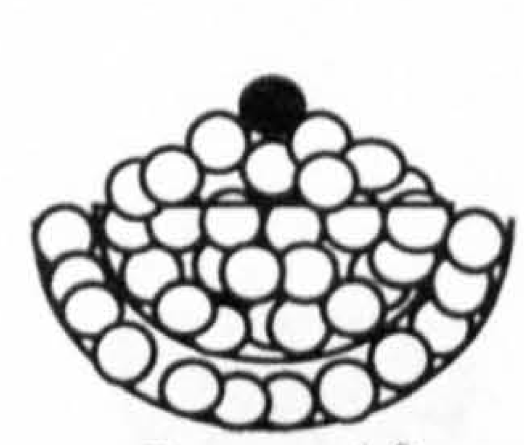


Scene 16

Scene 17

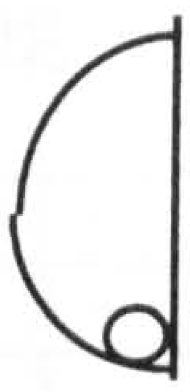


Scene 18



Scene 19

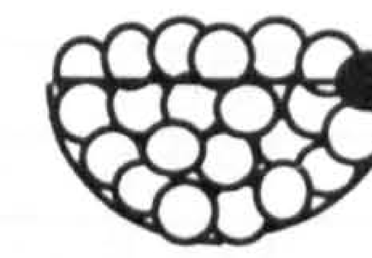
Scene 20



Scene 21

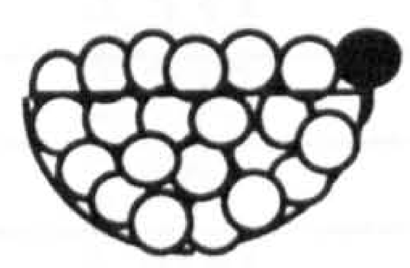
Scene 22

Scene 23

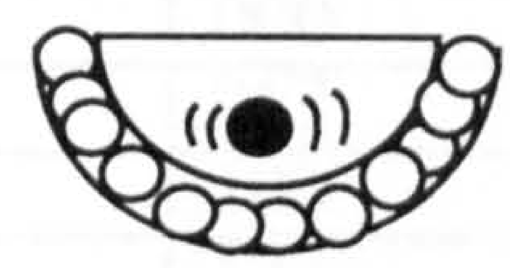


Scene 24

Scene 25

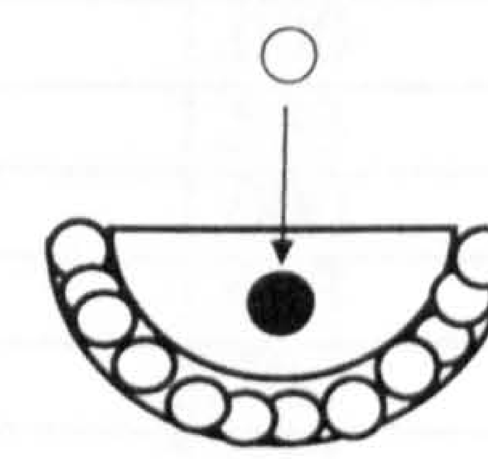


Scene 26



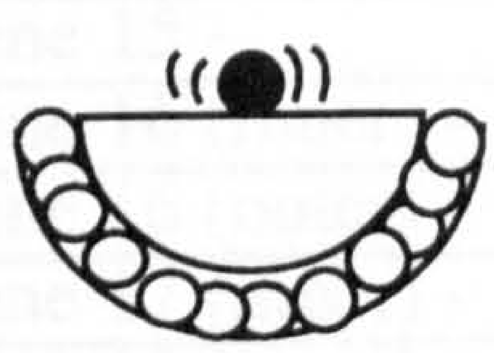
Ball (x) hitting off sides

Scene 27

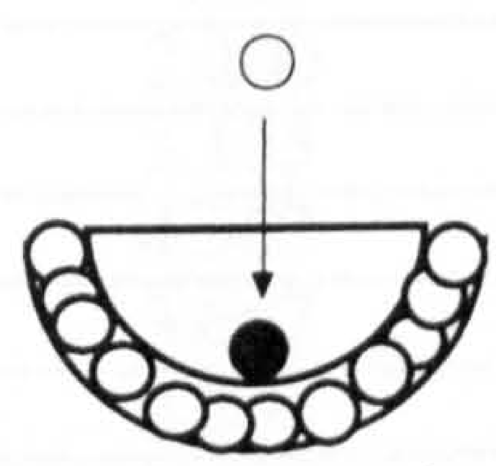


Ball (x) goes in and stops

Scene 28

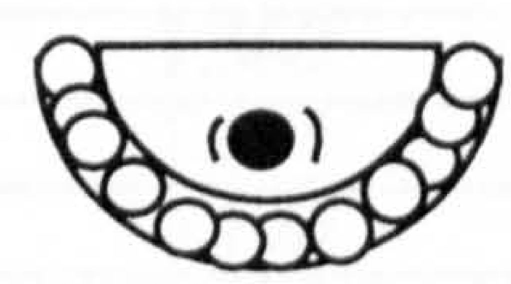


Scene 29



Ball (x) goes in

Scene 30



Ball (x) moving

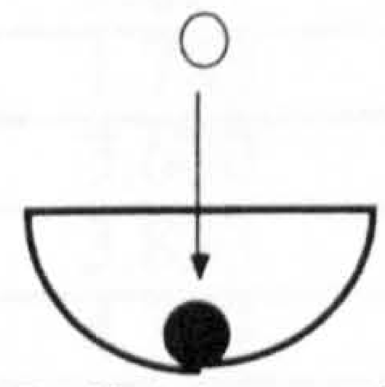
Scene 31

Ball (x) hitting off sides

Scene 32

Ball (x) moving along rim

Scene 33

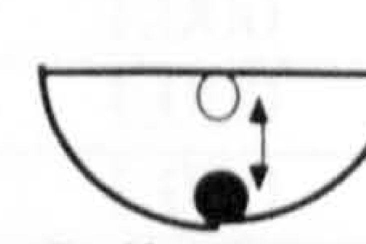


Ball (x) goes in

Scene 34

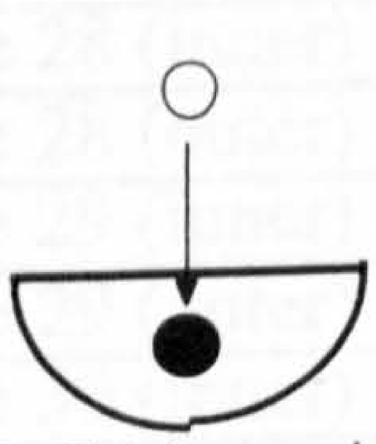
Ball (x) moving

Scene 35



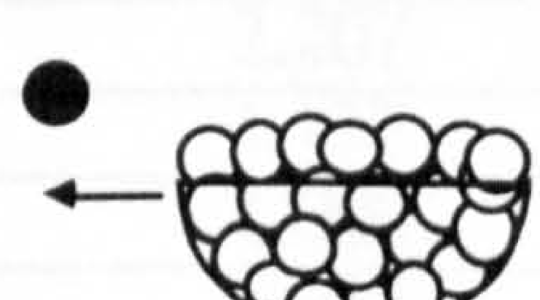
Ball (x) moves up and down

Scene 36



Ball (x) goes in and stops

Scene 37



Bowl (y) moves to ball (x)

Scene 38

Ball (x) moving

Scene 39

Ball (x) moving

Scene 40

Appendix C: Mean Values for IN, ON and OVER for PREP1

SCENE	IN	ON	OVER
Scene 1 -	5.000	1.000	1.000
Scene 2 -	1.000	1.000	4.867
Scene 3 -	1.333	2.167	2.733
Scene 4 -	1.000	1.000	4.633
Scene 5 -	4.433	1.000	1.000
Scene 6 (inner) -	2.033	1.433	2.800
Scene 6 (outer) -	1.567	1.100	3.567
Scene 7 (inner) -	4.667	1.100	1.000
Scene 7 (outer) -	3.500	1.167	1.533
Scene 8 (inner) -	4.533	1.000	1.000
Scene 8 (outer) -	2.733	1.267	1.633
Scene 9 (inner) -	2.567	1.100	2.700
Scene 9 (outer) -	1.400	1.133	3.233
Scene 10 (inner) -	2.400	2.133	1.467
Scene 10 (outer) -	1.433	1.200	3.133
Scene 11 -	2.867	1.233	2.167
Scene 12 -	2.767	3.267	1.300
Scene 13 -	4.867	1.000	1.000
Scene 14 -	2.200	1.567	2.500
Scene 15 -	3.133	1.100	2.167
Scene 16 (inner) -	4.567	1.300	1.000
Scene 16 (outer) -	3.667	1.167	1.500
Scene 17 (inner) -	2.233	1.100	2.833
Scene 17 (outer) -	1.400	1.133	3.200
Scene 18 (inner) -	4.500	1.000	1.000
Scene 18 (outer) -	2.800	1.300	1.767
Scene 19 (inner) -	2.933	1.333	2.033
Scene 19 (outer) -	1.667	1.333	2.800
Scene 20 (inner) -	2.667	2.567	1.600
Scene 20 (outer) -	1.733	1.233	2.667
Scene 21 -	3.600	2.100	1.000
Scene 22 -	3.833	1.433	1.000
Scene 23 -	4.367	1.600	1.000
Scene 24 -	2.267	3.333	1.100
Scene 25 -	2.167	2.900	1.133
Scene 26 -	2.033	3.300	1.400
Scene 27 (inner) -	4.286	1.067	1.367
Scene 27 (outer) -	2.567	1.033	2.233
Scene 28 (inner) -	3.400	1.100	2.133
Scene 28 (outer) -	2.207	1.000	2.800
Scene 29 (inner) -	1.133	2.333	2.833
Scene 29 (outer) -	1.000	1.000	4.100
Scene 30 (inner) -	4.233	1.267	1.567
Scene 30 (outer) -	3.100	1.067	2.133
Scene 31 (inner) -	4.517	1.000	1.433
Scene 31 (outer) -	2.533	1.100	1.933
Scene 32 -	4.567	1.000	1.167

SCENE	IN	ON	OVER
Scene 33 -	1.000	2.467	2.733
Scene 34 -	3.867	1.033	2.267
Scene 35 -	4.233	1.067	1.267
Scene 36 -	4.533	1.100	1.000
Scene 37 -	3.400	1.000	2.000
Scene 38 -	1.833	1.833	2.700
Scene 39 -	4.467	1.000	1.100
Scene 40 -	2.433	1.833	2.133

Appendix D: PREP2 Questionnaire Booklet

LANGUAGE EXPERIMENT

In this experiment you will be shown 58 scenes on video. A group of statements are provided for **each** scene and it is your task to rate the appropriateness of each statement for the corresponding scene. You **must** circle a rating (1 to 5) for each statement from 1 = Highly Unlikely to 5 = Most Likely. Please read the relevant statements before the scene appears on screen. The statements are randomised and the ball referred to is indicated by a pointer.

(1)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(2)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(3)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(4)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(5)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

(6)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

(7)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5

(8)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

(9)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

(10)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5

(11)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

(12)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

(13)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(14)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(15)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(16)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(17)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(18)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(19)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

(20)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(21)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(22)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(23)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(24)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(25)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(26)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

(27)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(28)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(29)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(30)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(31)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(32)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(33)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

(34)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	he ball is **below** the bowl	1	2	3	4	5

---

(35)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5

---

(36)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

---

(37)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

---

(38)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	he ball is **below** the bowl	1	2	3	4	5

---

(39)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

---

(40)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

---

(41)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

(42)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5

(43)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

(44)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

(45)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5

(46)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	he ball is **on** the bowl	1	2	3	4	5

(47)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5

(48)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(49)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(50)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(51)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(52)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(53)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(54)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

(55)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5

(56)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

(57)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

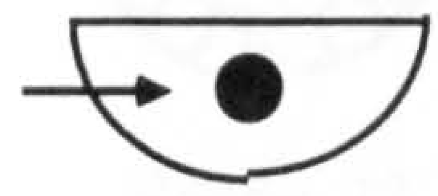
(58)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5

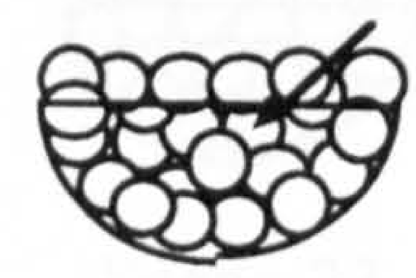
THE END

Appendix E: PREP2 Pictorial Representations

These scenes are in the randomised order in which they were shown to the subjects.

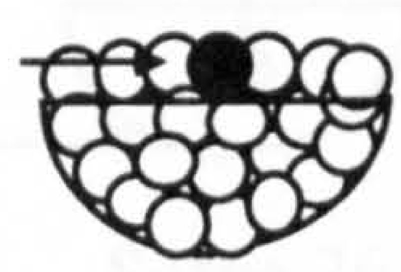

Scene 1

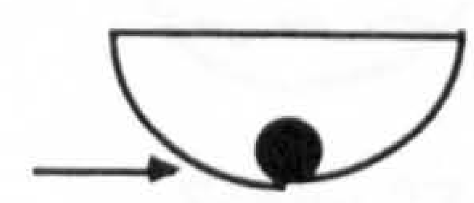

Scene 2

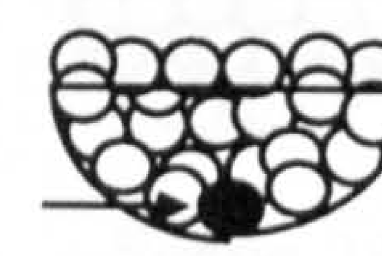

Scene 3

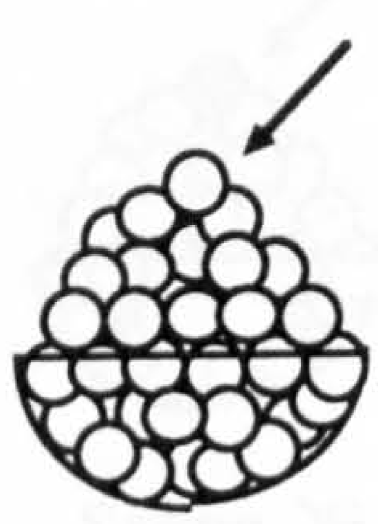

Scene 4

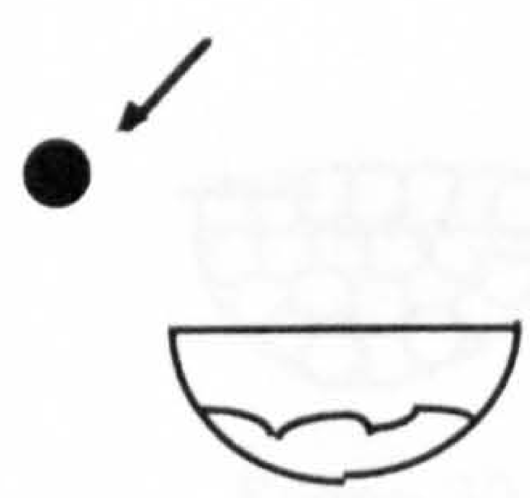

Scene 5

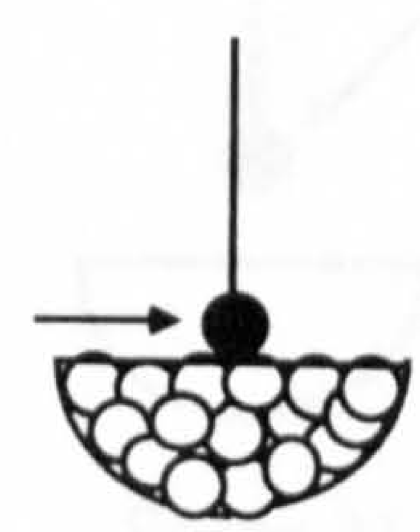

Scene 6

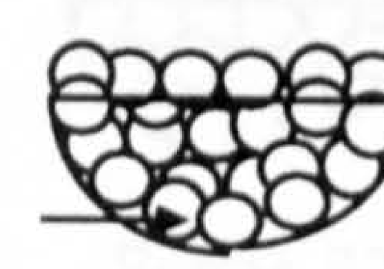

Scene 7

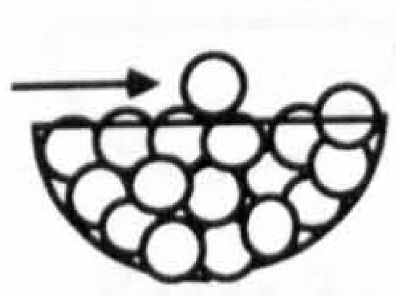

Scene 8

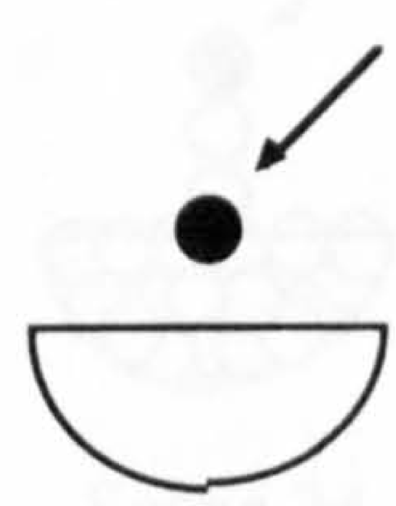

Scene 9

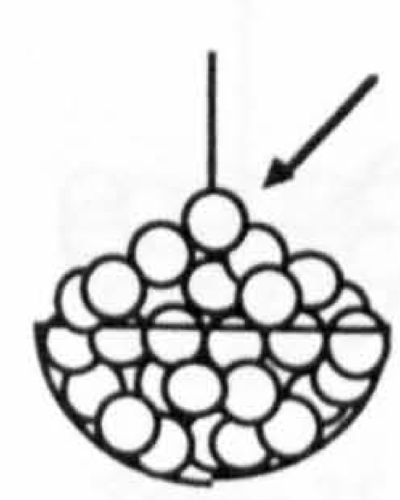

Scene 10

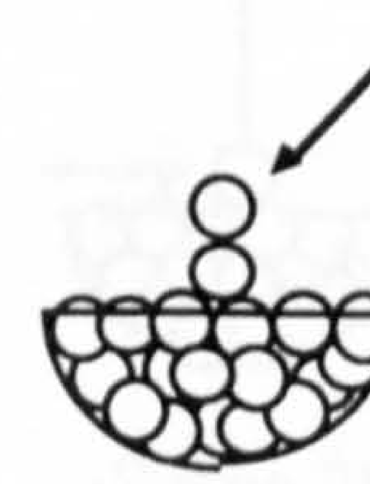

Scene 11

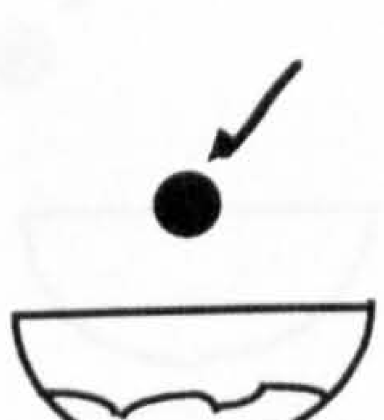

Scene 12

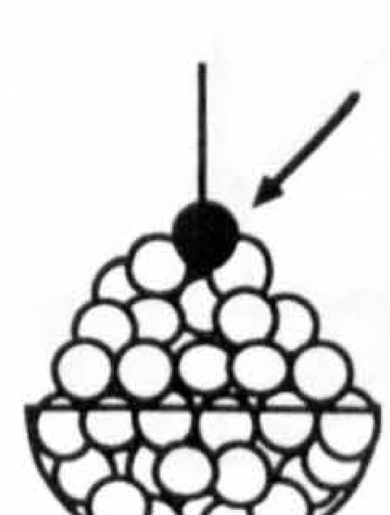

Scene 13


Scene 14

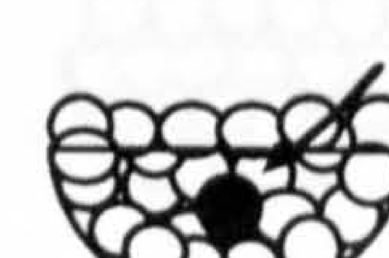

Scene 15

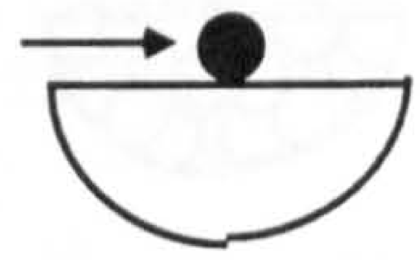

Scene 16

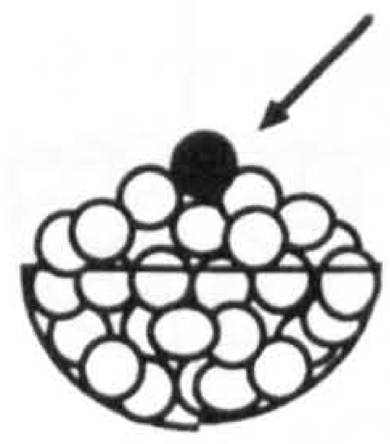

Scene 17

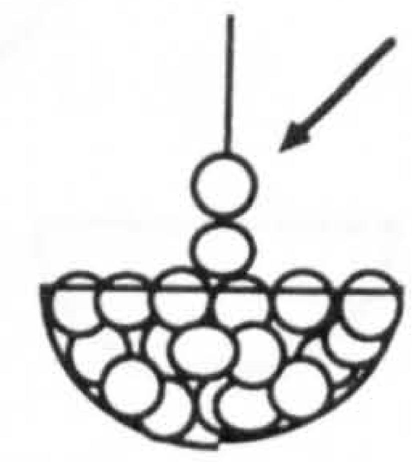

Scene 18

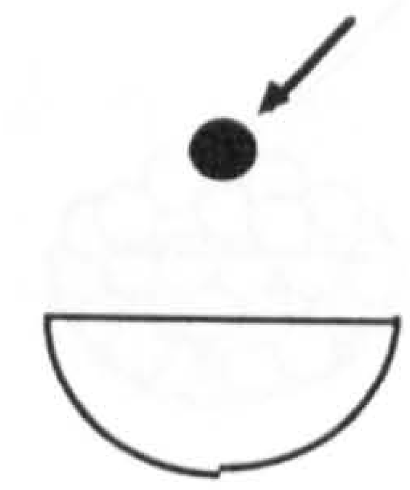

Scene 19

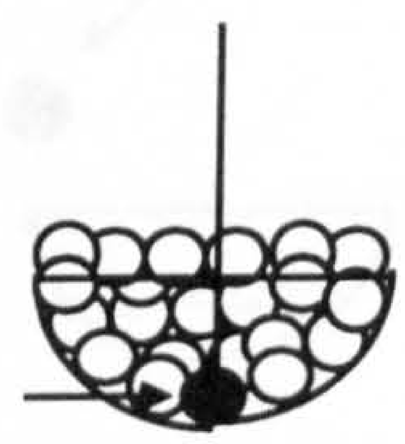

Scene 20

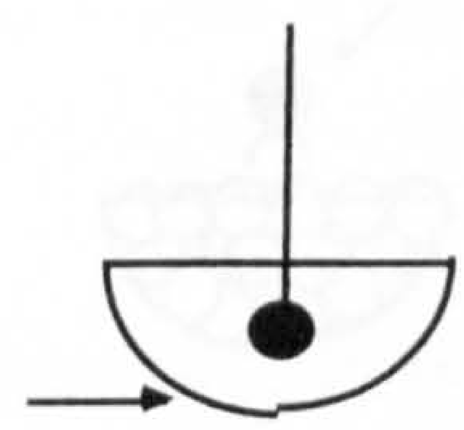

Scene 21

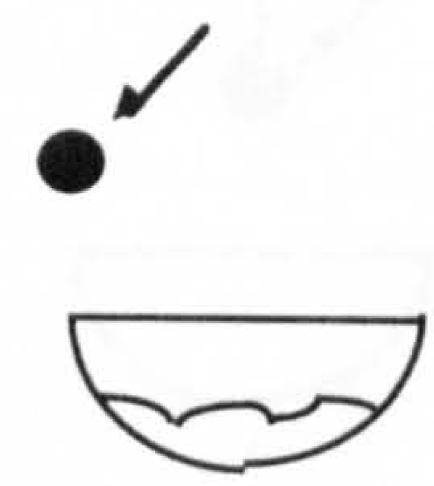

Scene 22

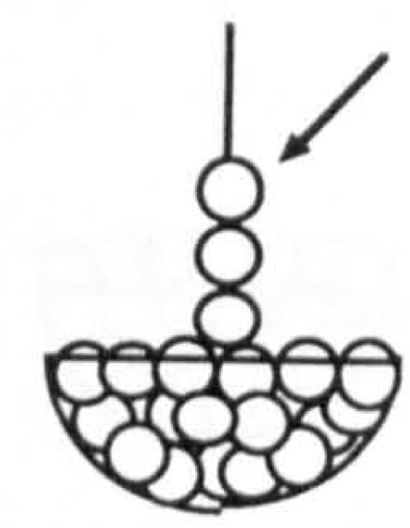

Scene 23

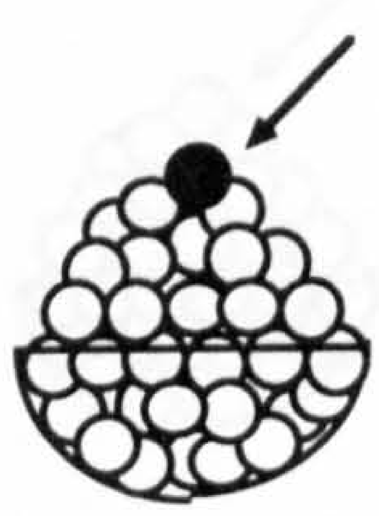

Scene 24

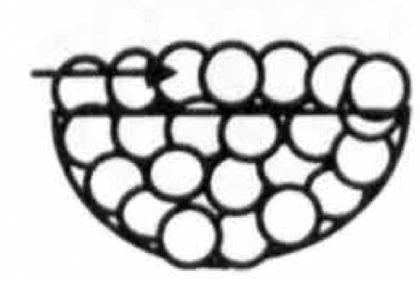

Scene 25

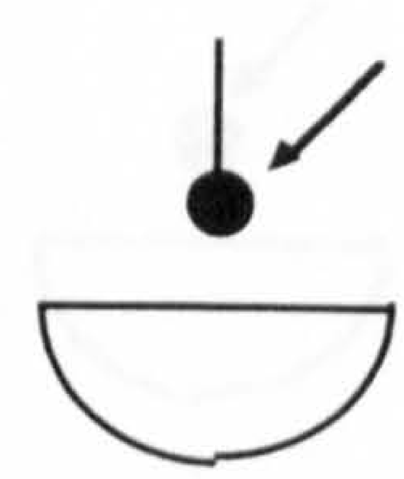

Scene 26

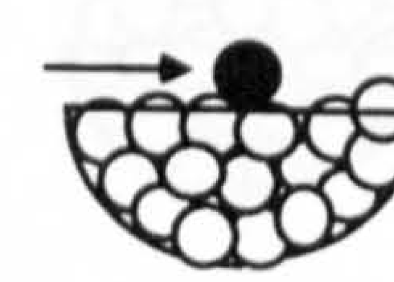

Scene 27

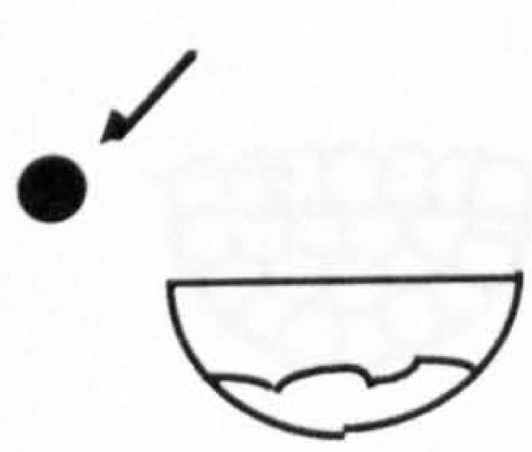

Scene 28


Scene 29

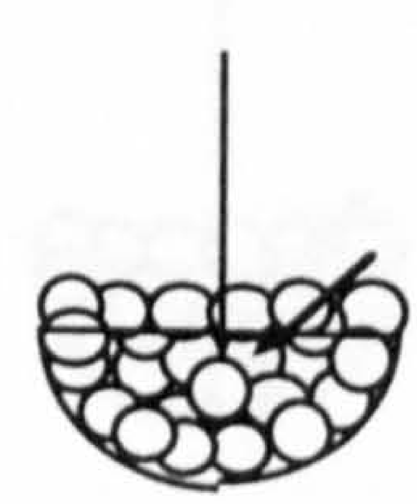

Scene 30

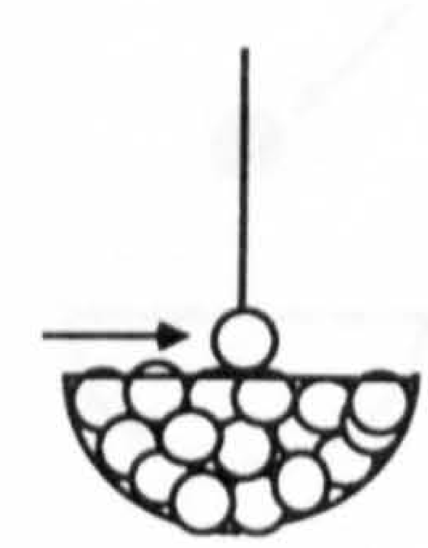

Scene 31

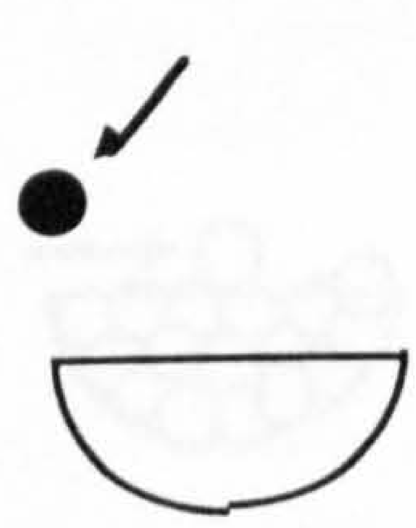

Scene 32


Scene 33

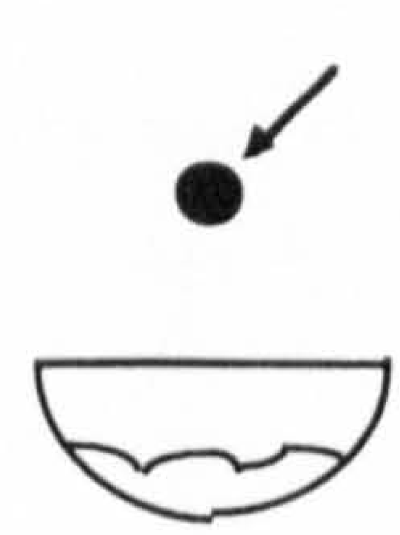

Scene 34

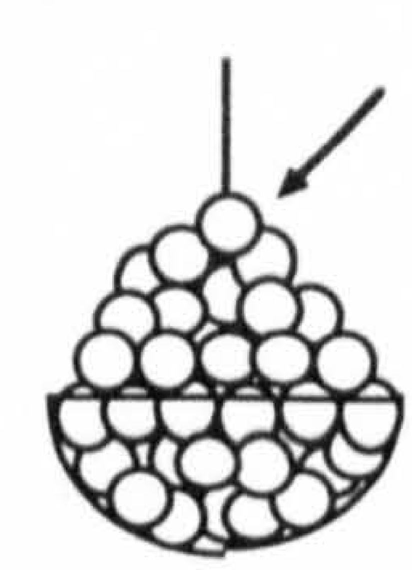

Scene 35

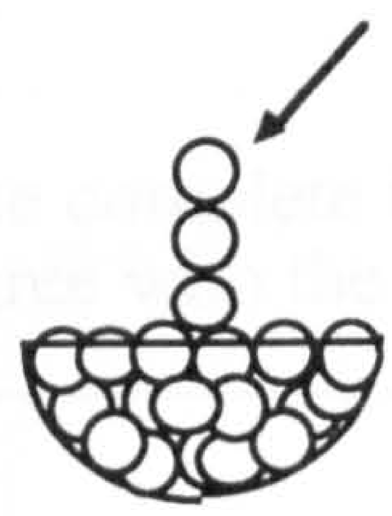

Scene 36


Scene 37


Scene 38

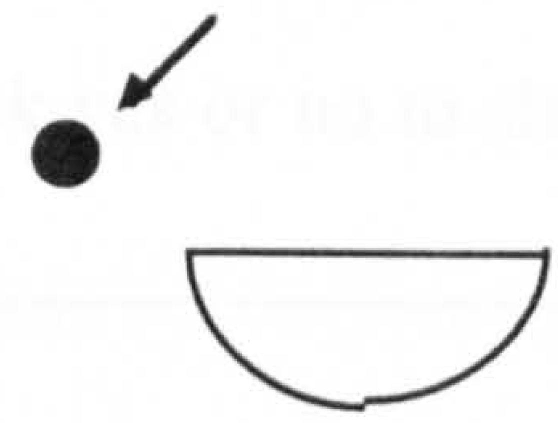

Scene 39


Scene 40

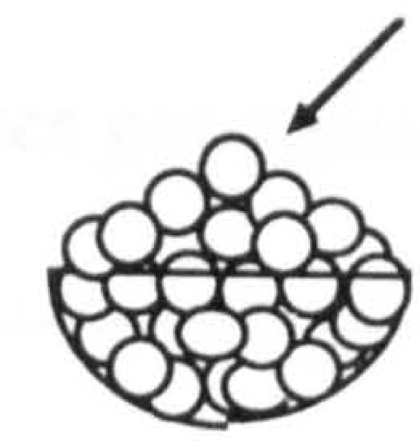


Scene 41

Scene 42

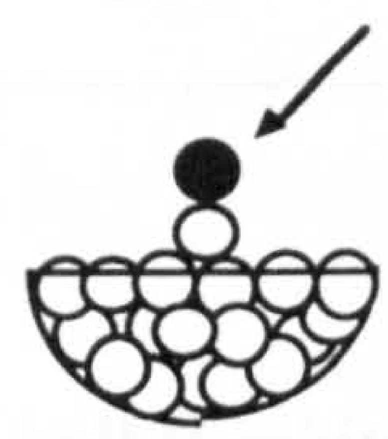


Scene 43

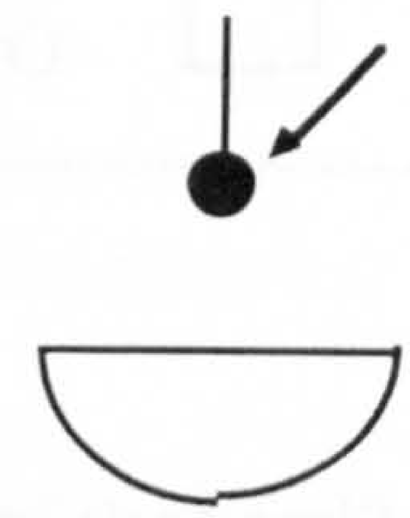


Scene 44

Scene 45

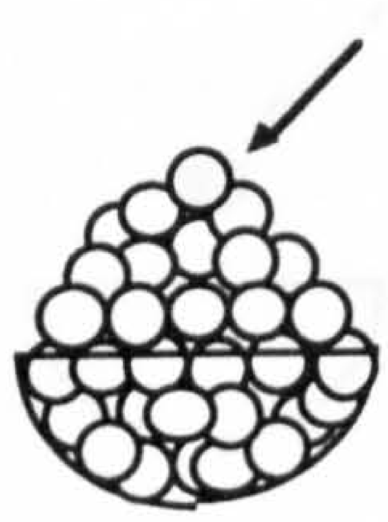


Scene 46



Scene 47

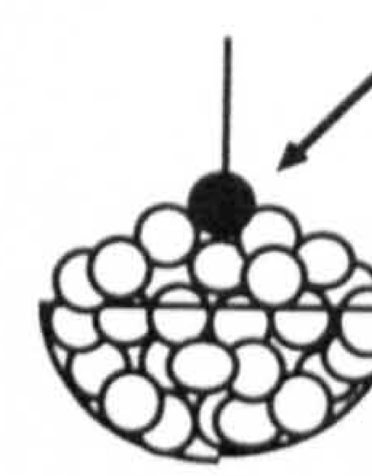
Scene 48



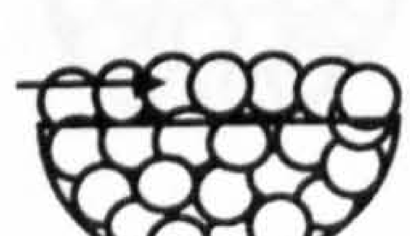
Scene 49

Scene 50

Scene 51

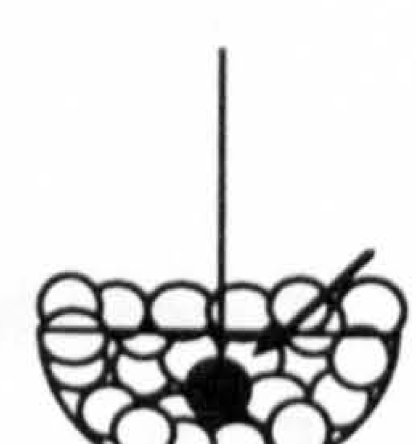


Scene 52



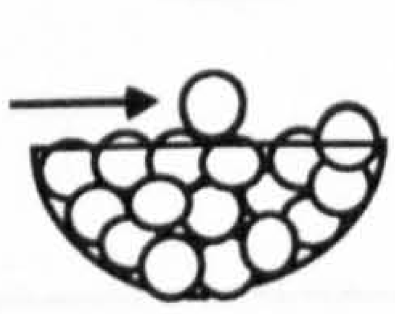
Scene 53

Scene 54

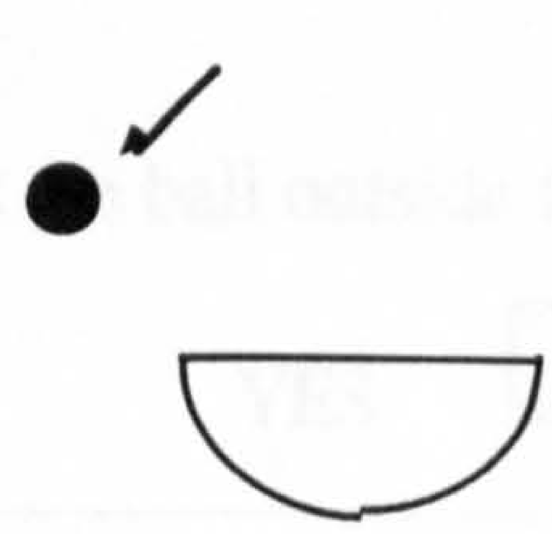


Scene 55

Scene 56



Scene 57

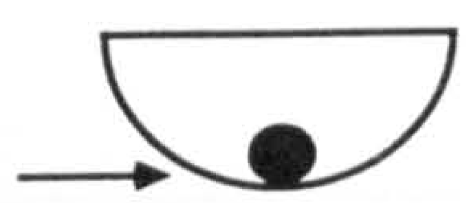


Scene 58

Appendix F: Checklist for PREP2 and IJ1

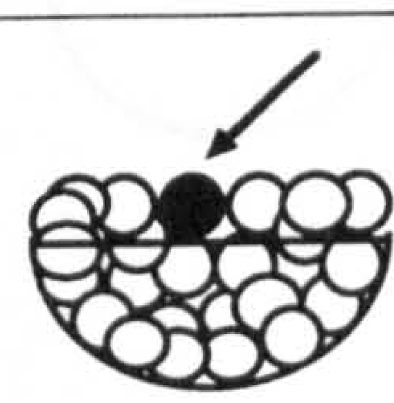
Language Experiment

Please complete the following checklist. Tick yes or no to show whether you agree or disagree with the accompanying question.



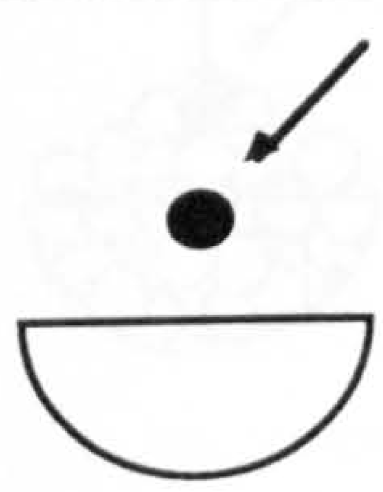
(a) Is the ball touching the base of the bowl?

YES ☐ NO ☐



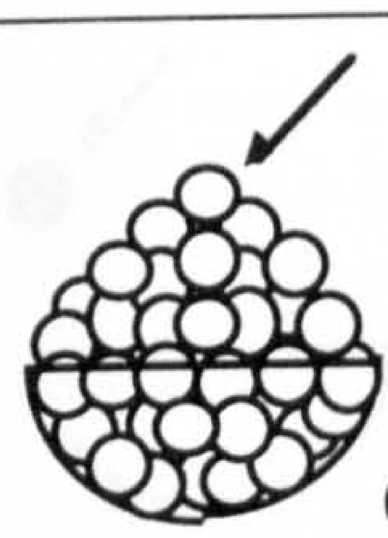
(b) Is the ball touching the rim of the bowl?

YES ☐ NO ☐



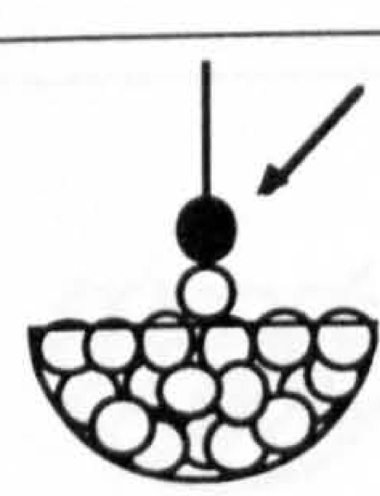
(c) Is the ball touching the bowl?

YES ☐ NO ☐



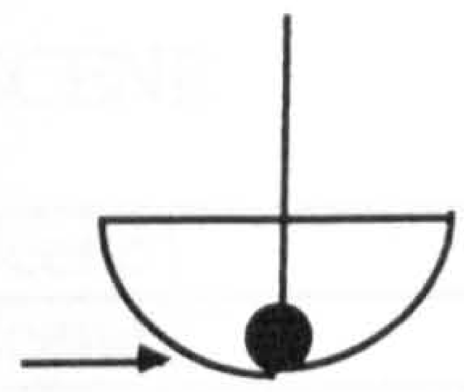
(d) Is the ball outside the rim of the bowl?

YES ☐ NO ☐



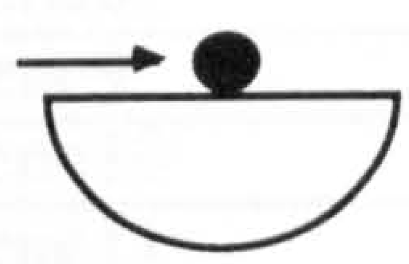
(e) Is the ball outside the rim of the bowl?

YES ☐ NO ☐



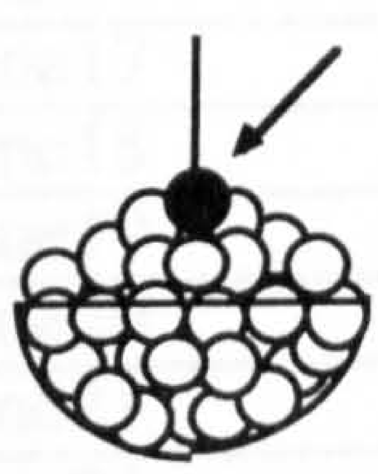
(f) Is the ball touching the base of the bowl?

YES ☐ NO ☐



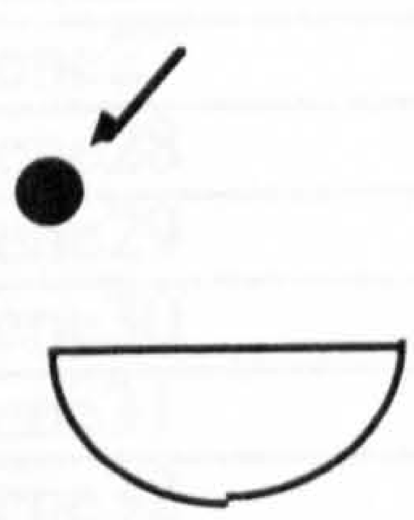
(g) Is the ball touching the rim of the bowl?

YES ☐ NO ☐



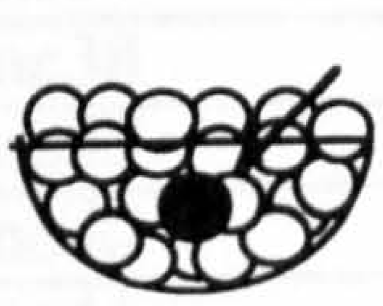
(h) Is the ball outside the rim of the bowl?

YES ☐ NO ☐



(i) Is the ball outside the rim of the bowl?

YES ☐ NO ☐



(j) Is the ball within the rim of the bowl?

YES ☐ NO ☐

END

Appendix G: Mean Values for IN, ON, OVER and ABOVE for PREP2

SCENE	IN	ON	OVER	ABOVE
Scene1	4.93	2.204	1.407	1.204
Scene2	4.48	2.185	2.037	1.722
Scene3	4.72	2.130	1.547	1.519
Scene4	1.54	3.111	3.704	4.037
Scene5	1.32	1.407	4.302	4.667
Scene6	3.46	2.852	3.000	3.111
Scene7	4.93	3.019	1.296	1.315
Scene8	4.74	2.796	1.358	1.547
Scene9	2.19	1.407	4.057	4.358
Scene10	1.07	1.019	2.593	3.852
Scene11	1.46	3.352	3.500	3.963
Scene12	4.70	2.833	1.278	1.315
Scene13	2.63	3.407	3.019	3.315
Scene14	1.000	1.056	4.519	4.759
Scene15	3.037	1.648	3.556	3.623
Scene16	2.111	1.481	4.167	4.407
Scene17	1.259	1.148	4.500	4.685
Scene18	2.019	1.519	4.259	4.352
Scene19	4.759	3.111	1.340	1.453
Scene20	4.648	2.556	1.208	1.389
Scene21	1.463	4.204	2.944	3.352
Scene22	2.833	1.741	3.796	3.778
Scene23	2.093	1.537	4.415	4.245
Scene24	1.222	1.093	4.481	4.611
Scene25	4.815	2.778	1.296	1.278
Scene26	4.556	1.389	1.907	1.833
Scene27	1.074	1.037	3.019	4.259
Scene28	1.741	1.426	4.167	4.444
Scene29	2.074	1.370	4.094	4.204
Scene30	3.130	3.648	2.778	2.852
Scene31	1.056	1.074	4.537	4.315
Scene32	3.574	2.630	2.352	2.537
Scene33	1.037	1.000	2.259	3.811
Scene34	1.685	1.333	3.870	4.556
Scene35	4.667	2.204	1.204	1.241
Scene36	2.444	4.019	2.889	3.074
Scene37	1.185	1.148	3.370	4.204
Scene38	1.815	1.426	3.815	4.241
Scene39	1.130	1.056	4.463	4.593
Scene40	2.019	1.556	4.241	4.222
Scene41	1.815	1.537	4.037	4.377
Scene42	2.389	3.815	3.148	3.222
Scene43	1.019	1.000	2.352	3.509
Scene44	2.833	1.333	3.463	3.704
Scene45	1.148	1.185	3.296	3.815
Scene46	2.093	1.352	3.796	4.204
Scene47	1.037	1.000	4.426	4.741

SCENE	IN	ON	OVER	ABOVE
Scene48	2.944	3.556	2.870	2.722
Scene49	2.093	1.537	3.642	4.241
Scene50	4.537	2.296	1.204	1.333
Scene51	1.185	1.074	4.389	4.463
Scene52	2.481	1.463	3.537	3.849
Scene53	3.167	3.556	2.593	2.667
Scene54	1.037	1.130	3.259	4.321
Scene55	4.556	2.352	1.241	1.259
Scene56	1.056	1.056	4.315	4.593
Scene57	2.778	3.667	2.833	2.796
Scene58	1.000	1.037	2.426	3.722

Appendix H: PREP3 Questionnaire Booklet

LANGUAGE EXPERIMENT

In this experiment you will be shown 44 scenes on video. A group of statements are provided for **each** scene and it is your task to rate the appropriateness of each statement for the corresponding scene. You **must** circle a rating (1 to 5) for each statement from 1 = Highly Unlikely to 5 = Most Likely. Please read the relevant statements before the scene appears on screen. The statements are randomised and the ball referred to is indicated by a black arrow.

EXAMPLE 1:	The weight is **over** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5
	The weight is **in** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
EXAMPLE 2:	The ball is **under** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **over** the wood	1	2	3	4	5
EXAMPLE 3:	The ball is **below** the wood	1	2	3	4	5
	The ball is **over** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5
	The ball is **under** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
EXAMPLE 4:	The weight is **in** the plywood	1	2	3	4	5
	The weight is **below** the plywood	1	2	3	4	5
	The weight is **above** the plywood	1	2	3	4	5
	The weight is **on** the plywood	1	2	3	4	5
	The weight is **under** the plywood	1	2	3	4	5
	The weight is **over** the plywood	1	2	3	4	5

(1)	The weight is **in** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **over** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5
(2)	The weight is **under** the gauze	1	2	3	4	5
	The weight is **on** the gauze	1	2	3	4	5
	The weight is **below** the gauze	1	2	3	4	5
	The weight is **in** the gauze	1	2	3	4	5
	The weight is **over** the gauze	1	2	3	4	5
	The weight is **above** the gauze	1	2	3	4	5
(3)	The ball is **over** the wood	1	2	3	4	5
	The ball is **under** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
(4)	The weight is **over** the gauze	1	2	3	4	5
	The weight is **above** the gauze	1	2	3	4	5
	The weight is **on** the gauze	1	2	3	4	5
	The weight is **below** the gauze	1	2	3	4	5
	The weight is **under** the gauze	1	2	3	4	5
	The weight is **in** the gauze	1	2	3	4	5
(5)	The weight is **on** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5
	The weight is **in** the wood	1	2	3	4	5
	The weight is **over** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
(6)	The weight is **in** the gauze	1	2	3	4	5
	The weight is **under** the gauze	1	2	3	4	5
	The weight is **below** the gauze	1	2	3	4	5
	The weight is **on** the gauze	1	2	3	4	5
	The weight is **over** the gauze	1	2	3	4	5
	The weight is **above** the gauze	1	2	3	4	5
(7)	The weight is **over** the plywood	1	2	3	4	5
	The weight is **below** the plywood	1	2	3	4	5
	The weight is **on** the plywood	1	2	3	4	5
	The weight is **above** the plywood	1	2	3	4	5
	The weight is **in** the plywood	1	2	3	4	5
	The weight is **under** the plywood	1	2	3	4	5

(8)	The ball is **in** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
	The ball is **under** the wood	1	2	3	4	5
	The ball is **over** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
(9)	The weight is **above** the plywood	1	2	3	4	5
	The weight is **below** the plywood	1	2	3	4	5
	The weight is **in** the plywood	1	2	3	4	5
	The weight is **on** the plywood	1	2	3	4	5
	The weight is **under** the plywood	1	2	3	4	5
	The weight is **over** the plywood	1	2	3	4	5
(10)	The weight is **below** the gauze	1	2	3	4	5
	The weight is **over** the gauze	1	2	3	4	5
	The weight is **in** the gauze	1	2	3	4	5
	The weight is **above** the gauze	1	2	3	4	5
	The weight is **under** the gauze	1	2	3	4	5
	The weight is **on** the gauze	1	2	3	4	5
(11)	The weight is **over** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5
	The weight is **in** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
(12)	The weight is **in** the plywood	1	2	3	4	5
	The weight is **below** the plywood	1	2	3	4	5
	The weight is **above** the plywood	1	2	3	4	5
	The weight is **on** the plywood	1	2	3	4	5
	The weight is **under** the plywood	1	2	3	4	5
	The weight is **over** the plywood	1	2	3	4	5
(13)	The ball is **under** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **over** the wood	1	2	3	4	5
(14)	The weight is **above** the wood	1	2	3	4	5
	The weight is **over** the wood	1	2	3	4	5
	The weight is **in** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5

(15)	The weight is **on** the gauze	1	2	3	4	5
	The weight is **over** the gauze	1	2	3	4	5
	The weight is **in** the gauze	1	2	3	4	5
	The weight is **above** the gauze	1	2	3	4	5
	The weight is **below** the gauze	1	2	3	4	5
	The weight is **under** the gauze	1	2	3	4	5
(16)	The weight is **over** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
	The weight is **in** the wood	1	2	3	4	5
(17)	The weight is **over** the plywood	1	2	3	4	5
	The weight is **below** the plywood	1	2	3	4	5
	The weight is **on** the plywood	1	2	3	4	5
	The weight is **above** the plywood	1	2	3	4	5
	The weight is **in** the plywood	1	2	3	4	5
	The weight is **under** the plywood	1	2	3	4	5
(18)	The ball is **in** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
	The ball is **under** the wood	1	2	3	4	5
	The ball is **over** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
(19)	The ball is **over** the wood	1	2	3	4	5
	The ball is **under** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
(20)	The weight is **over** the plywood	1	2	3	4	5
	The weight is **below** the plywood	1	2	3	4	5
	The weight is **on** the plywood	1	2	3	4	5
	The weight is **above** the plywood	1	2	3	4	5
	The weight is **in** the plywood	1	2	3	4	5
	The weight is **under** the plywood	1	2	3	4	5
(21)	The weight is **in** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **over** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5

(22)	The weight is **over** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5
	The weight is **in** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
(23)	The weight is **over** the plywood	1	2	3	4	5
	The weight is **under** the plywood	1	2	3	4	5
	The weight is **on** the plywood	1	2	3	4	5
	The weight is **above** the plywood	1	2	3	4	5
	The weight is **below** the plywood	1	2	3	4	5
	The weight is **in** the plywood	1	2	3	4	5
(24)	The weight is **in** the wood	1	2	3	4	5
	The weight is **over** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5
(25)	The ball is **under** the wood	1	2	3	4	5
	The ball is **over** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5
(26)	The weight is **on** the wood	1	2	3	4	5
	The weight is **over** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **in** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5
(27)	The weight is **under** the plywood	1	2	3	4	5
	The weight is **below** the plywood	1	2	3	4	5
	The weight is **above** the plywood	1	2	3	4	5
	The weight is **on** the plywood	1	2	3	4	5
	The weight is **in** the plywood	1	2	3	4	5
	The weight is **over** the plywood	1	2	3	4	5
(28)	The weight is **below** the gauze	1	2	3	4	5
	The weight is **over** the gauze	1	2	3	4	5
	The weight is **in** the gauze	1	2	3	4	5
	The weight is **above** the gauze	1	2	3	4	5
	The weight is **under** the gauze	1	2	3	4	5
	The weight is **on** the gauze	1	2	3	4	5

(29)	The ball is **on** the wood	1	2	3	4	5
	The ball is **over** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **under** the wood	1	2	3	4	5

(30)	The ball is **above** the wood	1	2	3	4	5
	The ball is **under** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
	The ball is **over** the wood	1	2	3	4	5

(31)	The ball is **under** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **over** the wood	1	2	3	4	5

(32)	The weight is **in** the wood	1	2	3	4	5
	The weight is **over** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5

(33)	The weight is **in** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5
	The weight is **over** the wood	1	2	3	4	5

(34)	The weight is **below** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **over** the wood	1	2	3	4	5
	The weight is **in** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5

(35)	The ball is **over** the wood	1	2	3	4	5
	The ball is **under** the wood	1	2	3	4	5
	The ball is **in** wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5

(36)	The weight is **on** the wood	1	2	3	4	5
	The weight is **over** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **in** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5

(37)	The weight is **over** the wood	1	2	3	4	5
	The weight is **in** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5

(38)	The ball is **under** the wood	1	2	3	4	5
	The ball is **over** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5

(39)	The weight is **in** the gauze	1	2	3	4	5
	The weight is **under** the gauze	1	2	3	4	5
	The weight is **below** the gauze	1	2	3	4	5
	The weight is **on** the gauze	1	2	3	4	5
	The weight is **over** the gauze	1	2	3	4	5
	The weight is **above** the gauze	1	2	3	4	5

(40)	The ball is **in** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5
	The ball is **under** the wood	1	2	3	4	5
	The ball is **over** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5

(41)	The ball is **over** the wood	1	2	3	4	5
	The ball is **under** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5

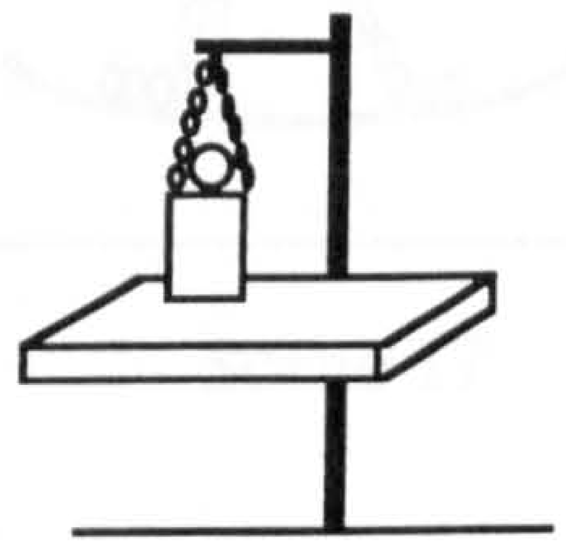
(42)	The weight is **on** the gauze	1	2	3	4	5
	The weight is **over** the gauze	1	2	3	4	5
	The weight is **in** the gauze	1	2	3	4	5
	The weight is **above** the gauze	1	2	3	4	5
	The weight is **below** the gauze	1	2	3	4	5
	The weight is **under** the gauze	1	2	3	4	5

(43)	The weight is **in** the wood	1	2	3	4	5
	The weight is **over** the wood	1	2	3	4	5
	The weight is **above** the wood	1	2	3	4	5
	The weight is **under** the wood	1	2	3	4	5
	The weight is **on** the wood	1	2	3	4	5
	The weight is **below** the wood	1	2	3	4	5
(44)	The ball is **over** the wood	1	2	3	4	5
	The ball is **under** the wood	1	2	3	4	5
	The ball is **in** the wood	1	2	3	4	5
	The ball is **below** the wood	1	2	3	4	5
	The ball is **above** the wood	1	2	3	4	5
	The ball is **on** the wood	1	2	3	4	5

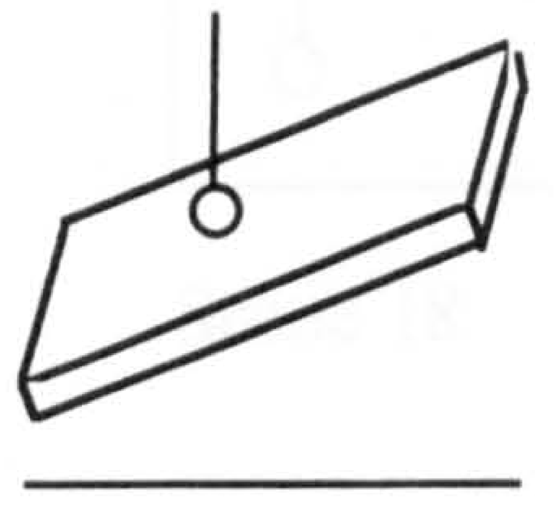
END

Appendix I: PREP3 Pictorial Representations

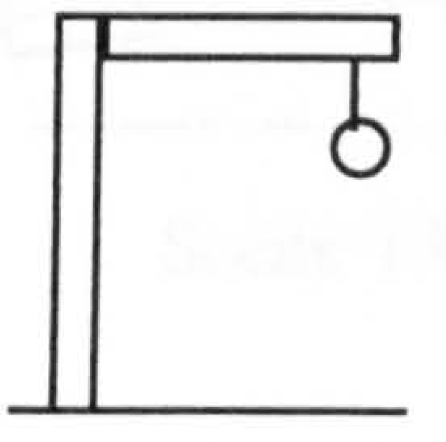
These scenes are in the randomised order in which they were shown to the subjects.



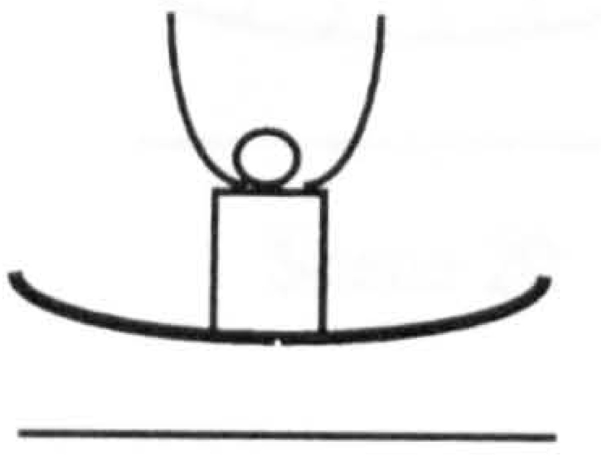
Example 1



Example 2

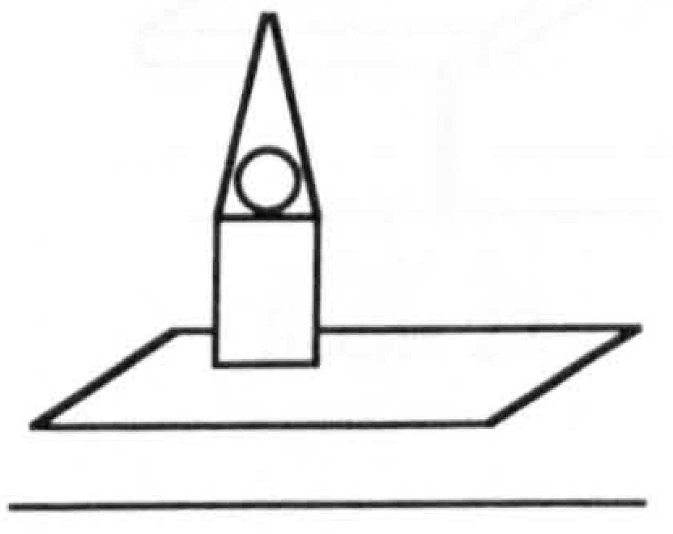


Example 3

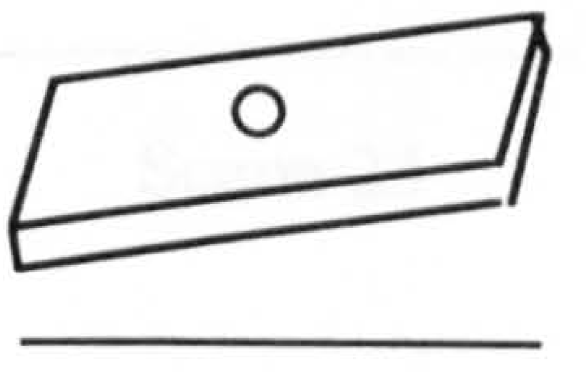


Example 4

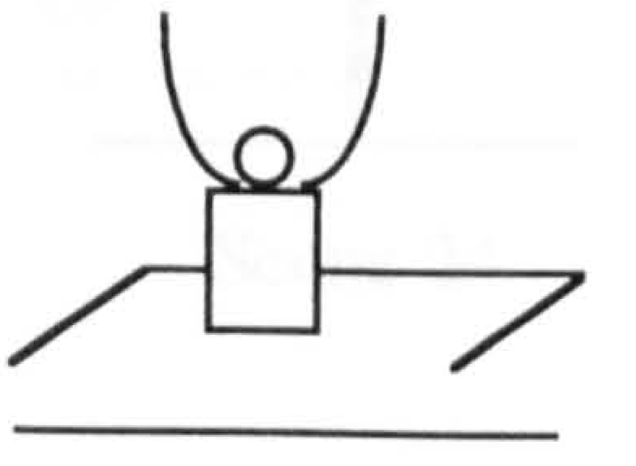
Scene 1



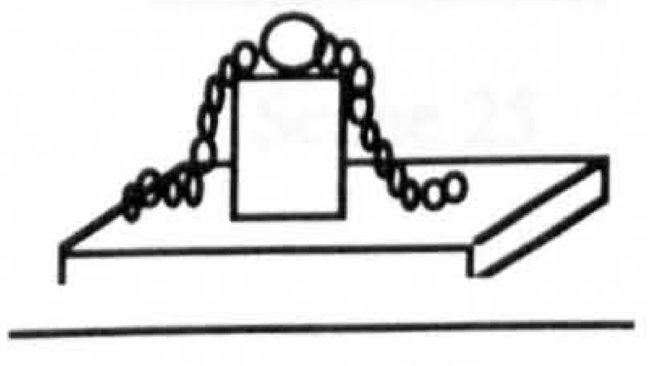
Scene 2



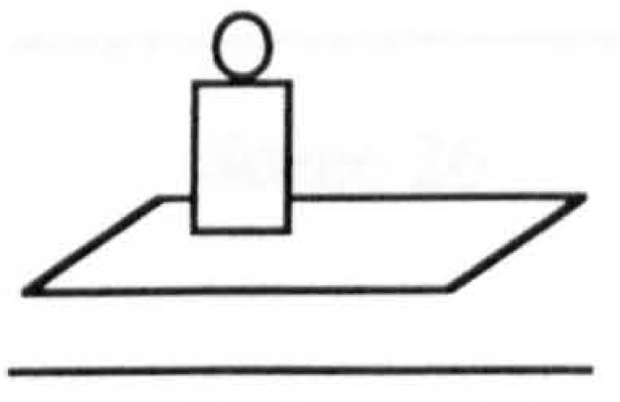
Scene 3



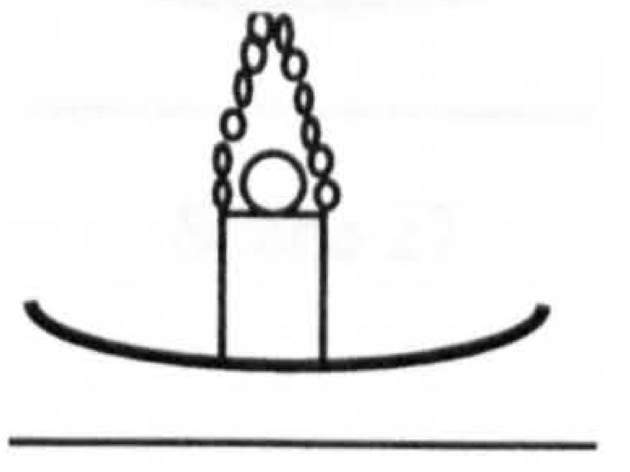
Scene 4



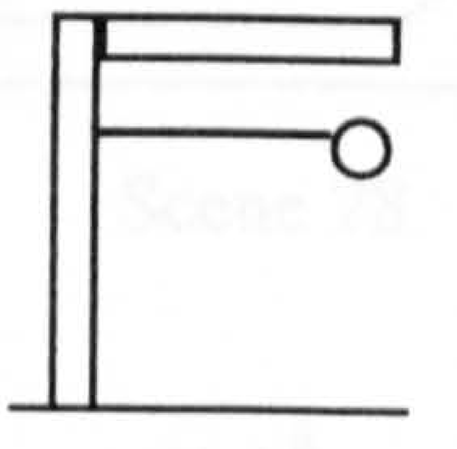
Scene 5



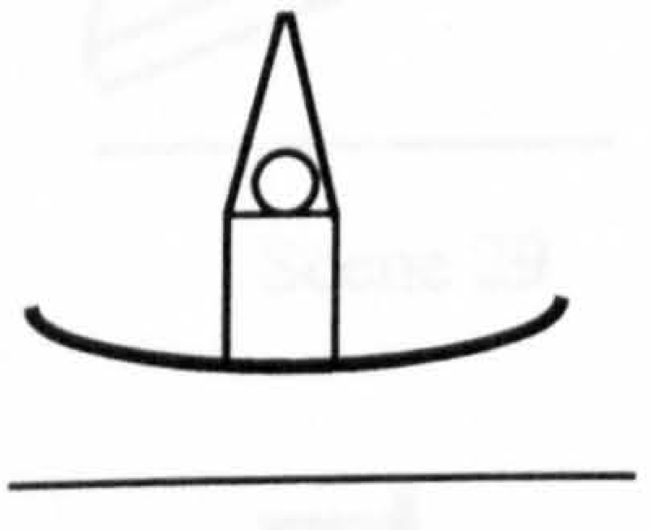
Scene 6



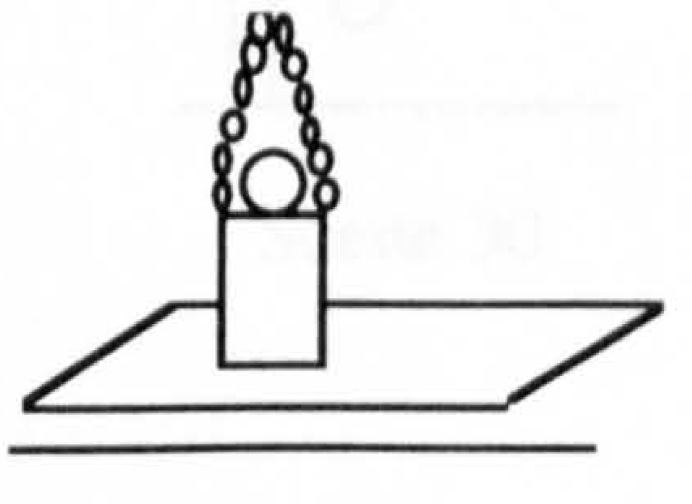
Scene 7



Scene 8

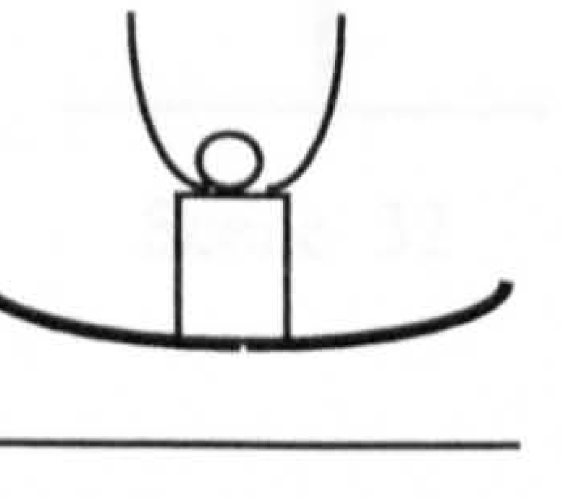


Scene 9

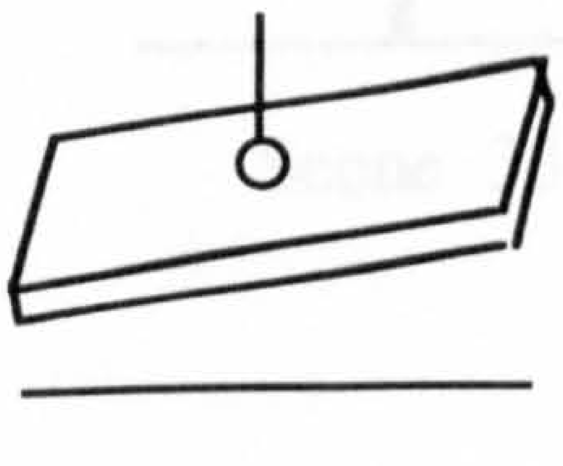


Scene 10

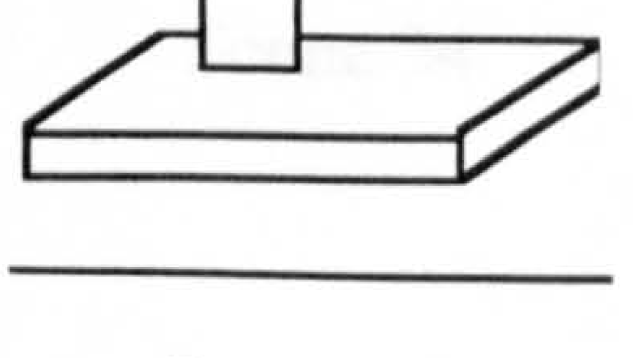
Scene 11



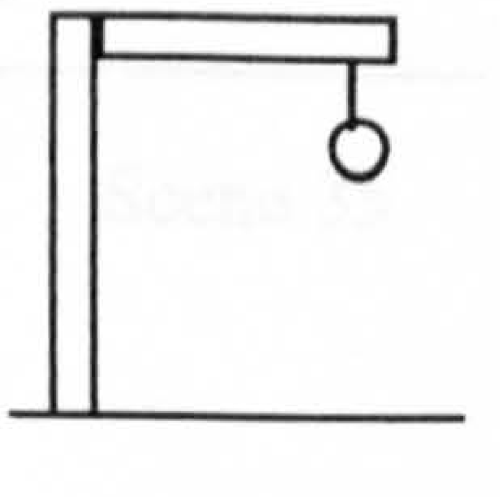
Scene 12



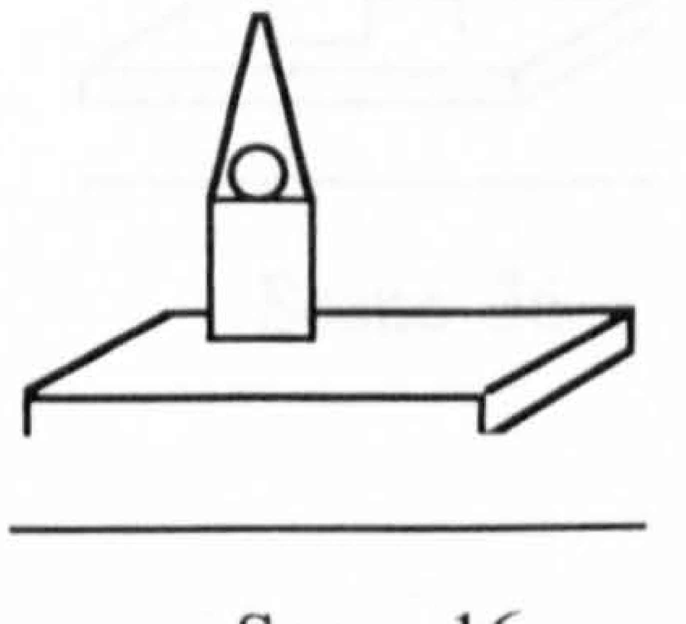
Scene 13



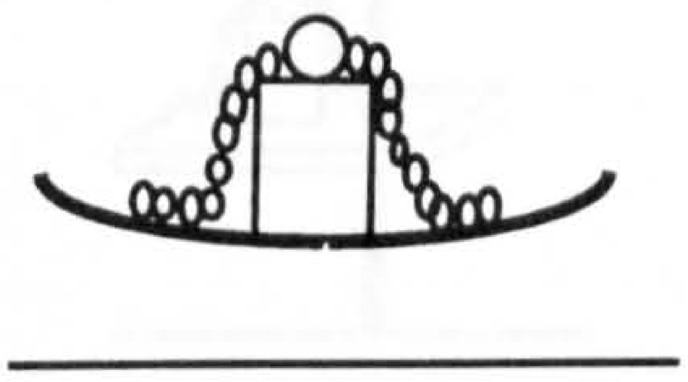
Scene 14

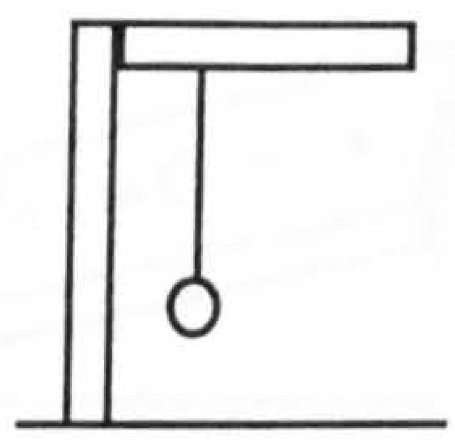


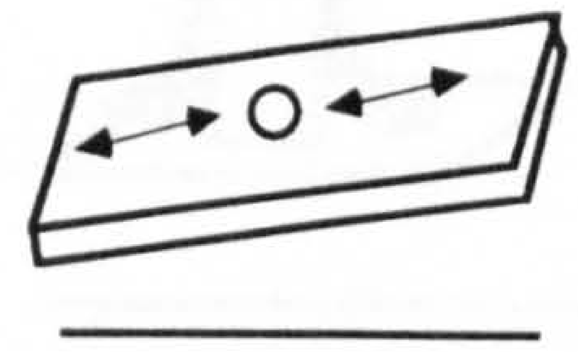
Scene 15

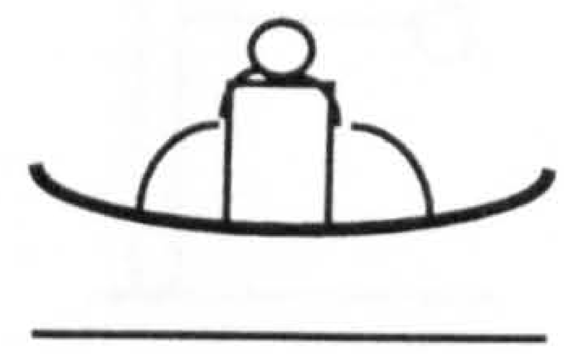


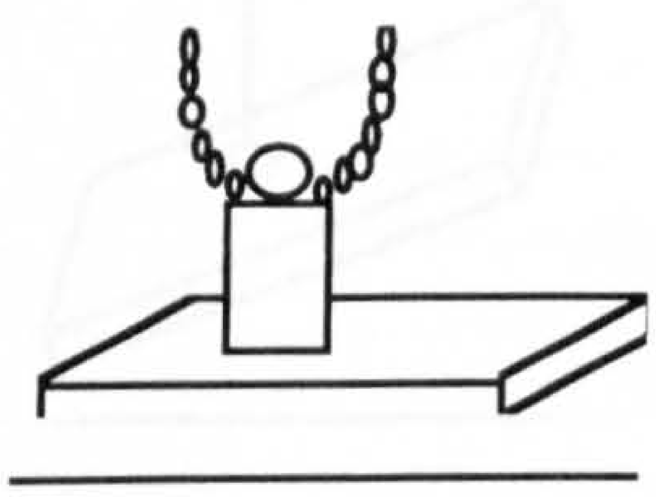
Scene 16

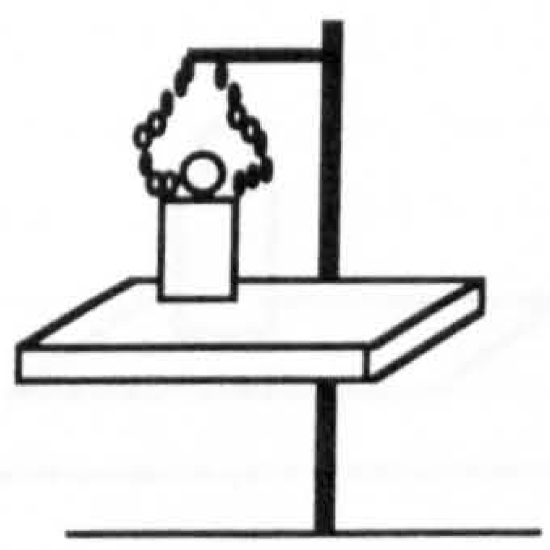

Scene 17

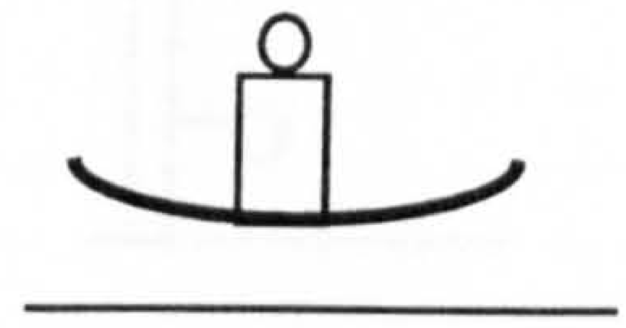

Scene 18


Scene 19

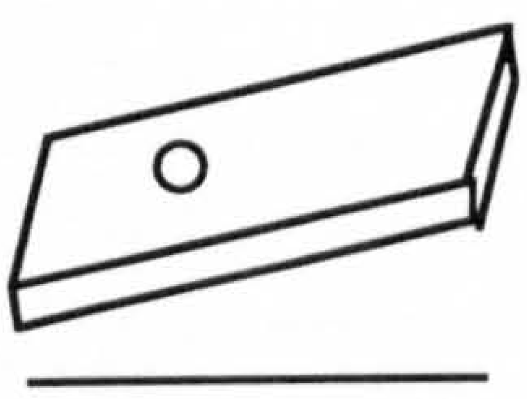

Scene 20

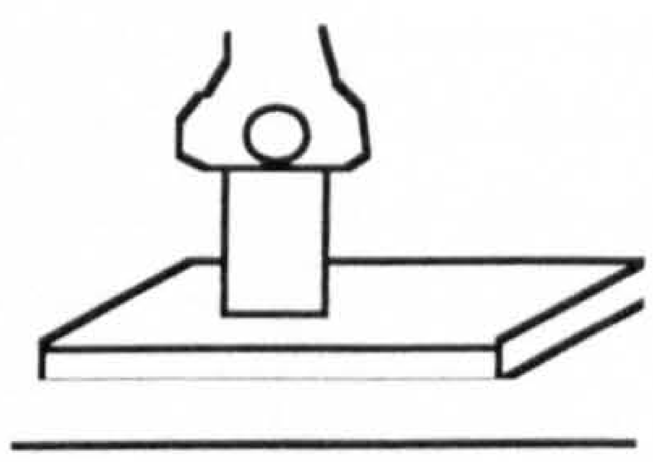

Scene 21

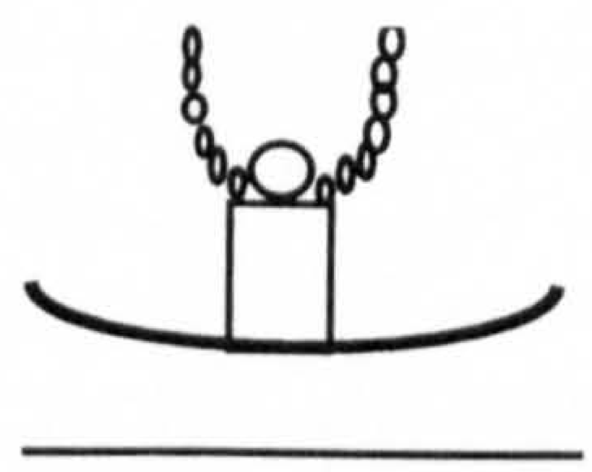

Scene 22

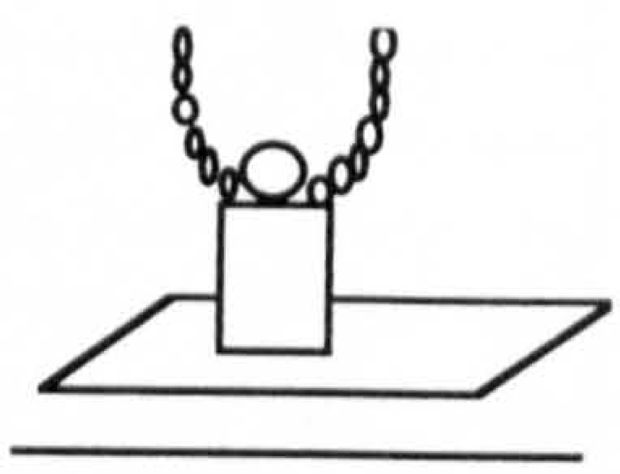

Scene 23

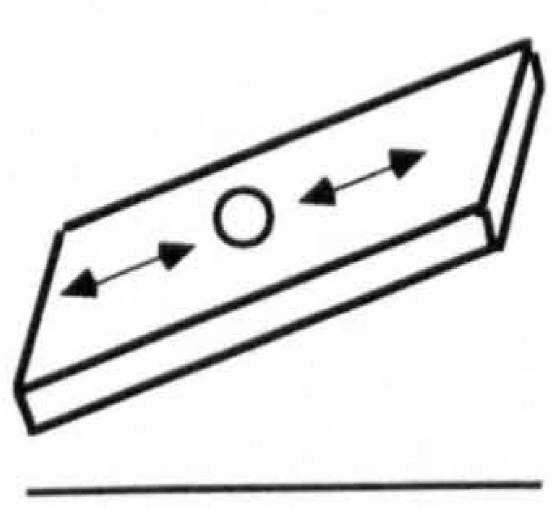

Scene 24

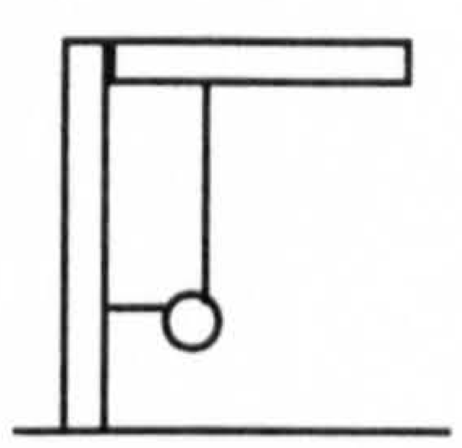

Scene 25

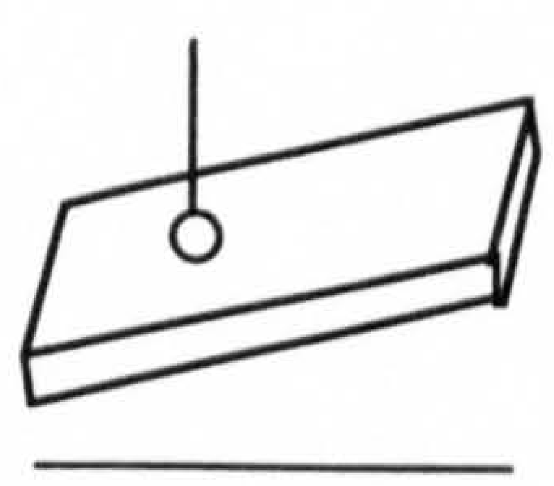

Scene 26

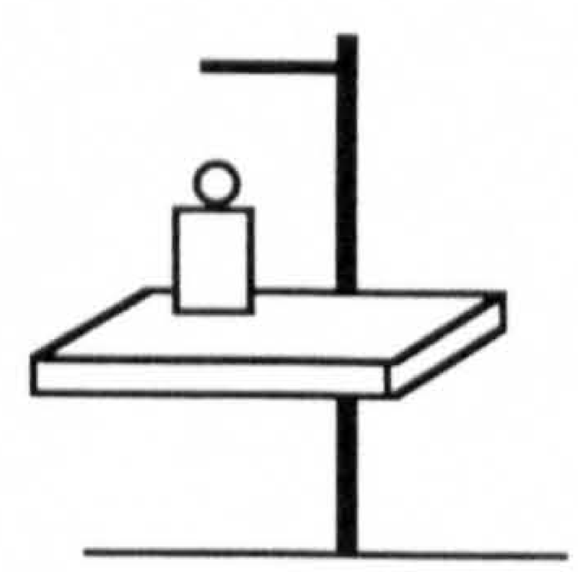

Scene 27

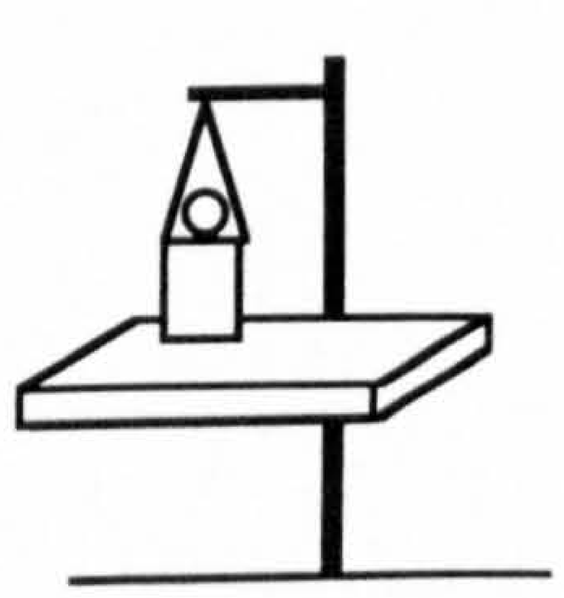

Scene 28

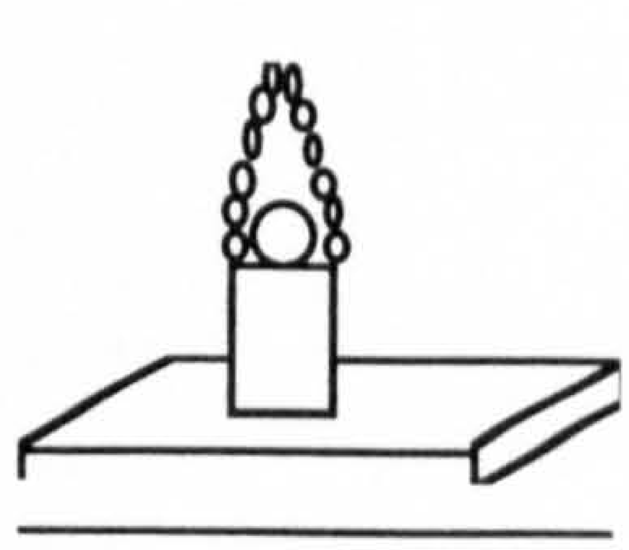

Scene 29

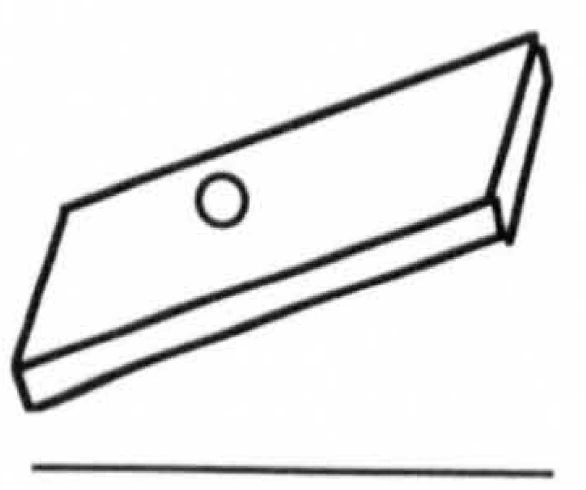

Scene 30

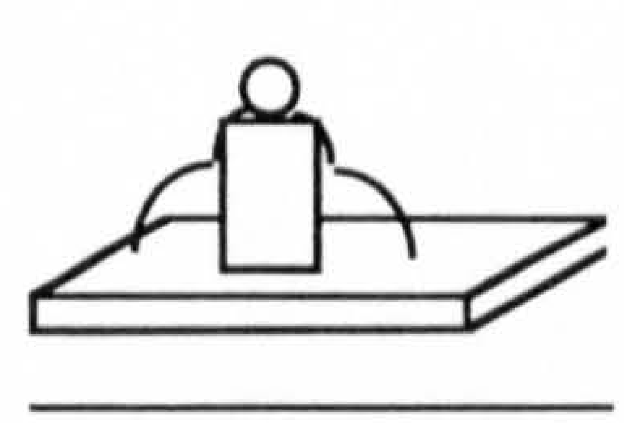

Scene 31

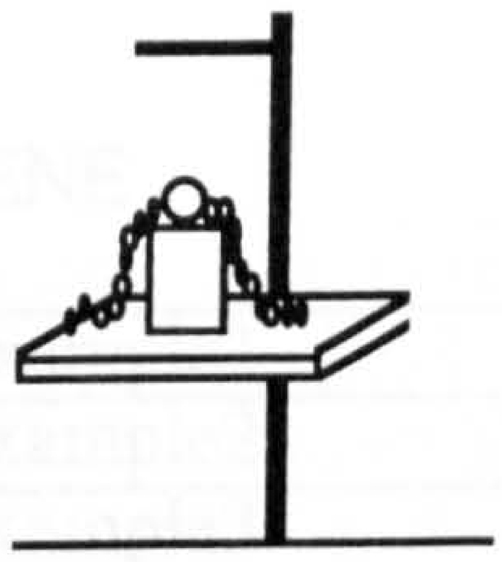

Scene 32


Scene 33

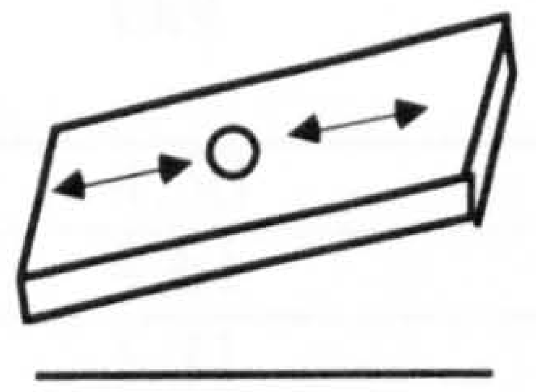

Scene 34


Scene 35

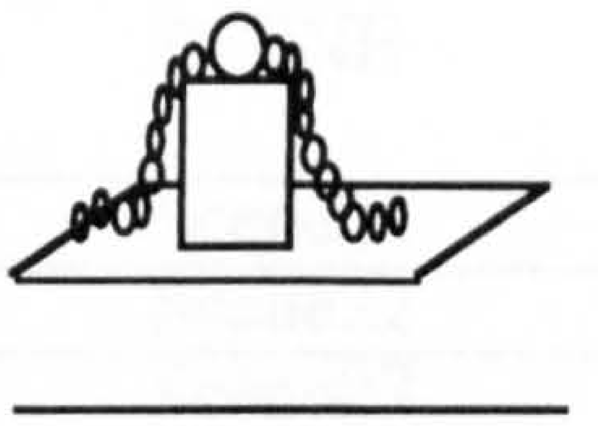

Scene 36



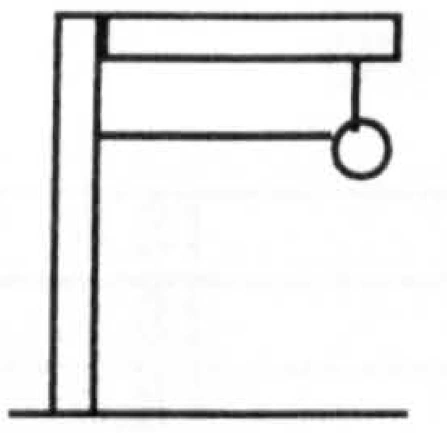
Scene 37



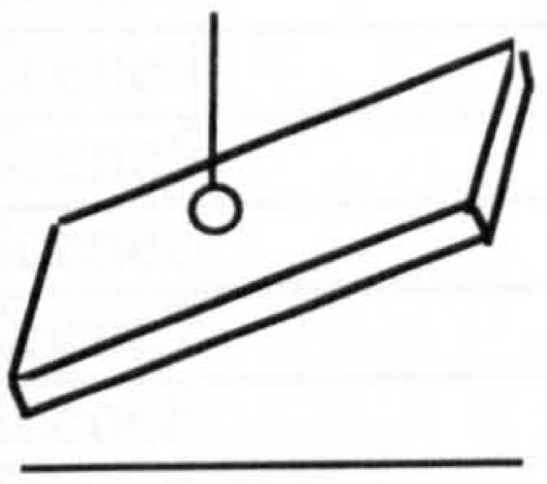
Scene 38



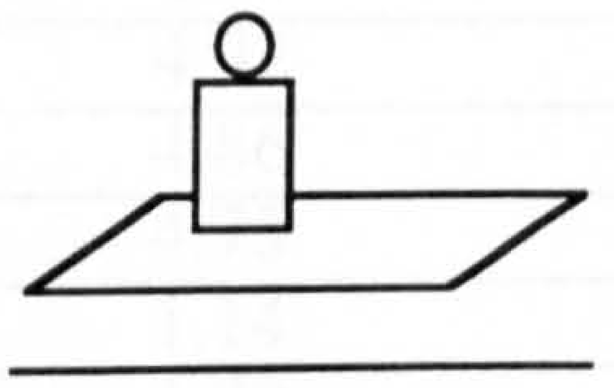
Scene 39



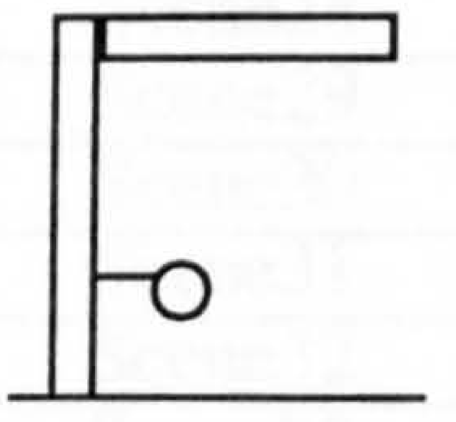
Scene 40



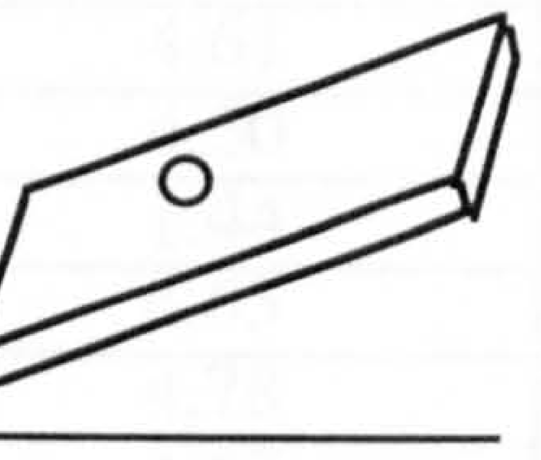
Scene 41



Scene 42



Scene 43



Scene 44

Appendix J: Mean Values for ON for PREP3

SCENE	ON	SCENE	ON
Example1	4.50	Scene21	4.81
Example2	4.61	Scene22	4.81
Example3	1.31	Scene23	4.83
Example4	4.69	Scene24	4.92
Scene1	4.64	Scene25	4.75
Scene2	4.44	Scene26	4.81
Scene3	4.92	Scene27	4.97
Scene4	4.78	Scene28	4.61
Scene5	4.92	Scene29	4.50
Scene6	4.86	Scene30	1.44
Scene7	4.75	Scene31	4.65
Scene8	1.14	Scene32	4.78
Scene9	4.89	Scene33	4.67
Scene10	4.50	Scene34	4.50
Scene11	4.50	Scene35	4.81
Scene12	4.92	Scene36	4.89
Scene13	4.56	Scene37	4.86
Scene14	4.94	Scene38	4.31
Scene15	1.47	Scene39	4.56
Scene16	4.61	Scene40	1.22
Scene17	4.69	Scene41	4.11
Scene18	1.11	Scene42	4.78
Scene19	4.39	Scene43	1.33
Scene20	4.92	Scene44	4.81

Appendix K: PREP4 Questionnaire Booklet

Language Experiment

In this experiment you will be shown 30 scenes on video. A group of statements are provided for **each** scene and it is your task to rate the appropriateness of each statement for the corresponding scene. You **must** circle a rating (1 to 5) for each statement from 1 = Highly Unlikely to 5 = Most Likely. Please read the relevant statements before the scene appears on screen. The statements are randomised and the ball referred to is indicated by a pointer. Certain scenes involve the ball moving.

(1)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(2)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(3)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(4)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(5)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

(6)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(7)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(8)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(9)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(10)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(11)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(12)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

(13)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(14)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(15)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(16)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(17)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(18)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(19)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

(20)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(21)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(22)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(23)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(24)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(25)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(26)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

(27)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5

(28)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

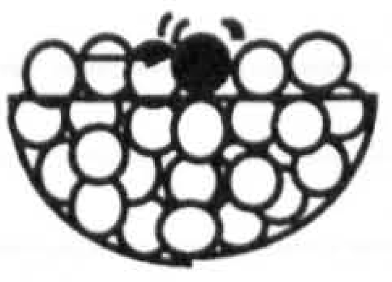
(29)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5

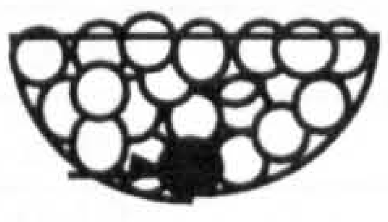
(30)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5

THE END

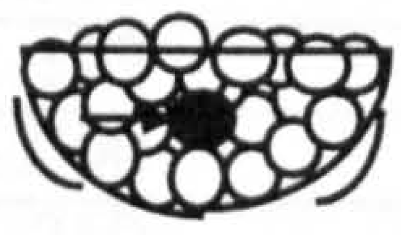
Appendix L: PREP4 Pictorial Representations

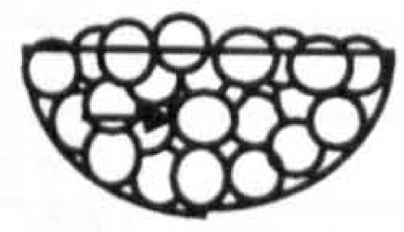
These scenes are in the randomised order in which they were shown to subjects.

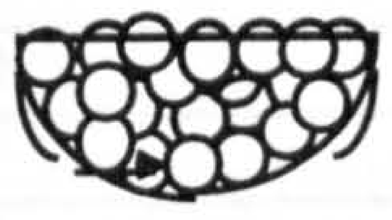

Scene 1


Scene 2

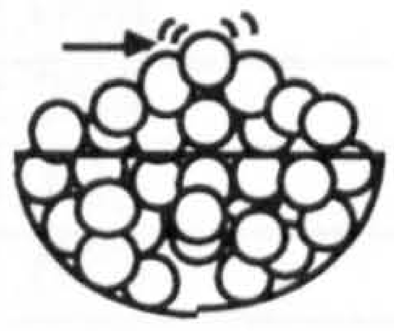

Scene 3

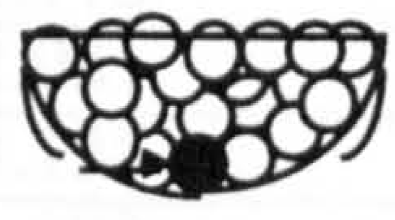

Scene 4

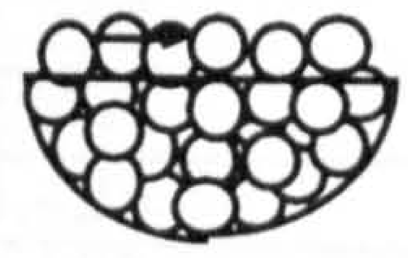

Scene 5

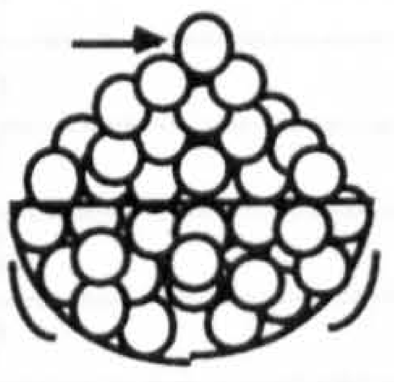

Scene 6

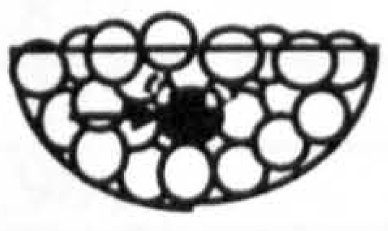

Scene 7

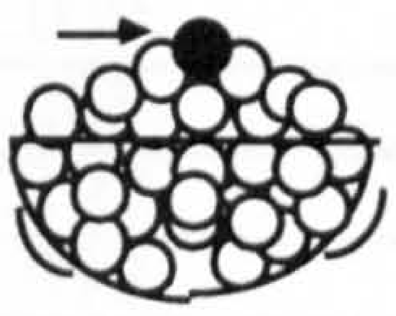

Scene 8

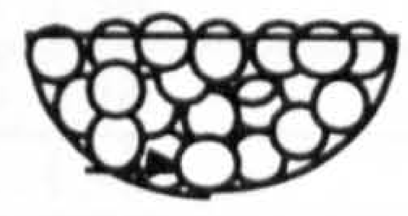

Scene 9

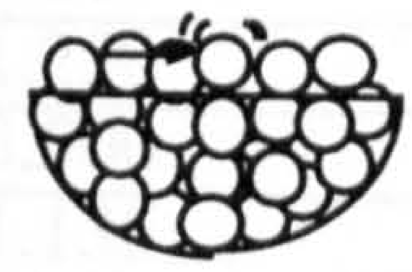

Scene 10


Scene 11

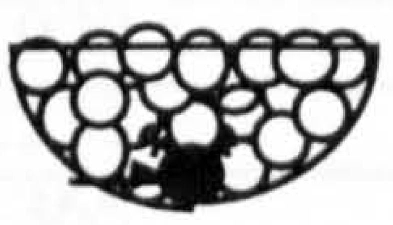

Scene 12

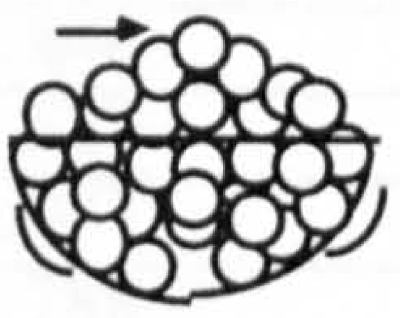

Scene 13

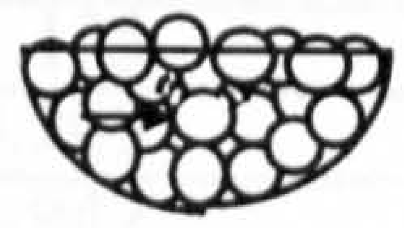

Scene 14


Scene 15

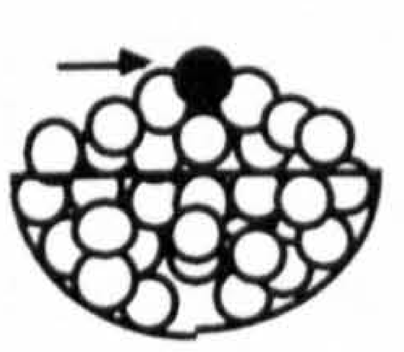

Scene 16

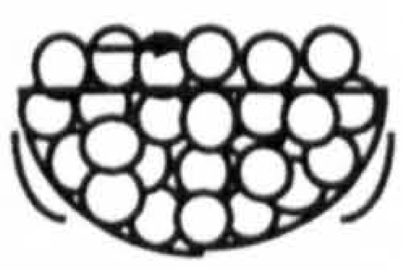

Scene 17

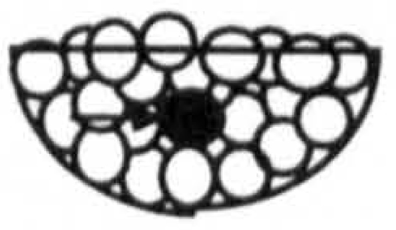

Scene 18

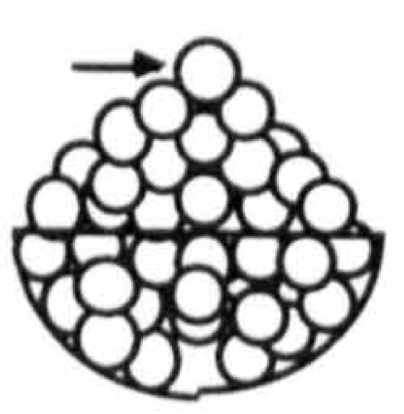

Scene 19

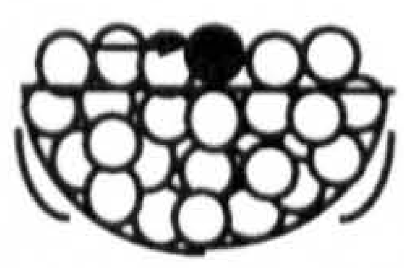

Scene 20

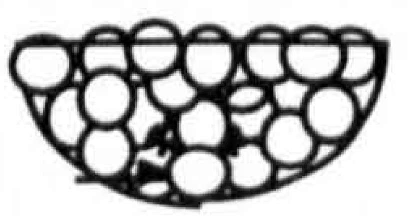

Scene 21


Scene 22


Scene 23

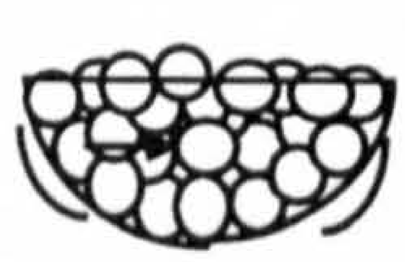

Scene 24

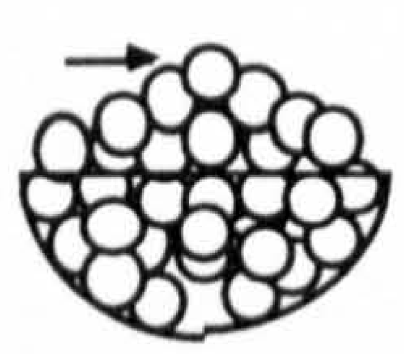

Scene 25


Scene 26


Scene 27


Scene 28


Scene 29


Scene 30

Appendix M: Mean Values for IN, ON, OVER and ABOVE for PREP4

SCENE	IN	ON	OVER	ABOVE
Scene 1	3.423	3.885	2.500	2.673
Scene 2	4.904	1.962	1.192	1.275
Scene 3	2.250	1.750	4.000	4.462
Scene 4	4.942	2.058	1.250	1.231
Scene 5	4.962	1.808	1.365	1.288
Scene 6	4.788	2.288	1.327	1.250
Scene 7	2.115	1.885	4.212	4.404
Scene 8	3.115	2.098	3.769	3.635
Scene 9	4.962	2.288	1.173	1.212
Scene 10	3.077	4.135	2.981	2.969
Scene 11	2.269	1.673	4.135	4.423
Scene 12	4.942	2.019	1.192	1.192
Scene 13	3.000	2.038	3.462	3.615
Scene 14	4.904	2.462	1.059	1.176
Scene 15	3.769	4.346	2.885	2.885
Scene 16	2.250	2.039	4.039	4.269
Scene 17	4.827	2.288	1.154	1.250
Scene 18	3.288	2.192	3.098	3.500
Scene 19	4.981	2.019	1.135	1.135
Scene 20	2.519	1.692	4.019	4.327
Scene 21	3.000	2.019	3.373	3.569
Scene 22	3.327	4.077	2.827	2.519
Scene 23	4.904	1.962	1.154	1.154
Scene 24	2.327	1.846	4.096	4.519
Scene 25	3.615	3.846	3.019	2.769
Scene 26	4.923	2.519	1.135	1.115
Scene 27	3.231	2.077	3.269	3.423
Scene 28	3.365	3.788	2.942	2.962
Scene 29	4.923	2.077	1.077	1.192
Scene 30	2.942	1.923	3.346	3.596

Appendix N: PREP5 Questionnaire Booklet

Language Experiment

In this experiment you will be shown 18 scenes on video. A group of statements are provided for **each** scene and it is your task to rate the appropriateness of each statement for the corresponding scene. You **must** circle a rating (1 to 5) for each statement from 1 = Highly Unlikely to 5 = Most Likely. Please read the relevant statements before the scene appears on screen. The statements are randomised and the ball referred to is indicated by a pointer. Certain scenes involve the ball or bowl moving.

(1)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(2)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(3)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(4)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(5)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

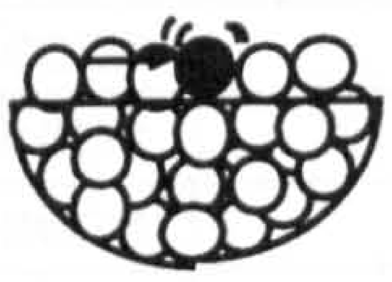
(6)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(7)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(8)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(9)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(10)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(11)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(12)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5

(13)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(14)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(15)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
(16)	The ball is **under** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
(17)	The ball is **over** the bowl	1	2	3	4	5
	The ball is **in** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
(18)	The ball is **in** the bowl	1	2	3	4	5
	The ball is **on** the bowl	1	2	3	4	5
	The ball is **under** the bowl	1	2	3	4	5
	The ball is **over** the bowl	1	2	3	4	5
	The ball is **above** the bowl	1	2	3	4	5
	The ball is **below** the bowl	1	2	3	4	5

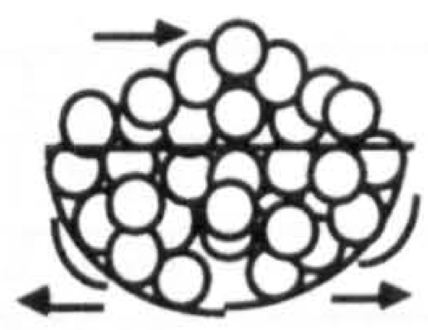
THE END

Appendix O: PREP5 Pictorial Representations

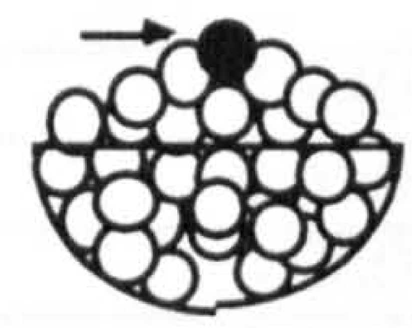
These scenes are in the randomised order in which they were shown to the subjects.



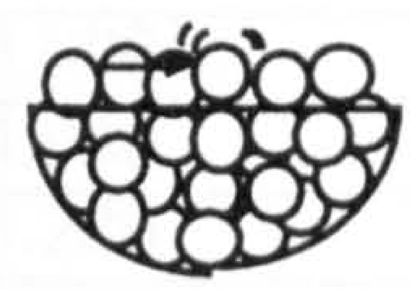
Scene 1



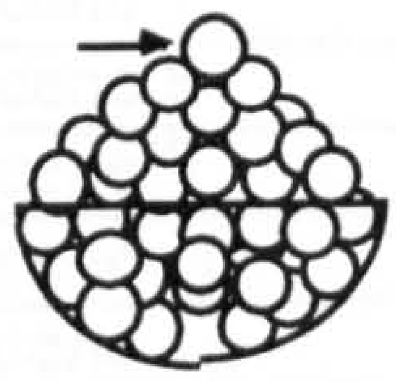
Scene 2



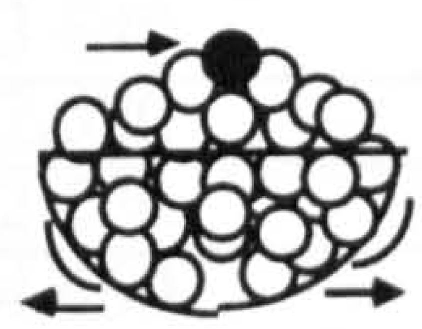
Scene 3



Scene 4

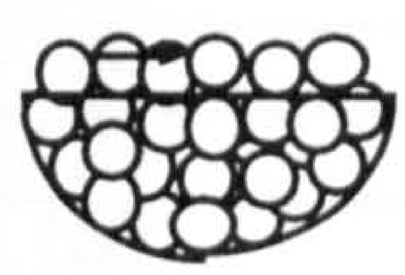


Scene 5

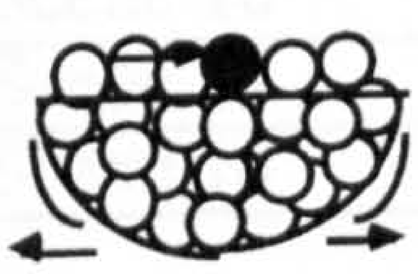


Scene 6

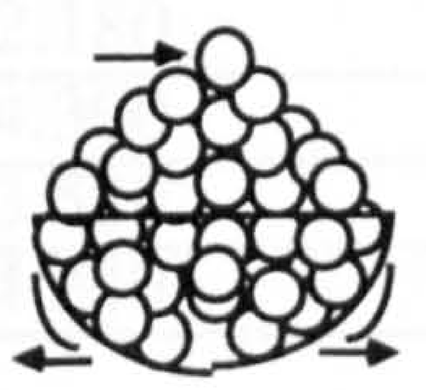
Scene 7



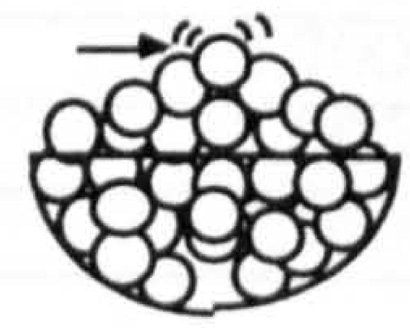
Scene 8



Scene 9

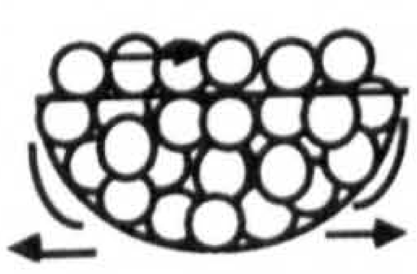


Scene 10



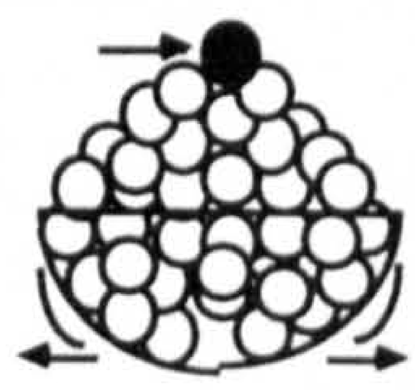
Scene 11

Scene 12

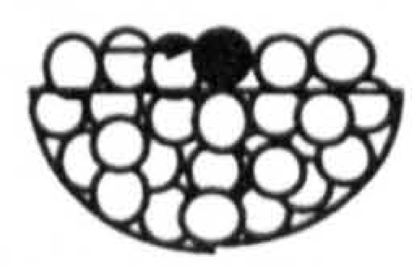


Scene 13

Scene 14

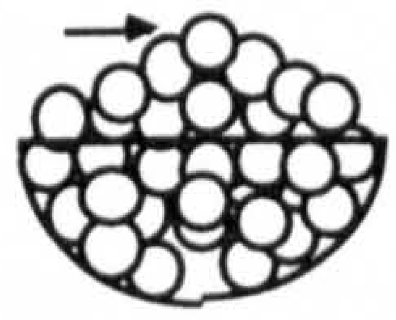


Scene 15



Scene 16

Scene 17



Scene 18

Appendix P: Mean Values for IN, ON, OVER and ABOVE for PREP5

SCENE	IN	ON	OVER	ABOVE
Scene 1	3.620	3.900	2.940	3.020
Scene 2	1.840	2.200	4.560	4.940
Scene 3	4.340	2.700	3.080	3.280
Scene 4	3.640	4.360	3.080	3.180
Scene 5	3.360	2.580	3.740	4.260
Scene 6	1.980	1.780	4.800	4.800
Scene 7	3.320	2.180	4.020	4.160
Scene 8	3.640	4.300	3.020	2.920
Scene 9	2.520	4.480	3.280	3.300
Scene 10	2.120	1.960	4.440	4.720
Scene 11	4.460	2.500	2.580	3.160
Scene 12	3.140	2.340	3.620	3.900
Scene 13	2.560	4.240	3.380	3.300
Scene 14	4.120	2.440	2.880	3.060
Scene 15	2.180	1.720	4.440	4.780
Scene 16	4.300	3.860	2.700	2.680
Scene 17	3.580	2.380	3.600	4.060
Scene 18	4.240	2.160	2.960	3.440

Appendix Q: IJ1 Questionnaire with Pictorial Representations

Language Experiment

In this language experiment you will be shown various scenes of balls with bowls on video. You will be shown 58 groupings of scenes in this experiment. In most cases the question you will be asked is "What do you think would happen to this scene if the bowl was moved to the right?".

Each grouping will be as follows:

(a) You will be shown a target scene.
(b)* A type of movement for this scene will be shown on screen
(c) Two suggested types of outcome (RESULT A or RESULT B) for the target scene.

* Certain groupings will not include a type of suggested movement and the question asked in such instances will be - "What do you think would happen to this scene if the ball were dropped".

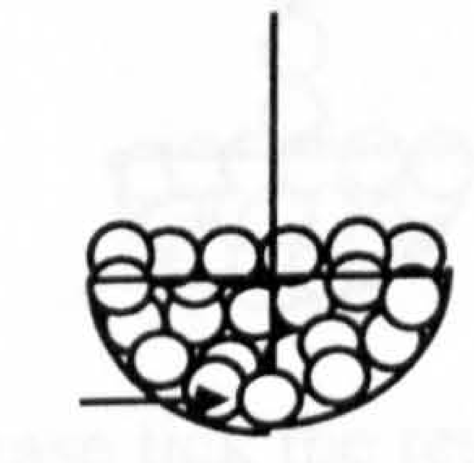
You must choose in each case what you think would be most likely to happen to the target scene after the suggested movement. Please indicate your choice by ticking the outcome scene that you agree with. You should pay special attention to the ball indicated by the black arrow.

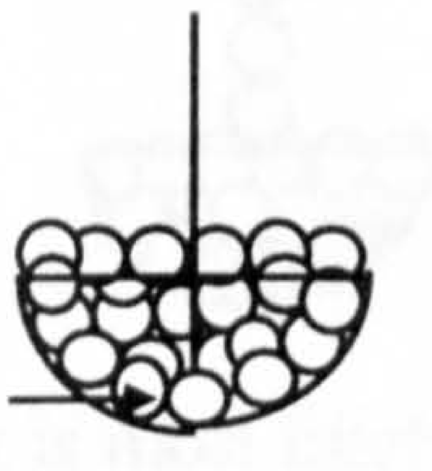
Each section of the experiment is also represented in pictorial form on the following questionnaire.

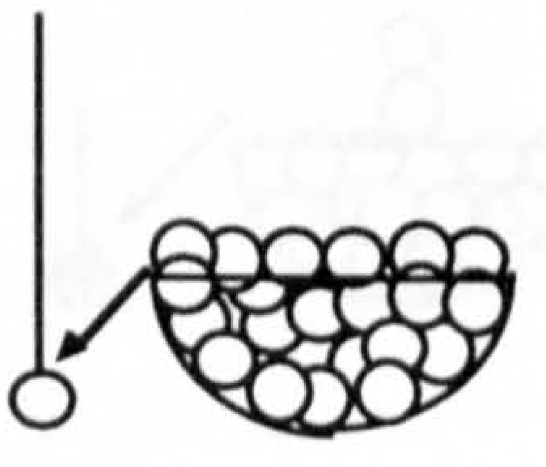
---

(1) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 1 RESULT A ☐ RESULT B ☐





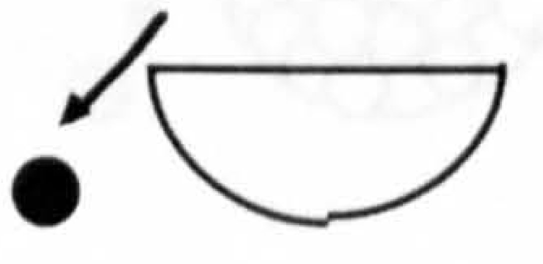


Please tick the result that you think is most likely

---

(2) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 2 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

---

(3) What do you think would happen to this scene if the bowl was moved to the right?

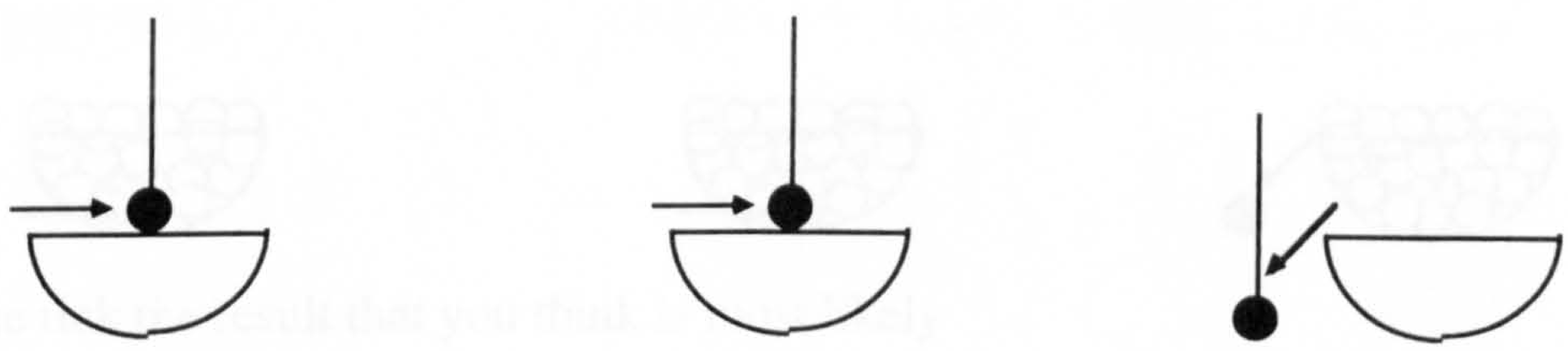
SCENE 3 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(4) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 4 RESULT A ☐ RESULT B ☐

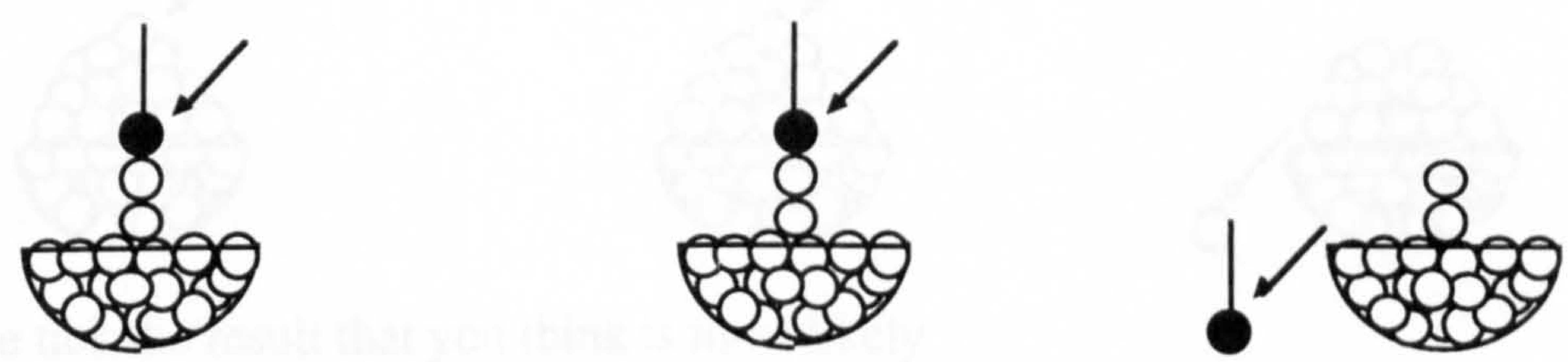


Please tick the result that you think is most likely

---

(5) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 5 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

---

(6) What do you think would happen to this scene if the bowl was moved to the right?

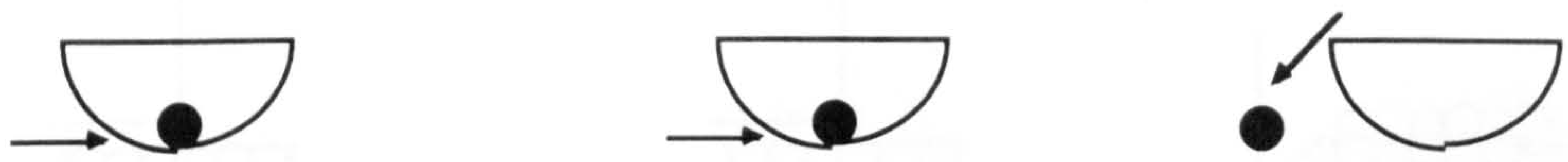
SCENE 6 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(7) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 7 RESULT A ☐ RESULT B ☐

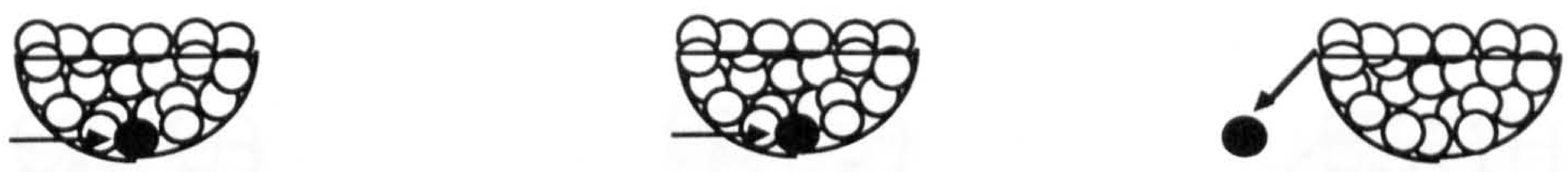


Please tick the result that you think is most likely

---

(8) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 8 RESULT A ☐ RESULT B ☐

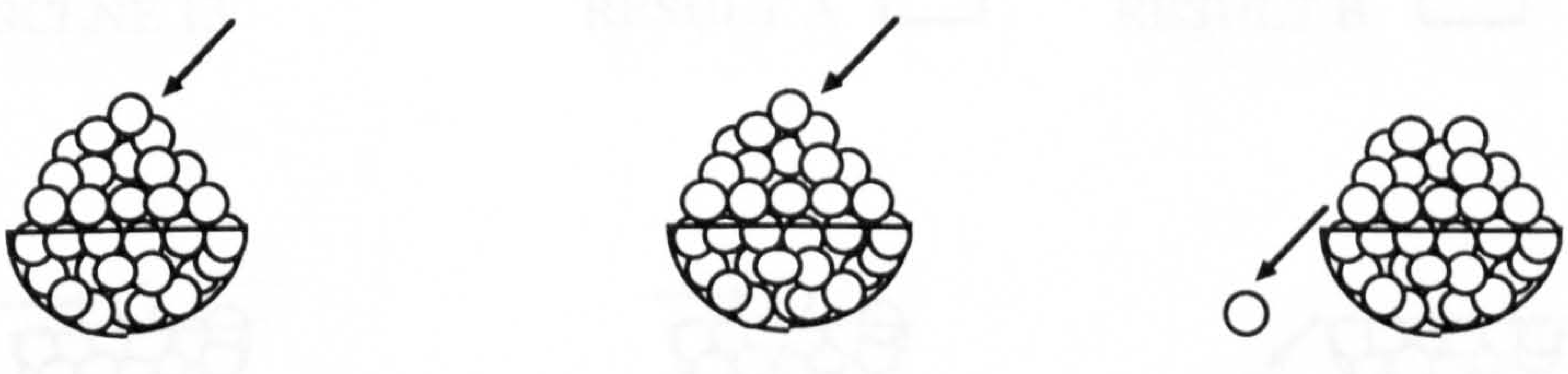


Please tick the result that you think is most likely

---

(9) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 9 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

---

(10) What do you think would happen to this scene if the ball was dropped?

SCENE 10 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(11) What do you think would happen to this scene if the bowl was moved to the right?

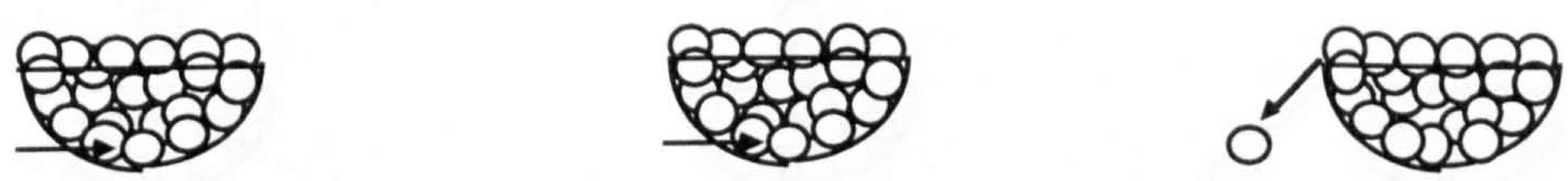
SCENE 11 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(12) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 12 RESULT A ☐ RESULT B ☐

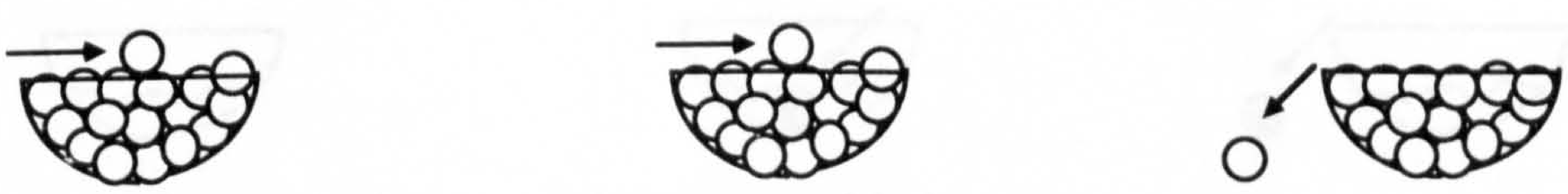


Please tick the result that you think is most likely

---

(13) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 13 RESULT A ☐ RESULT B ☐

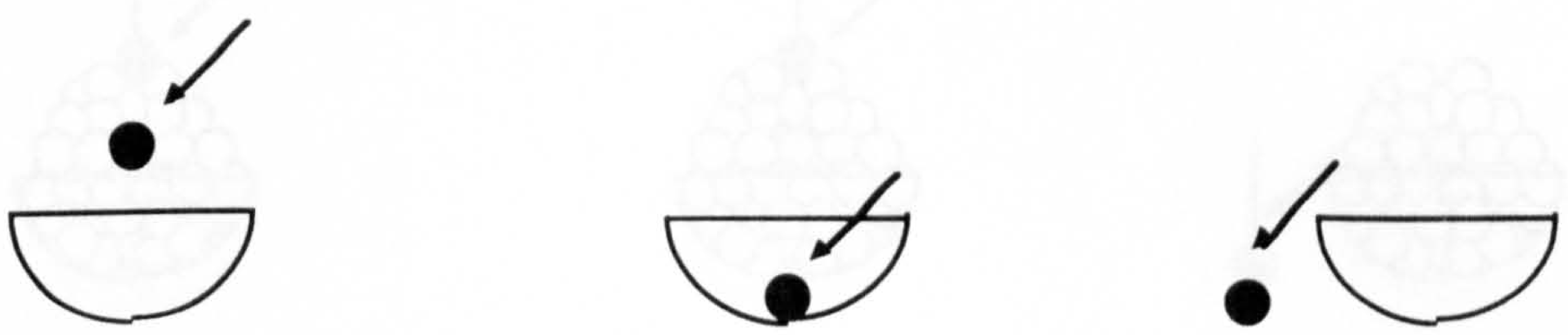


Please tick the result that you think is most likely

---

(14) What do you think would happen to this scene if the ball was dropped?

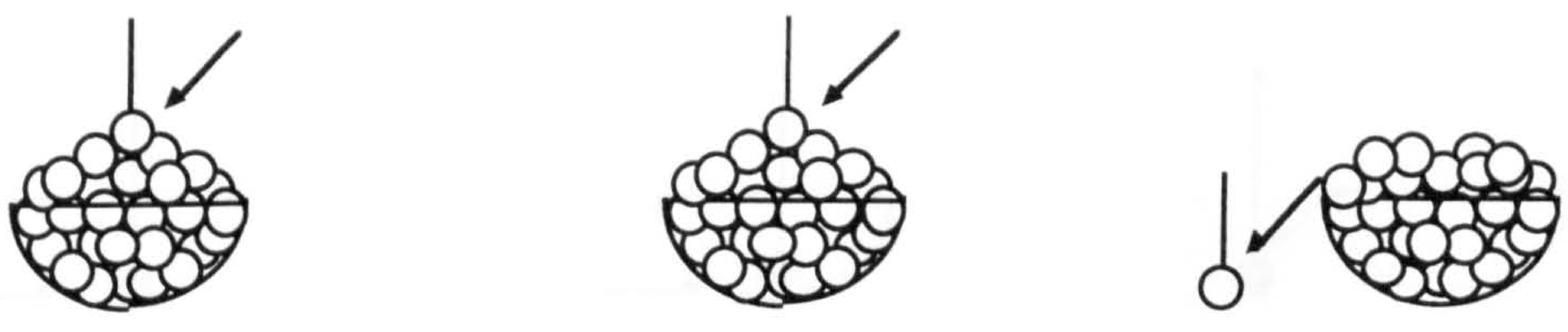
SCENE 14 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

(15) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 15 RESULT A ☐ RESULT B ☐

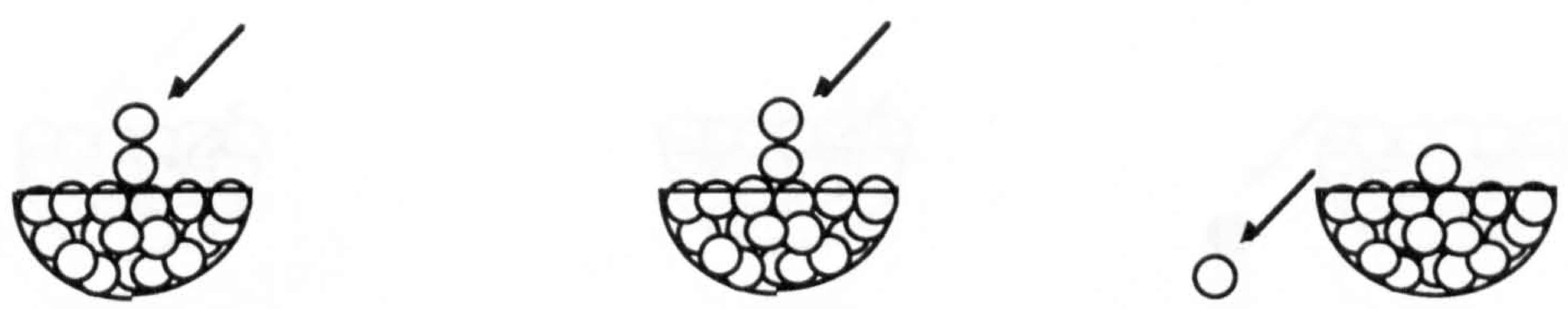


Please tick the result that you think is most likely

---

(16) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 16 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

---

(17) What do you think would happen to this scene if the ball was dropped?

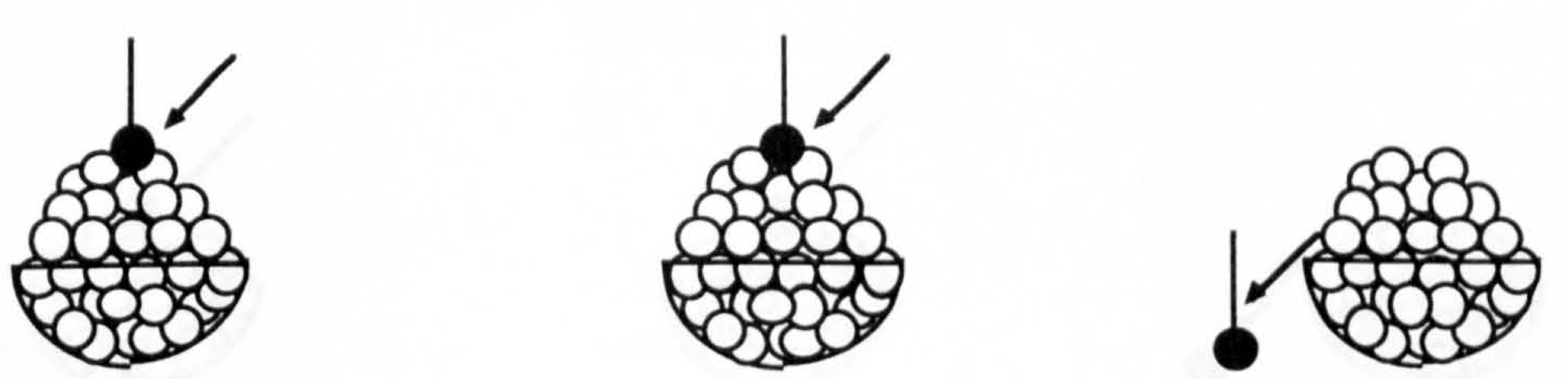
SCENE 17 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(18) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 18 RESULT A ☐ RESULT B ☐

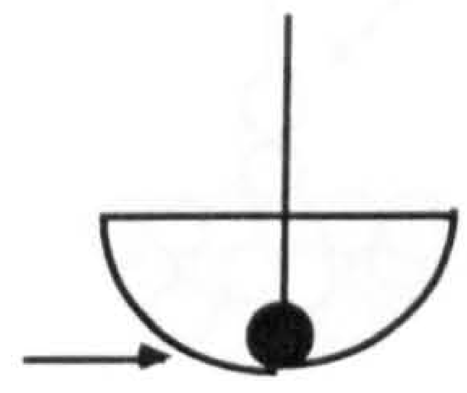


Please tick the result that you think is most likely

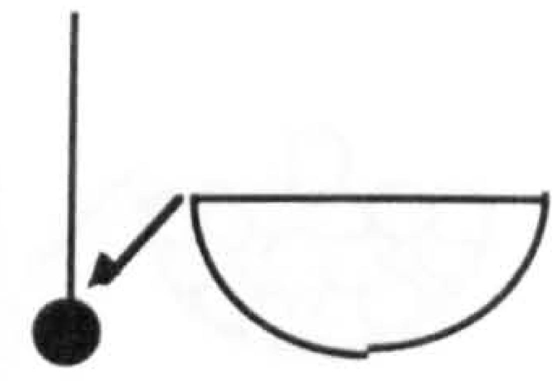
(19) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 19

RESULT A ☐



RESULT B ☐

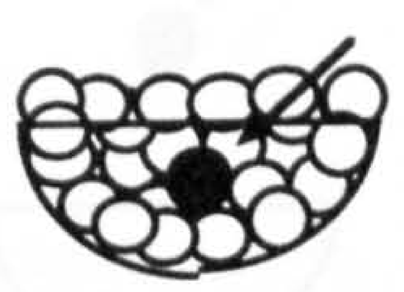


Please tick the result that you think is most likely

---

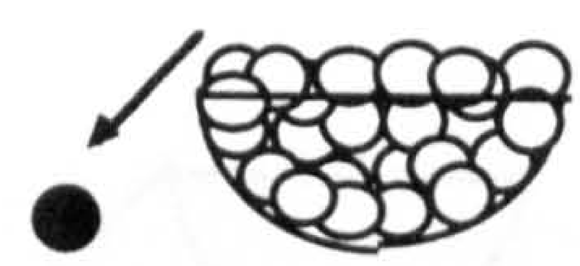
(20) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 20



RESULT A ☐

RESULT B ☐

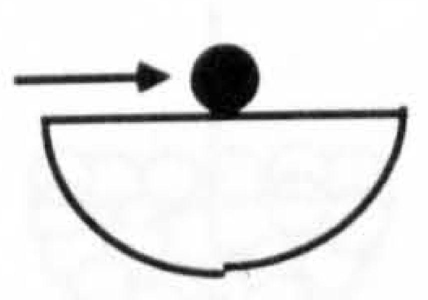


Please tick the result that you think is most likely

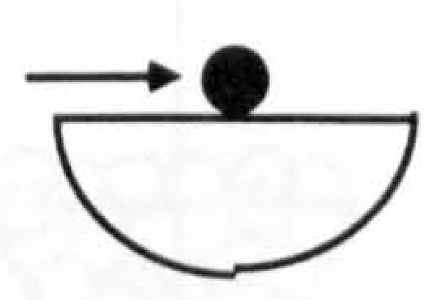
---

(21) What do you think would happen to this scene if the bowl was moved to the right?

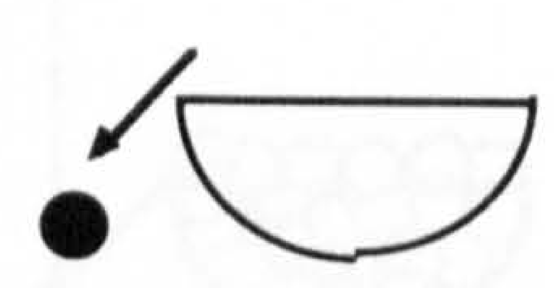
SCENE 21



RESULT A ☐



RESULT B ☐

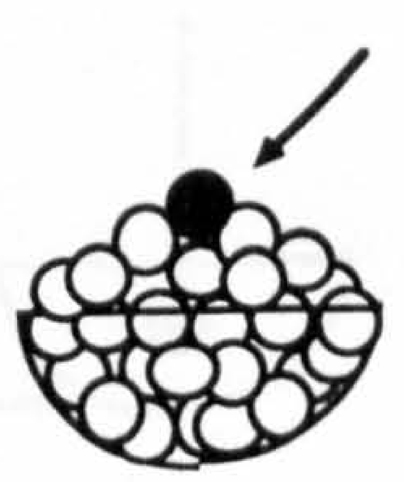


Please tick the result that you think is most likely

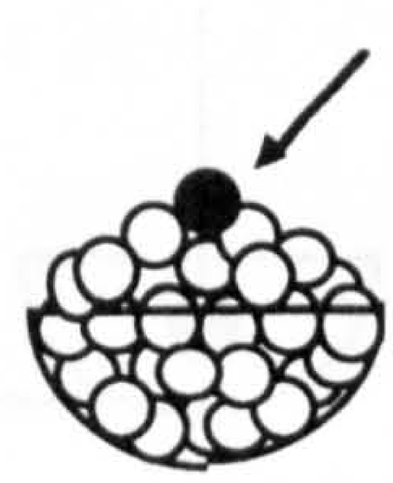
---

(22) What do you think would happen to this scene if the bowl was moved to the right?

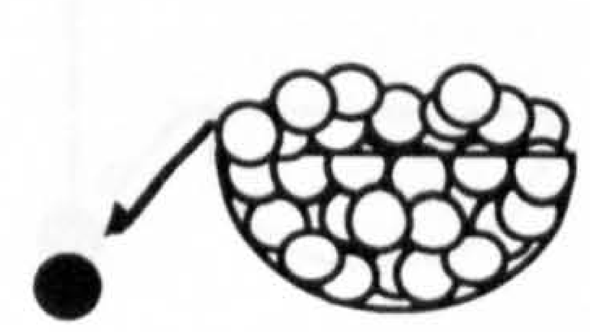
SCENE 22



RESULT A ☐



RESULT B ☐

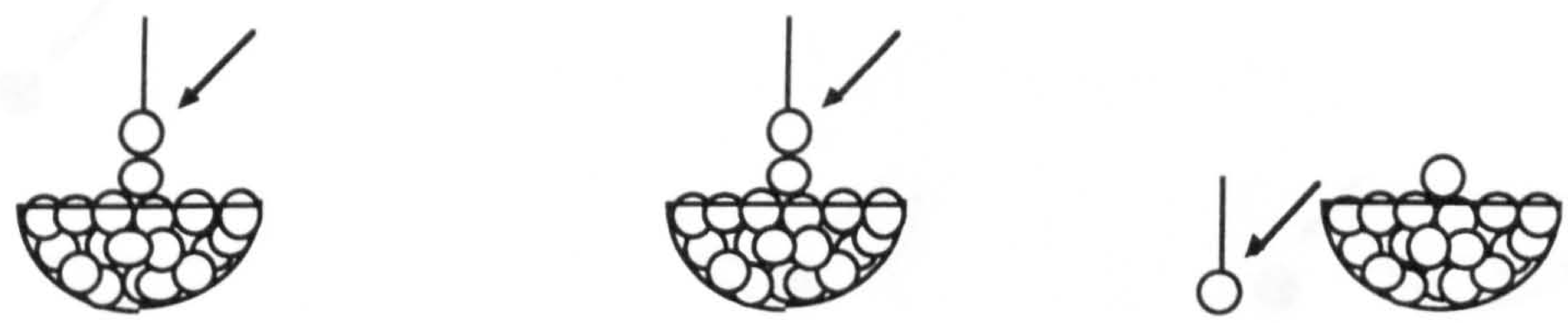


Please tick the result that you think is most likely

---

(23) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 23 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

---

(24) What do you think would happen to this scene if the ball was dropped?

SCENE 24 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(25) What do you think would happen to this scene if the bowl was moved to the right?

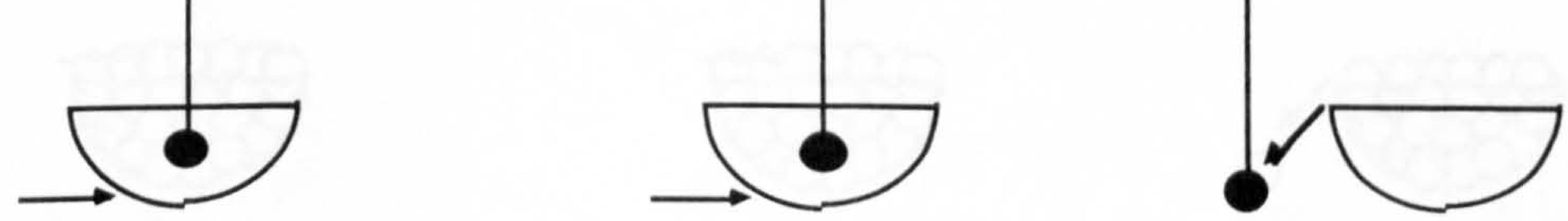
SCENE 25 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(26) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 26 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

---

(27) What do you think would happen to this scene if the ball was dropped?

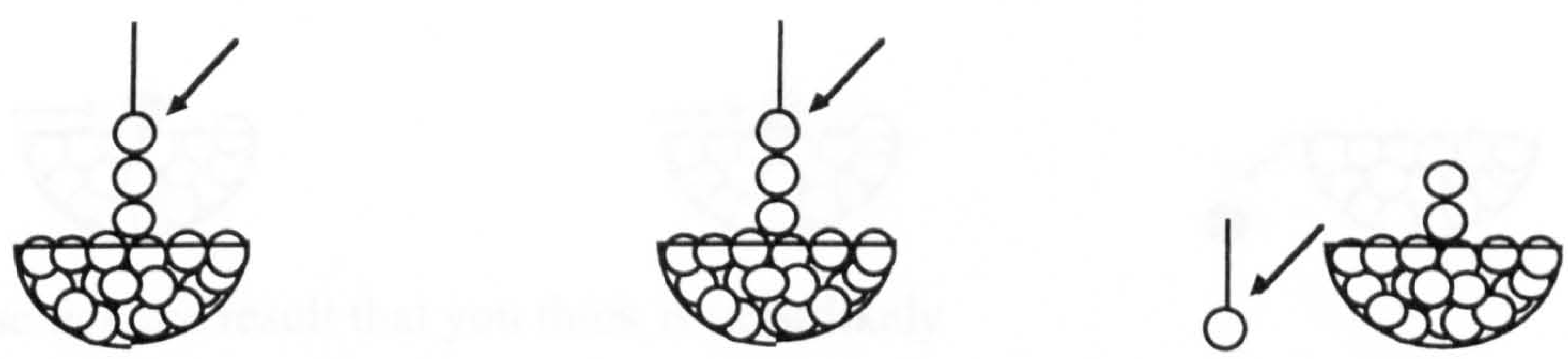
SCENE 27 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(28) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 28 RESULT A ☐ RESULT B ☐

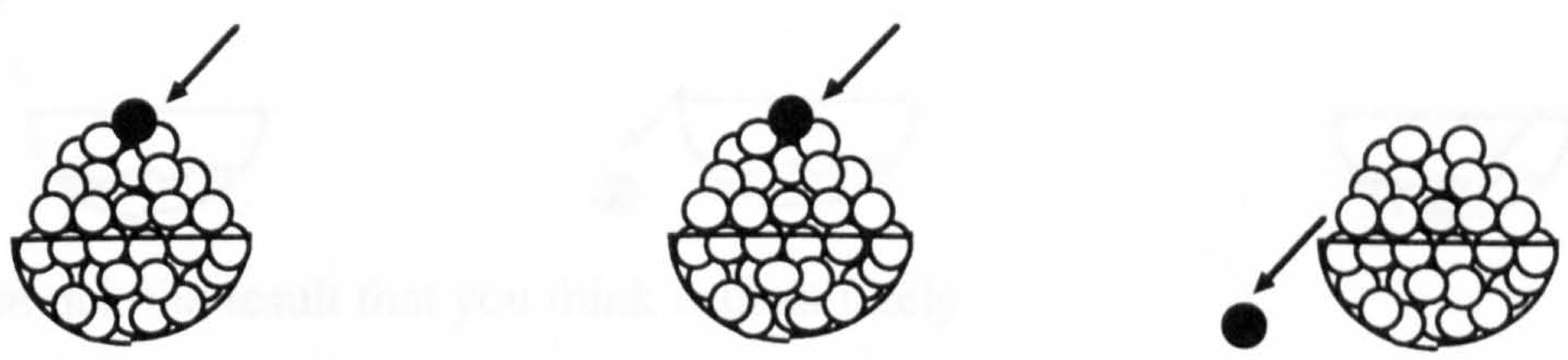


Please tick the result that you think is most likely

---

(29) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 29 RESULT A ☐ RESULT B ☐

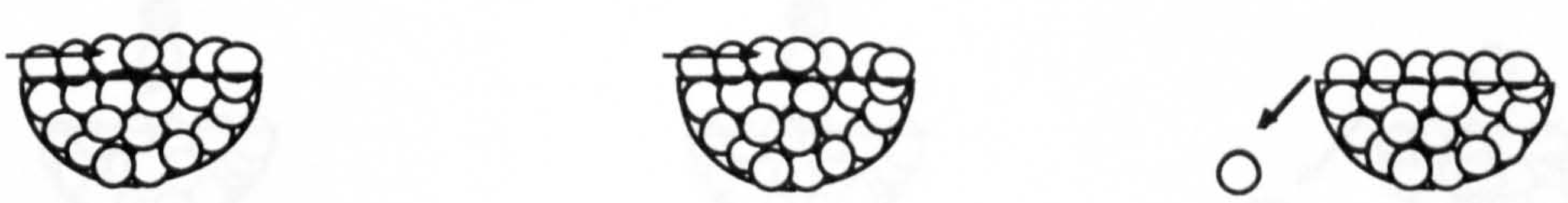


Please tick the result that you think is most likely

---

(30) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 30 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

---

(31) What do you think would happen to this scene if the bowl was moved to the right?

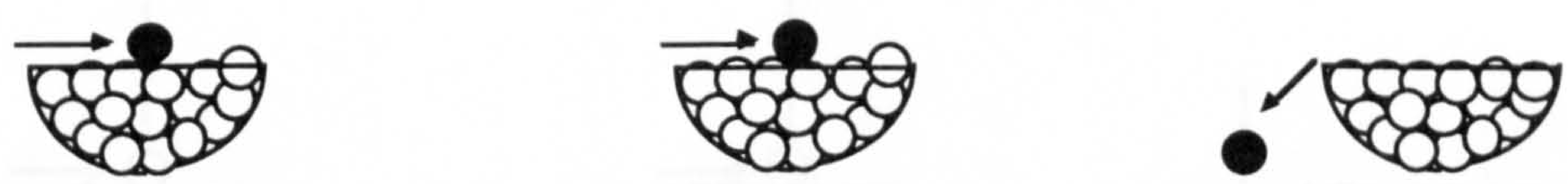
SCENE 31 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(32) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 32 RESULT A ☐ RESULT B ☐

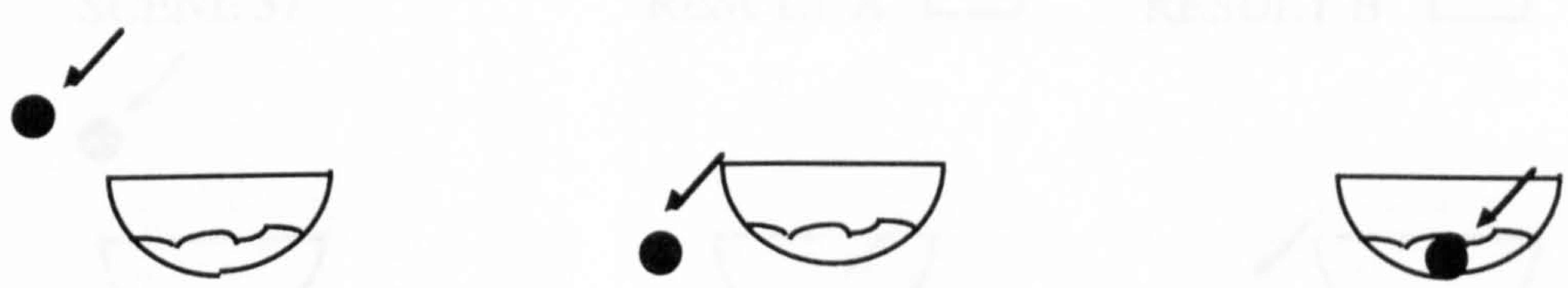


Please tick the result that you think is most likely

---

(33) What do you think would happen to this scene if the ball was dropped?

SCENE 33 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

---

(34) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 34 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(35) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 35 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(36) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 36 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(37) What do you think would happen to this scene if the ball was dropped?

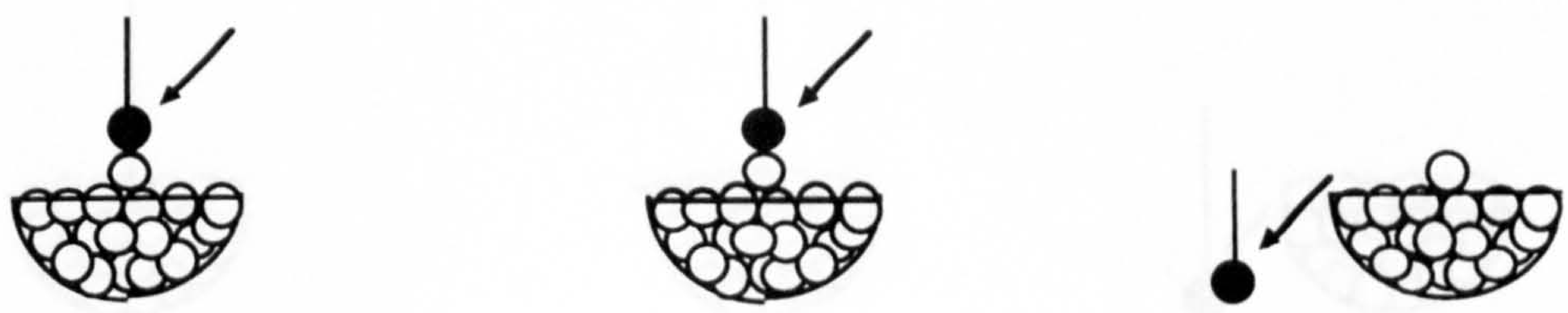
SCENE 37 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(38) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 38 RESULT A ☐ RESULT B ☐

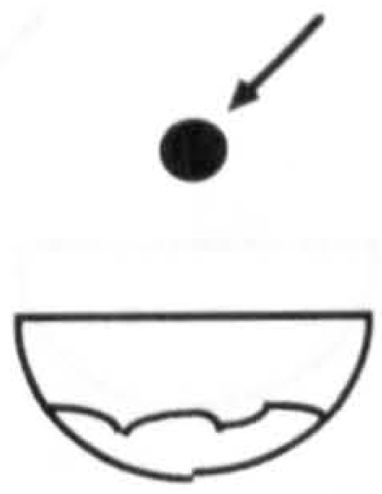


Please tick the result that you think is most likely

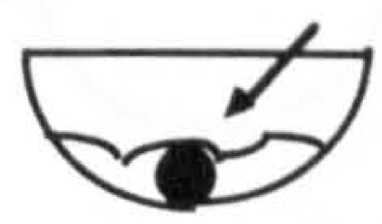
---

(39) What do you think would happen to this scene if the ball was dropped?

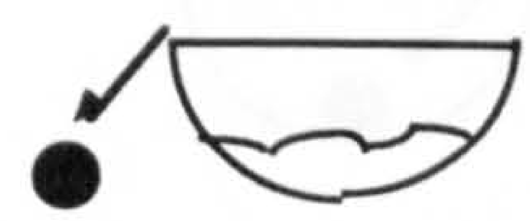
SCENE 39



RESULT A ☐



RESULT B ☐

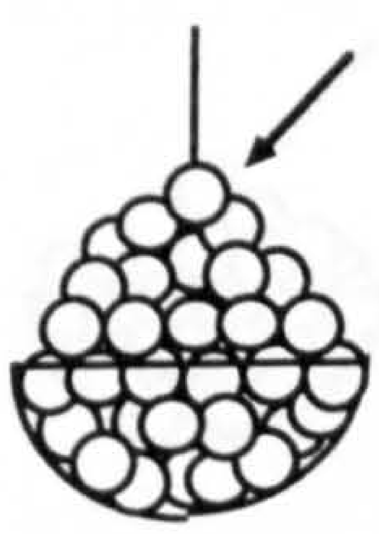


Please tick the result that you think is most likely

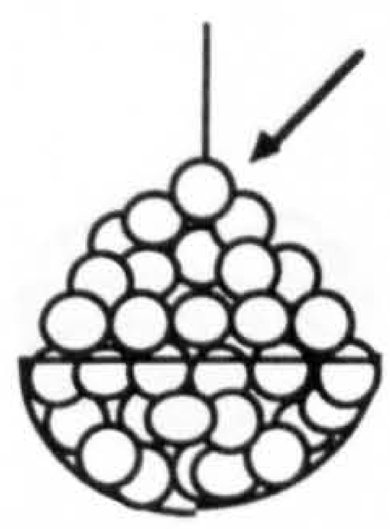
---

(40) What do you think would happen to this scene if the bowl was moved to the right?

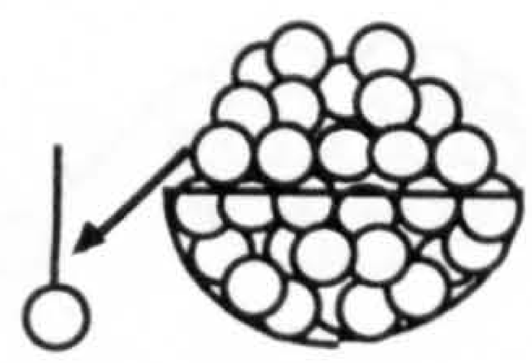
SCENE 40



RESULT A ☐



RESULT B ☐

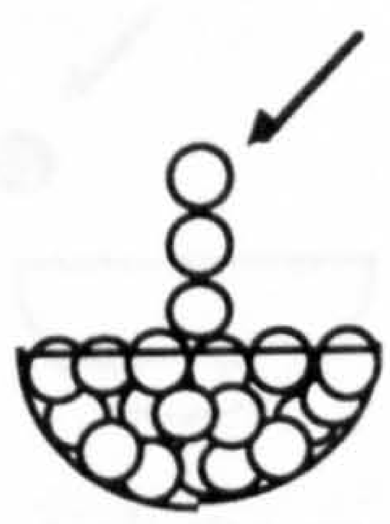


Please tick the result that you think is most likely

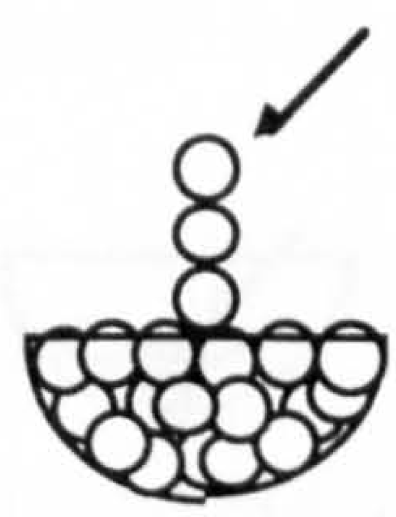
---

(41) What do you think would happen to this scene if the bowl was moved to the right?

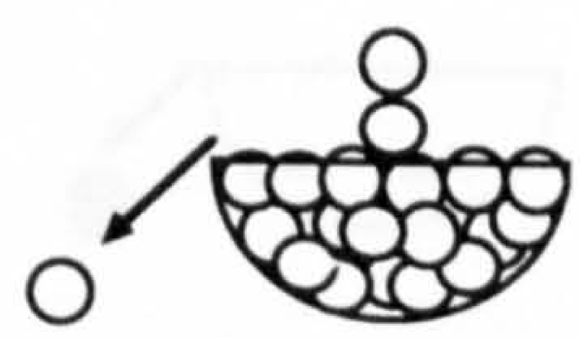
SCENE 41



RESULT A ☐



RESULT B ☐



Please tick the result that you think is most likely

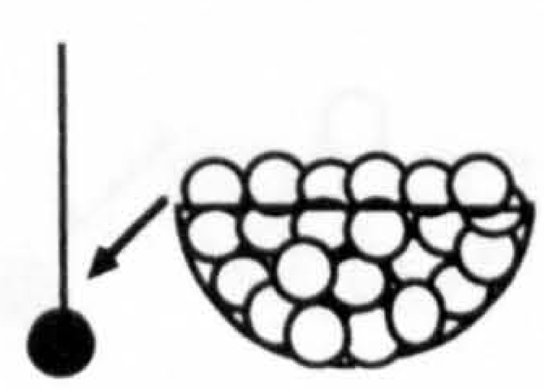
---

(42) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 42

RESULT A ☐

RESULT B ☐

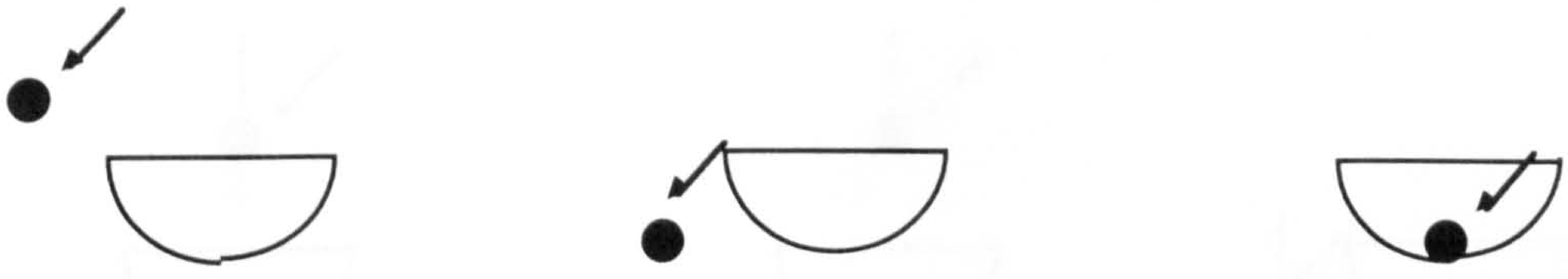


Please tick the result that you think is most likely

---

(43) What do you think would happen to this scene if the ball was dropped?

SCENE 43 RESULT A RESULT B

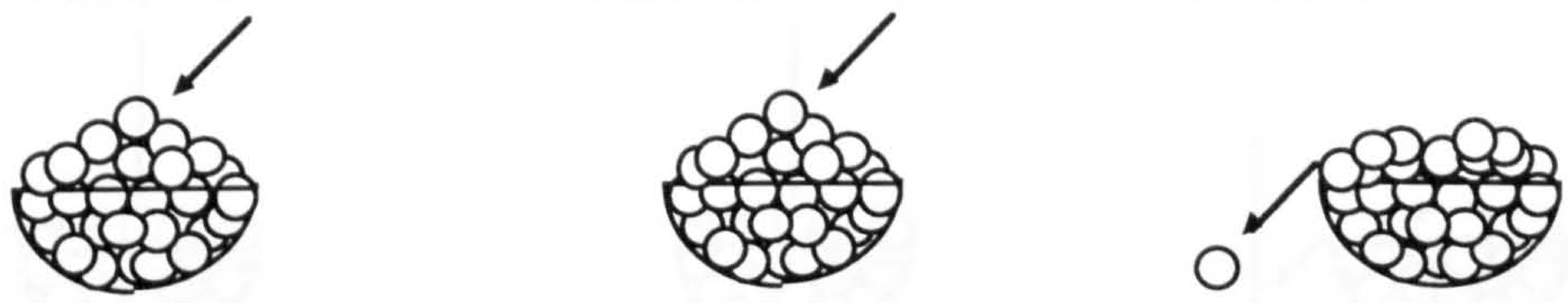


Please tick the result that you think is most likely

---

(44) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 44 RESULT A RESULT B



Please tick the result that you think is most likely

---

(45) What do you think would happen to this scene if the ball was dropped?

SCENE 45 RESULT A RESULT B

Please tick the result that you think is most likely

---

(46) What do you think would happen to this scene if the bowl was moved to the right?

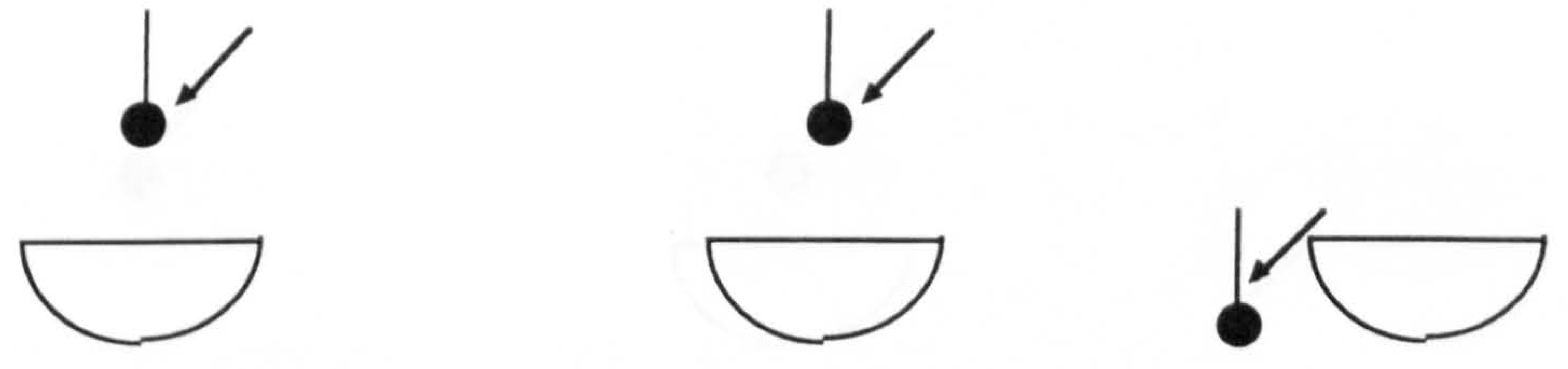
SCENE 46 RESULT A RESULT B

Please tick the result that you think is most likely

---

(47) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 47 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

---

(48) What do you think would happen to this scene if the bowl was moved to the right?

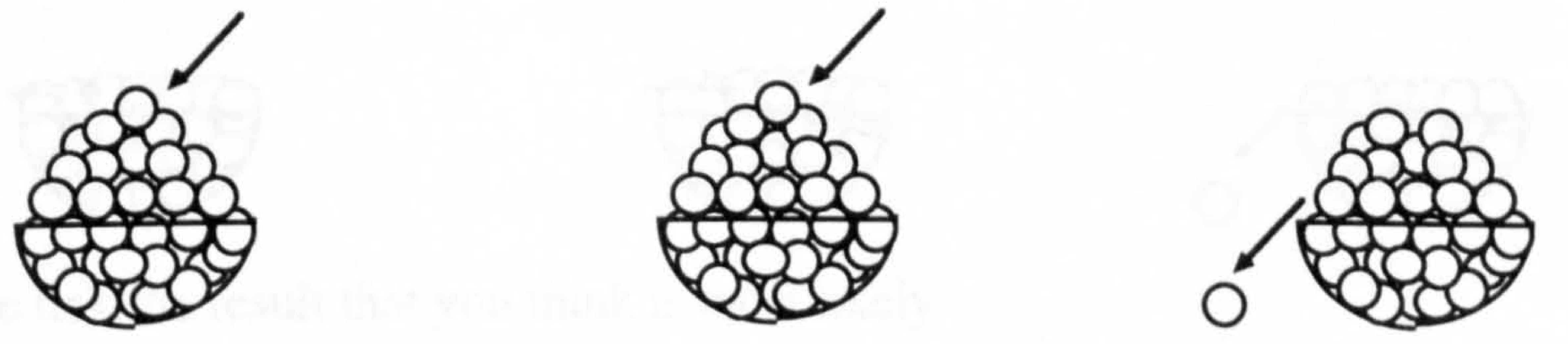
SCENE 48 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(49) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 49 RESULT A ☐ RESULT B ☐

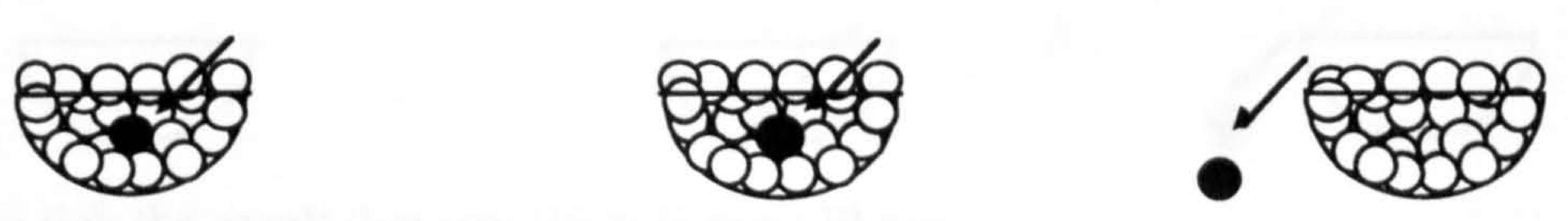


Please tick the result that you think is most likely

---

(50) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 50 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

(51) What do you think would happen to this scene if the bowl was moved to the right?

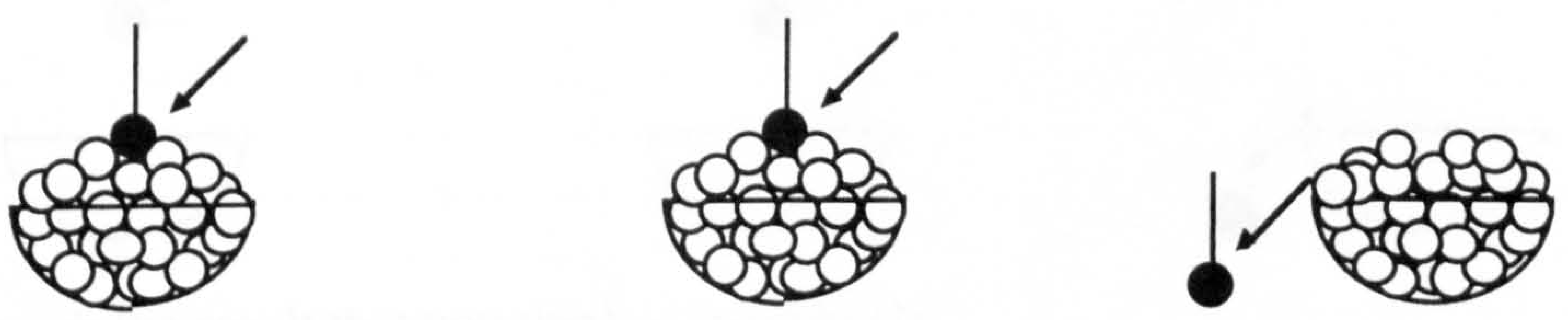
SCENE 51 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

---

(52) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 52 RESULT A ☐ RESULT B ☐

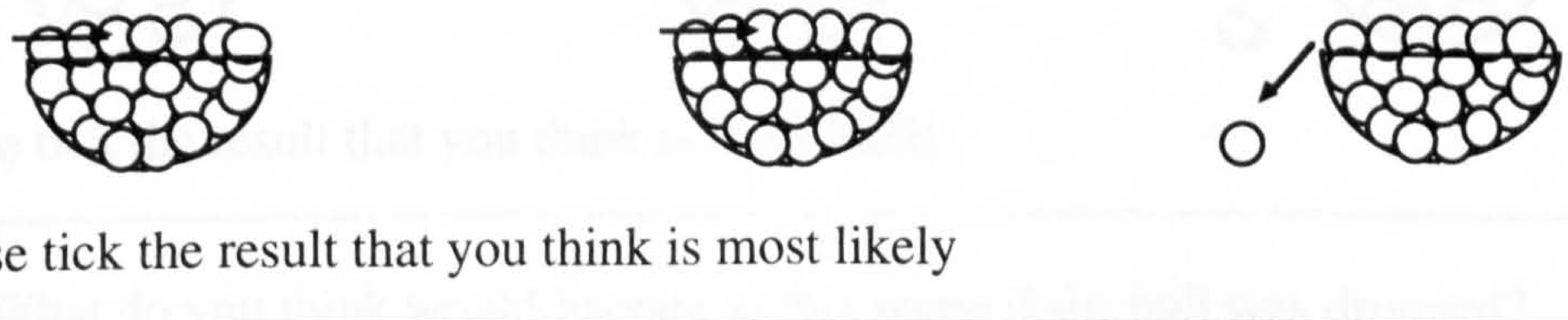


Please tick the result that you think is most likely

---

(53) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 53 RESULT A ☐ RESULT B ☐



Please tick the result that you think is most likely

---

(54) What do you think would happen to this scene if the ball was dropped?

SCENE 54 RESULT A ☐ RESULT B ☐

Please tick the result that you think is most likely

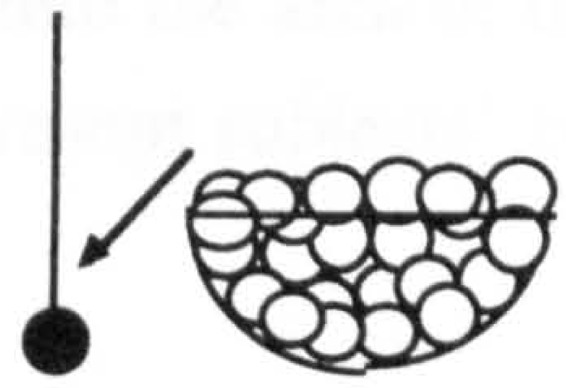
---

(55) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 55

RESULT A ☐

RESULT B ☐



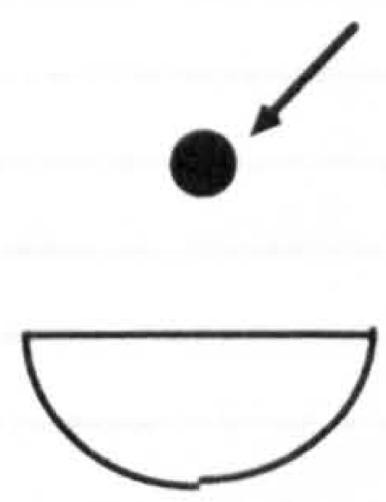
Please tick the result that you think is most likely

---

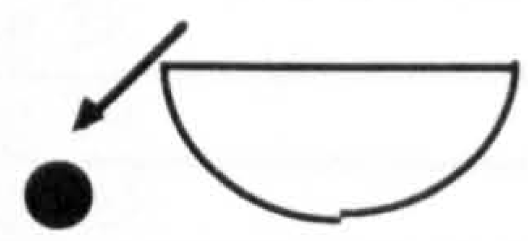
(56) What do you think would happen to this scene if the bowl was moved to the right?

SCENE 56

RESULT A ☐



RESULT B ☐

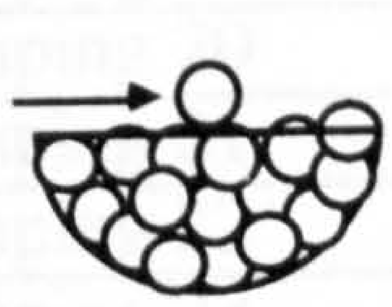


Please tick the result that you think is most likely

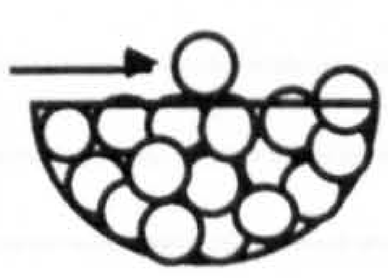
---

(57) What do you think would happen to this scene if the bowl was moved to the right?

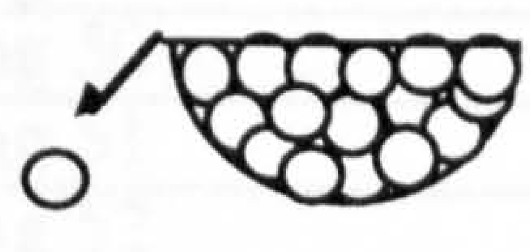
SCENE 57



RESULT A ☐



RESULT B ☐

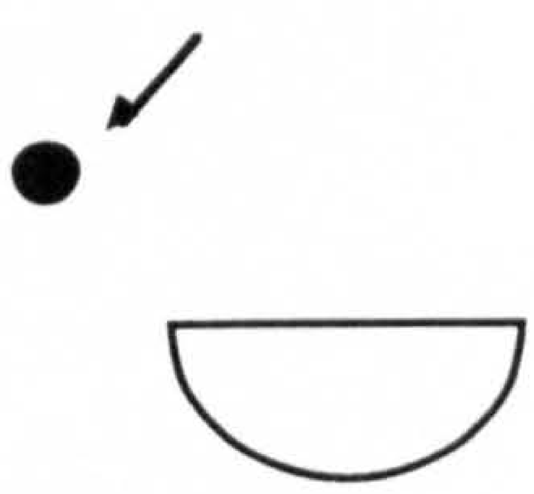


Please tick the result that you think is most likely

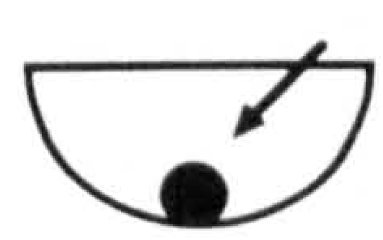
---

(58) What do you think would happen to this scene if the ball was dropped?

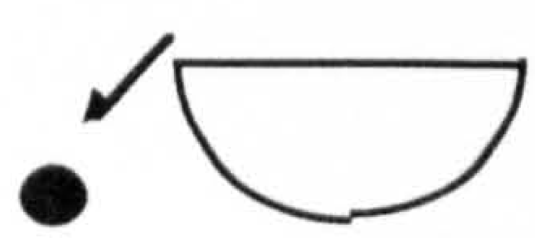
SCENE 58



RESULT A ☐



RESULT B ☐



Please tick the result that you think is most likely

END

Appendix R: Mean values for IJ1

The mean values for Groupings 10, 14, 17, 24, 27, 33, 37, 39, 43, 45, 54, and 58 represent subjects' confidence that the ball would not fall into the area of the bowl if dropped. The mean values for all the other Groupings represent subjects' confidence that there would be a change after a movement to the right.

GROUPING	MEANS	GROUPING	MEANS
Grouping 1	.313	Grouping 30	.239
Grouping 2	.134	Grouping 31	.701
Grouping 3	.119	Grouping 32	.209
Grouping 4	.881	Grouping 33	.940
Grouping 5	.896	Grouping 34	.821
Grouping 6	.209	Grouping 35	.313
Grouping 7	.030	Grouping 36	.731
Grouping 8	.000	Grouping 37	.493
Grouping 9	.642	Grouping 38	.851
Grouping 10	.731	Grouping 39	.015
Grouping 11	.731	Grouping 40	.776
Grouping 12	.030	Grouping 41	.851
Grouping 13	.567	Grouping 42	.463
Grouping 14	.209	Grouping 43	.985
Grouping 15	.597	Grouping 44	.179
Grouping 16	.836	Grouping 45	.463
Grouping 17	.015	Grouping 46	.821
Grouping 18	.716	Grouping 47	.642
Grouping 19	.328	Grouping 48	.433
Grouping 20	.015	Grouping 49	.507
Grouping 21	.866	Grouping 50	.015
Grouping 22	.179	Grouping 51	.731
Grouping 23	.836	Grouping 52	.582
Grouping 24	.239	Grouping 53	.179
Grouping 25	.209	Grouping 54	.552
Grouping 26	.612	Grouping 55	.284
Grouping 27	.522	Grouping 56	.731
Grouping 28	.896	Grouping 57	.478
Grouping 29	.537	Grouping 58	.925

Appendix S: IJ2 Questionnaire with Pictorial Representations

Language Experiment

In this language experiment you will be shown various scenes of balls involving: a 2kg weight; a ping-pong ball; a chain; thread; string; wire; gauze; plywood; and a plank of wood. All of these materials are demonstrated at the beginning of the video.

Your task in this experiment is to make simple judgements as to what you think the outcome would be if one of these materials was removed, or moved. There will be four examples at the beginning of the experiment to ascertain that you understand the task.

The questions will take the form:

"What do you think would happen if the ***material*** *was removed?"*
OR
"What do you think would happen if the ***material*** *was tilted, as illustrated?"* - the type of movement will be demonstrated with this type of scene.

The grouping of the scenes will be as follows:

(a) A target scene
(b) A demonstration of the type of movement (if there is one)
(c) Two suggested outcomes (RESULT A or RESULT B) for the target scene

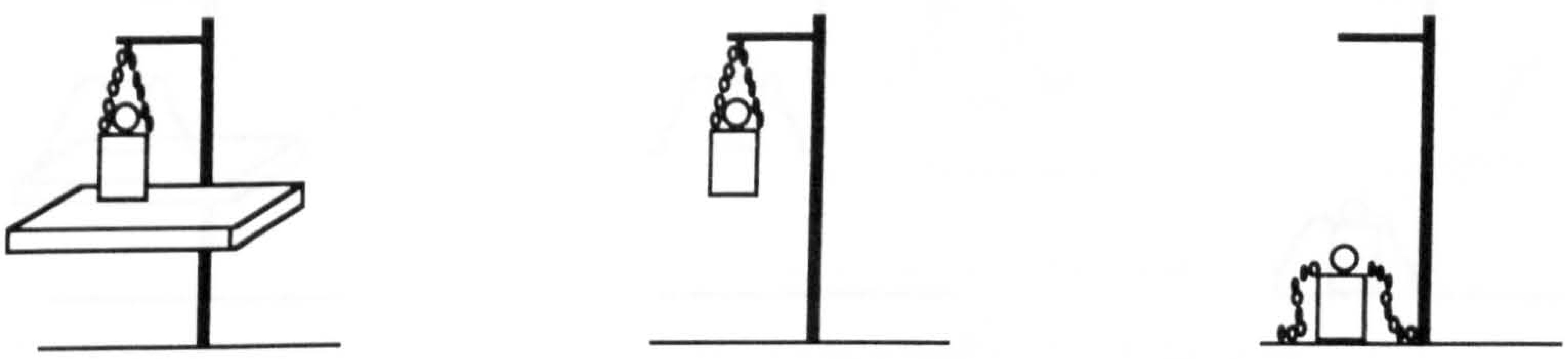
The task is to choose which of the results would be most likely to happen to the target scene once a material was removed, or moved. Please indicate your choice by ticking the result you most agree with. Attention is drawn to the relevant object by a black arrow.

Each section of the experiment is also represented in pictorial form on the questionnaire.

Please read the questions carefully as they do not all have the same form.

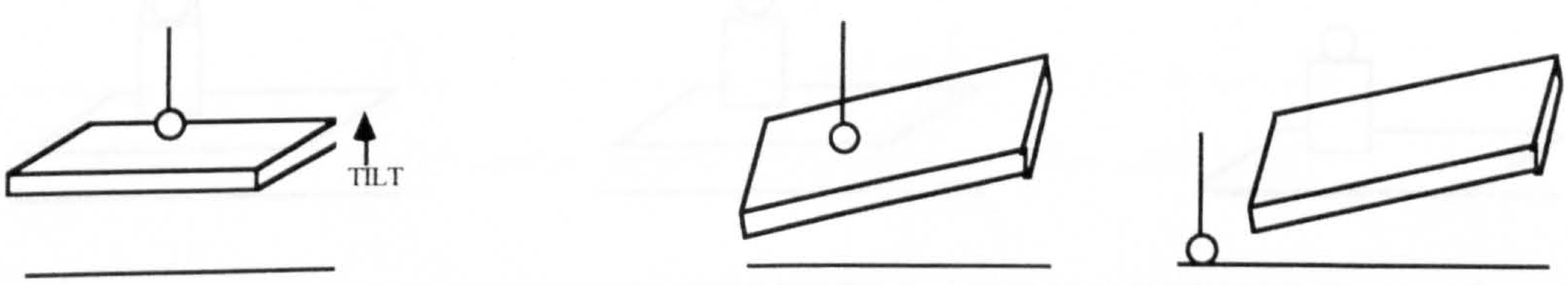
EXAMPLE 1:
What do you think would happen if the **plank of wood** was removed?

RESULT A ☐ RESULT B ☐



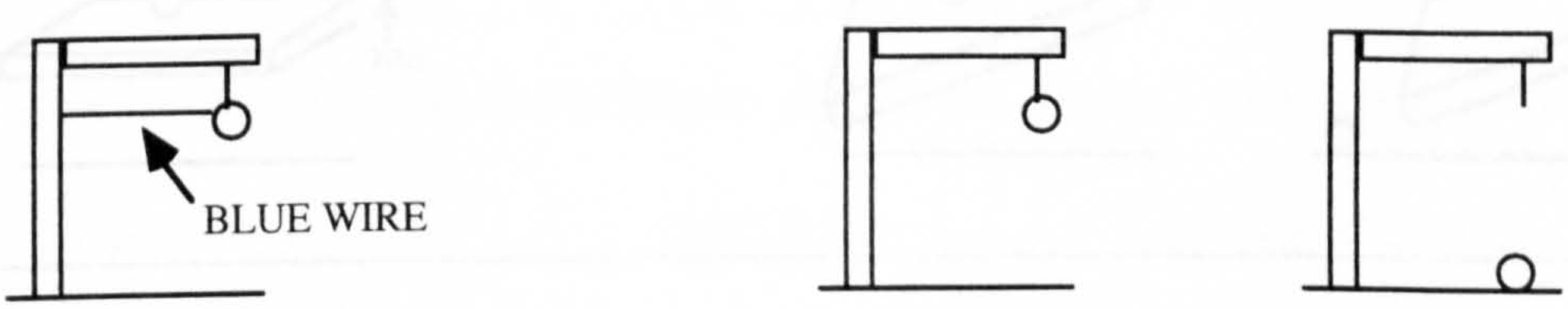
EXAMPLE 2:
What do you think would happen if the **plank of wood** was tilted, as illustrated?

RESULT A ☐ RESULT B ☐



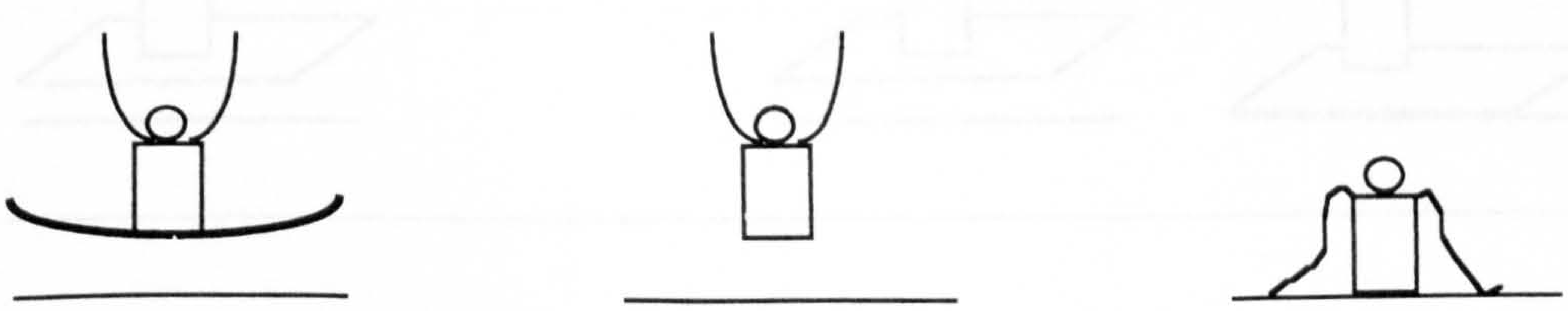
EXAMPLE 3:
What do you think would happen if the **blue**, (longer) wire was removed?

RESULT A ☐ RESULT B ☐



EXAMPLE 4:
What do you think would happen if the **plywood** was removed?

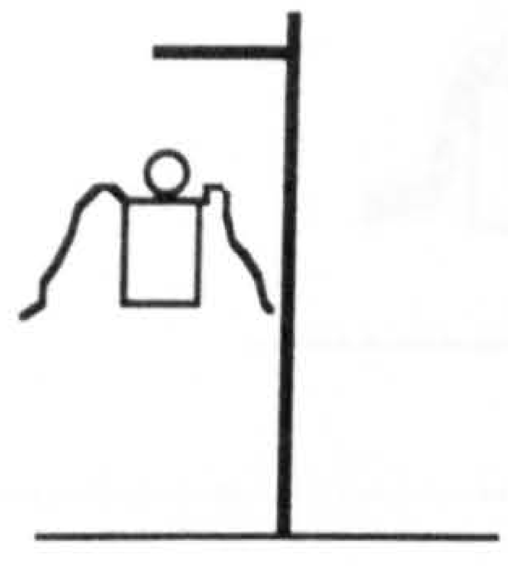
RESULT A ☐ RESULT B ☐



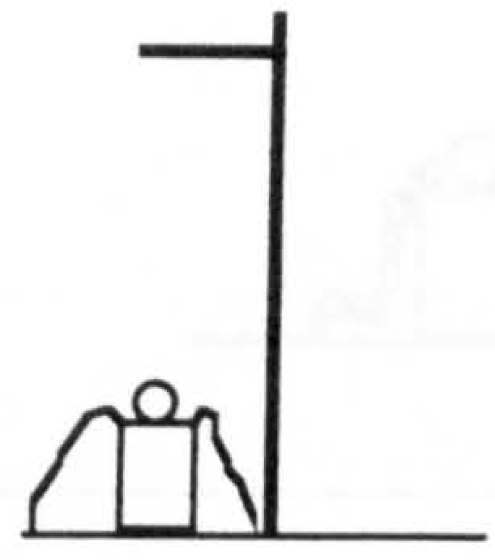
(1) What do you think would happen if the **plank of wood** was removed?

SCENE 1

RESULT A ☐

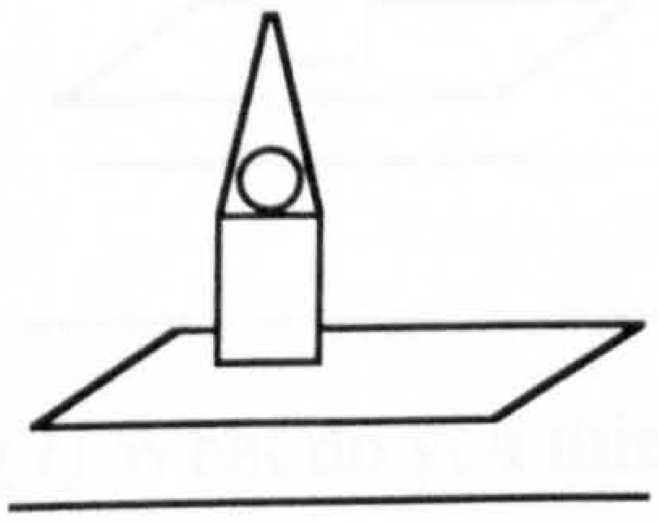


RESULT B ☐

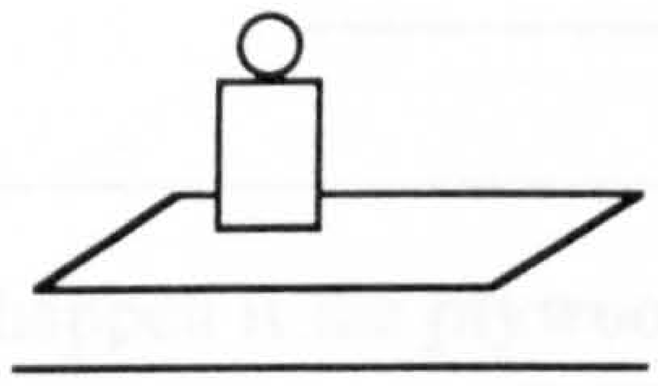


(2) What do you think would happen if the **thread** was removed?

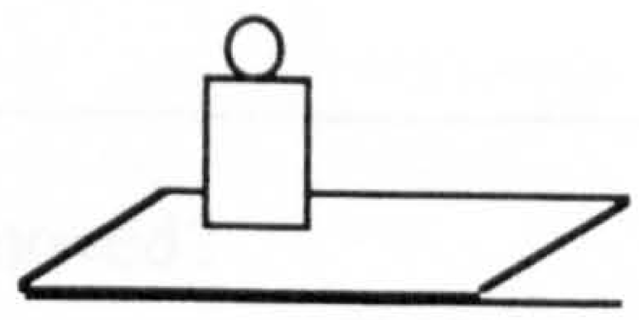
SCENE 2



RESULT A ☐

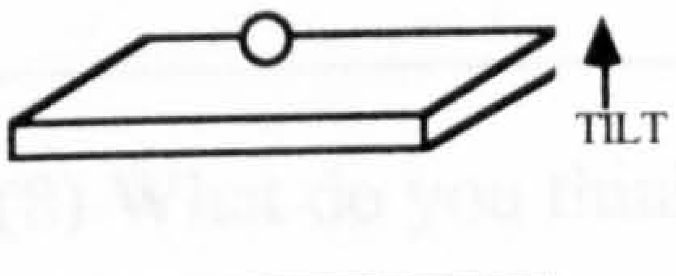


RESULT B ☐

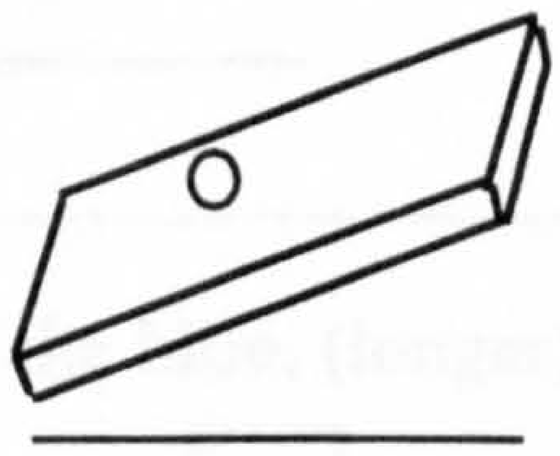


(3) What do you think would happen if the **plank of wood** was tilted, as illustrated?

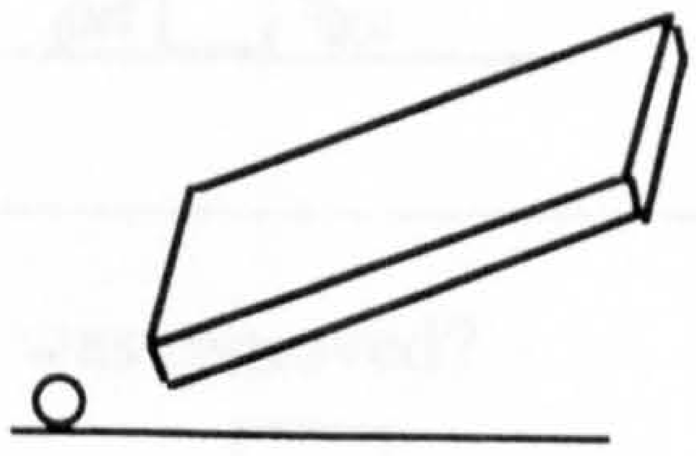
SCENE 3



RESULT A ☐

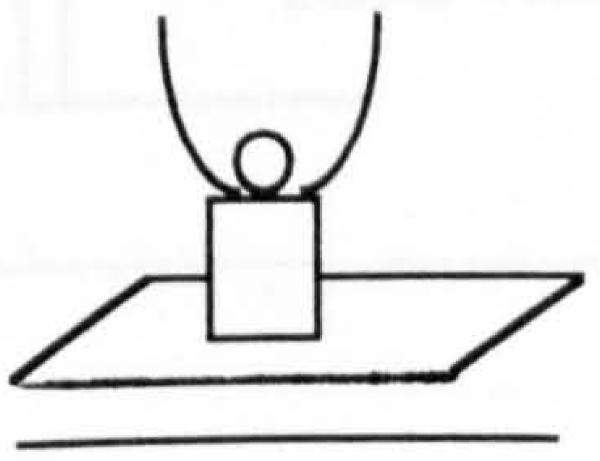


RESULT B ☐

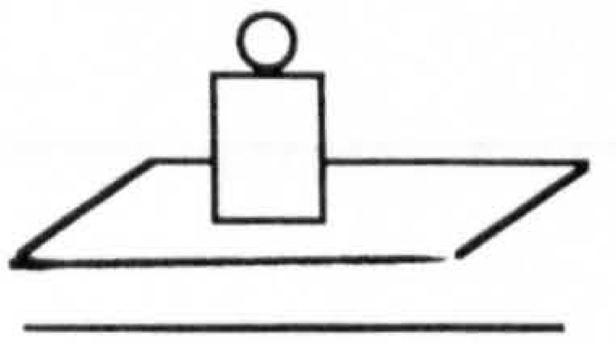


(4) What do you think would happen if the **thread** was removed?

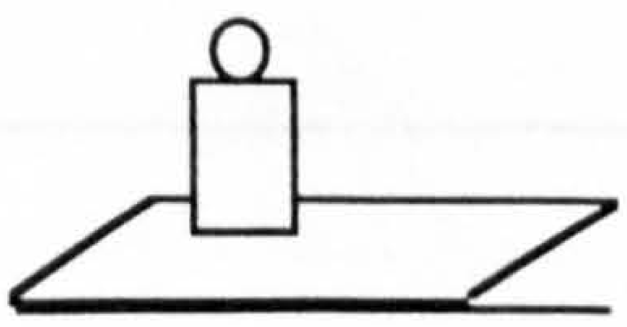
SCENE 4



RESULT A ☐

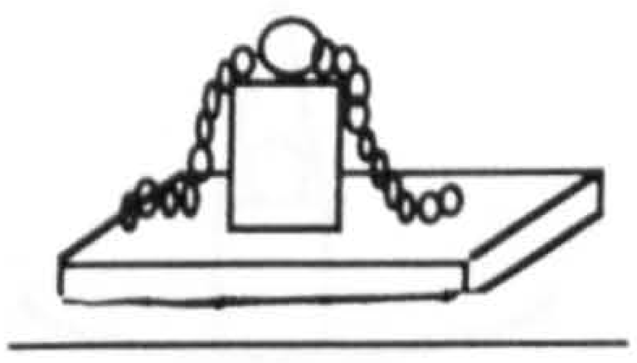


RESULT B ☐

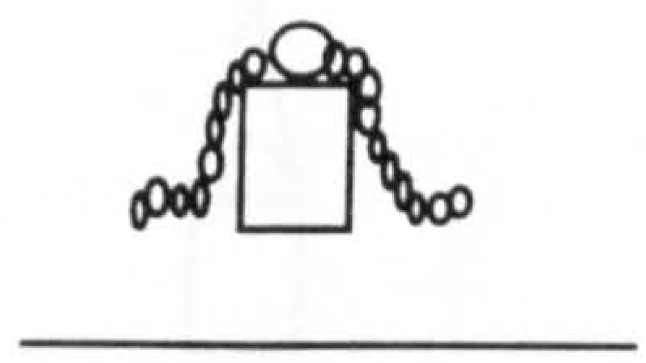


(5) What do you think would happen if the **plank of wood** was removed?

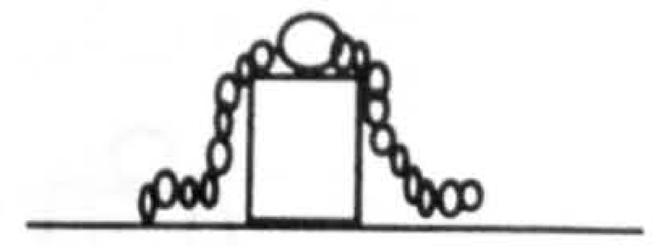
SCENE 5



RESULT A

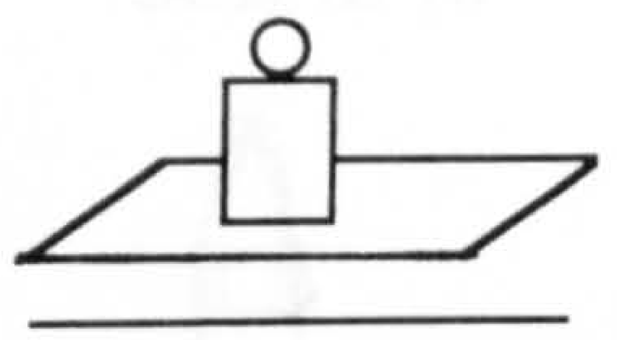


RESULT B

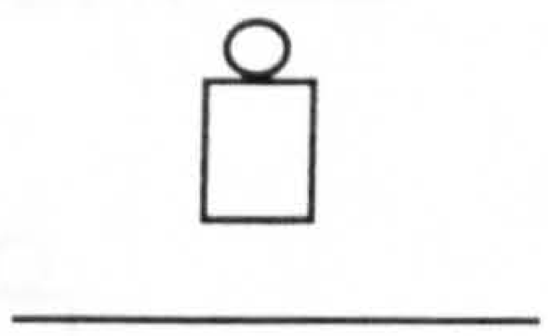


(6) What do you think would happen if the **gauze** was removed?

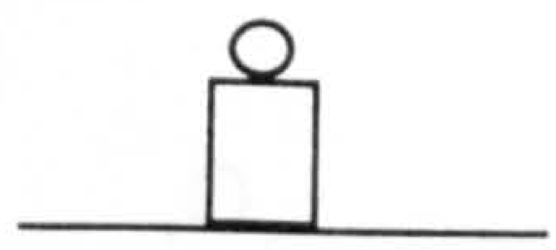
SCENE 6



RESULT A

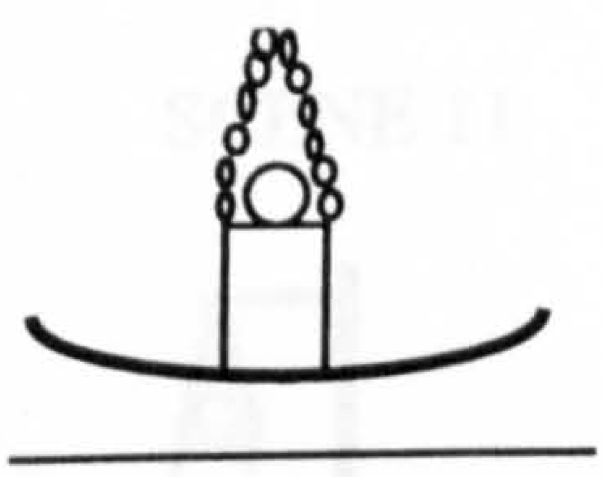


RESULT B

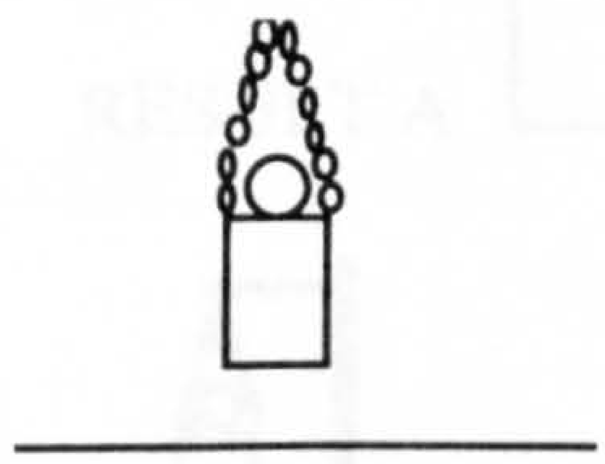


(7) What do you think would happen if the **plywood** was removed?

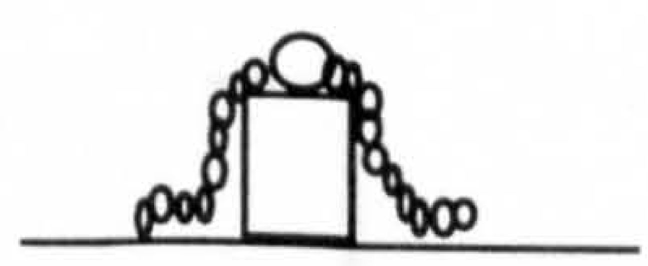
SCENE 7



RESULT A

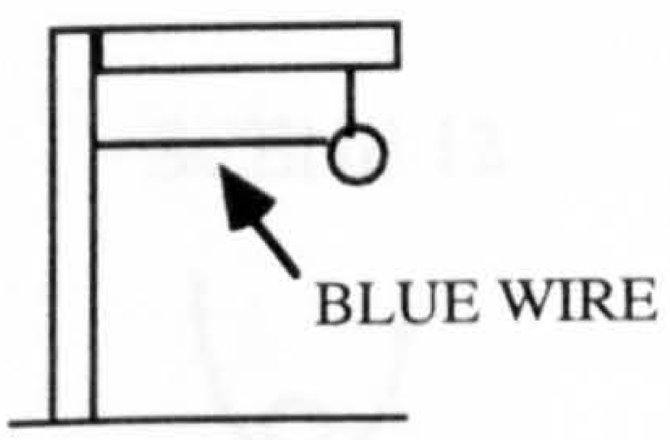


RESULT B

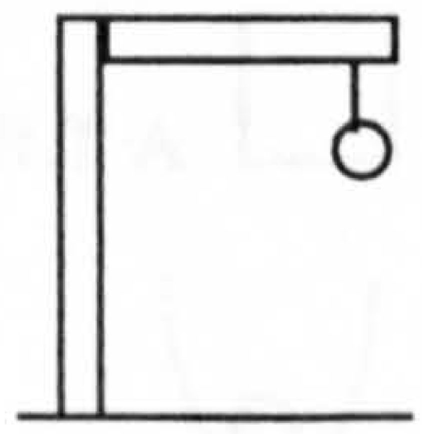


(8) What do you think would happen if the **blue**, (longer) wire was removed?

SCENE 8



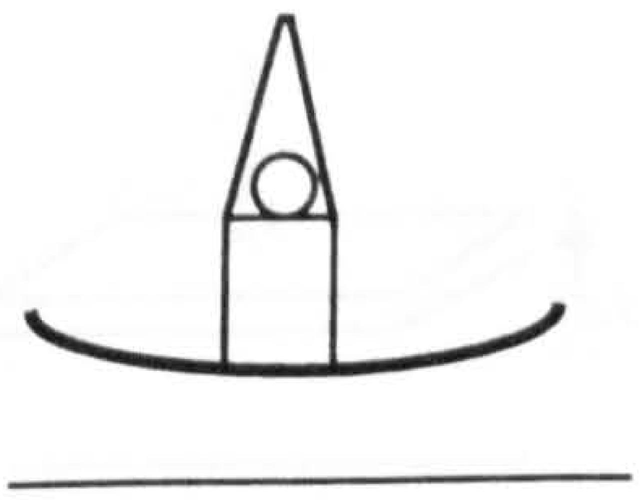
RESULT A



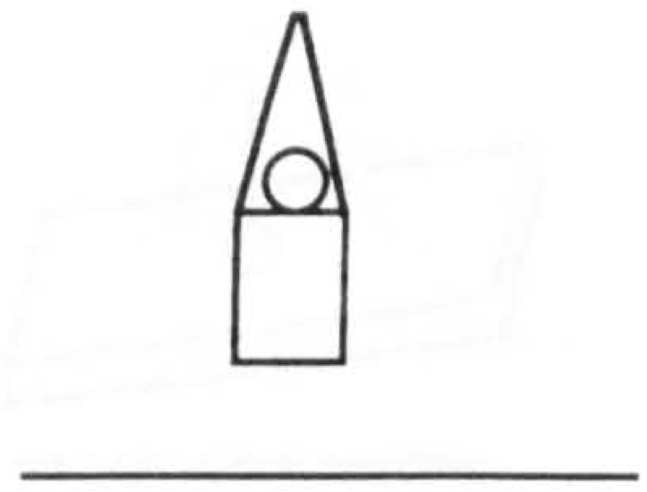
RESULT B

(9) What do you think would happen if the **plywood** was removed?

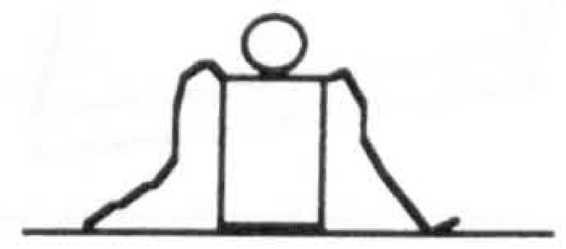
SCENE 9



RESULT A

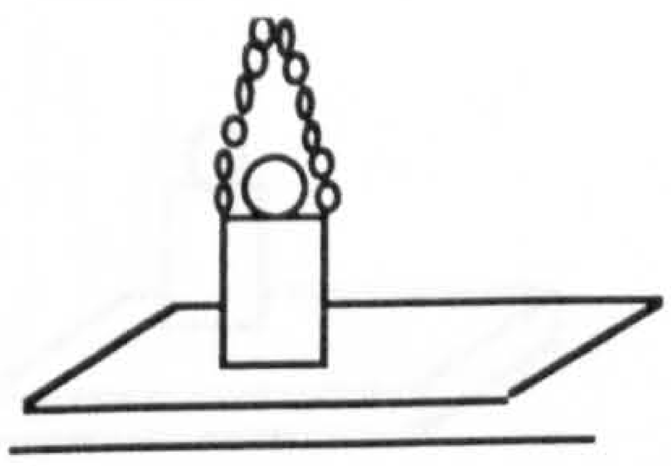


RESULT B

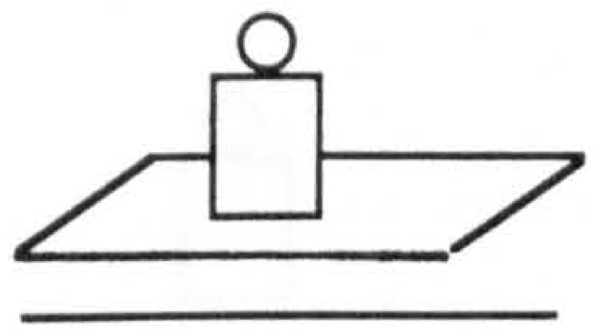


(10) What do you think would happen if the **chain** was removed?

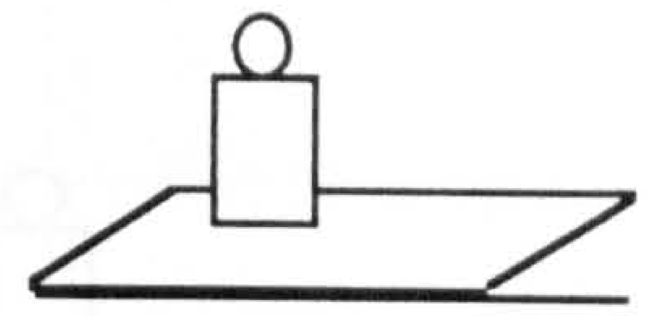
SCENE 10



RESULT A

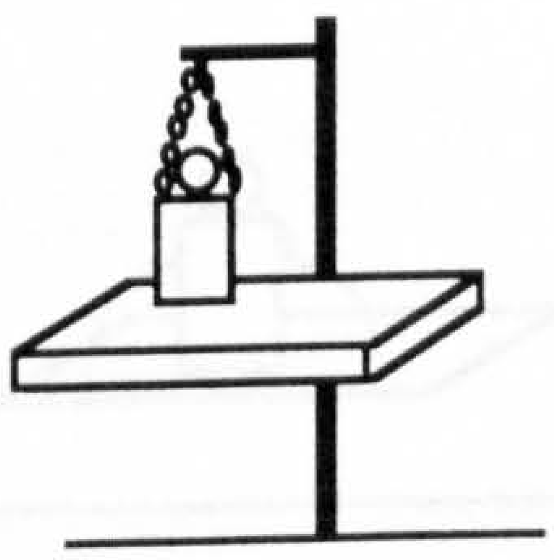


RESULT B

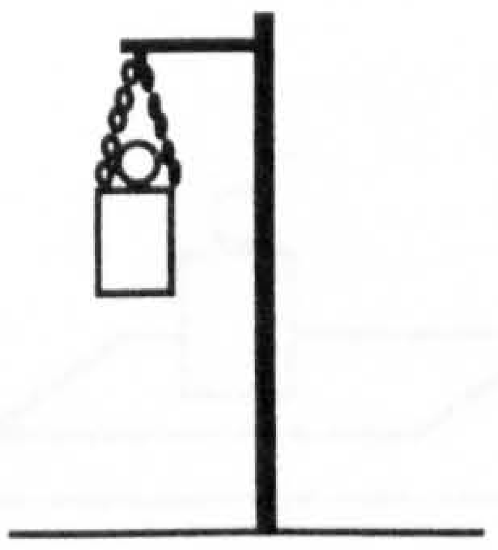


(11) What do you think would happen if the **plank of wood** was removed?

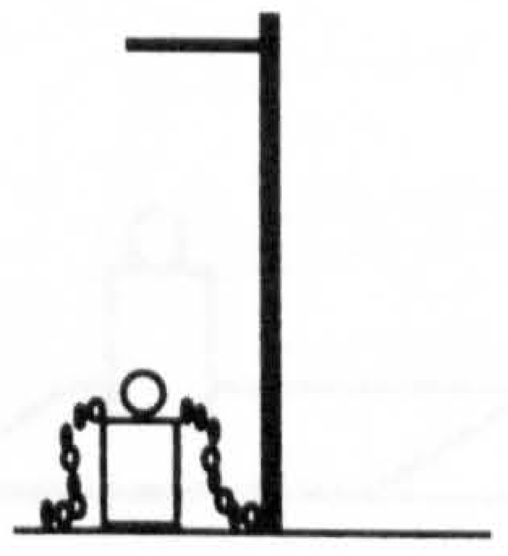
SCENE 11



RESULT A

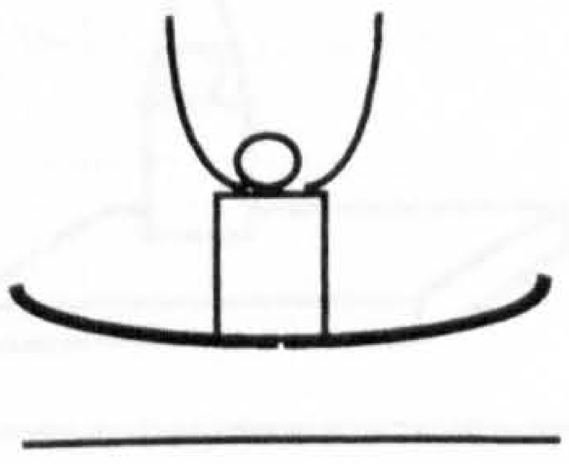


RESULT B

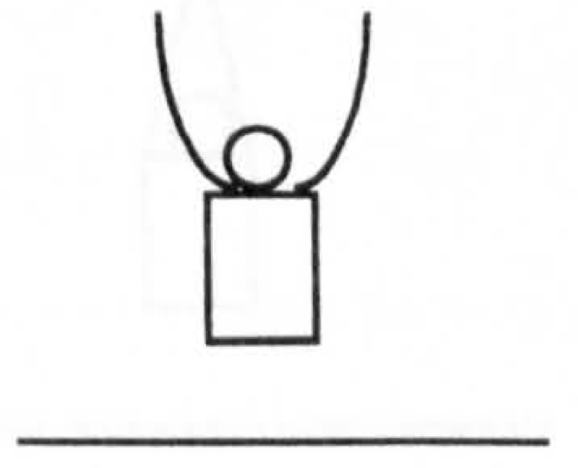


(12) What do you think would happen if the **plywood** was removed?

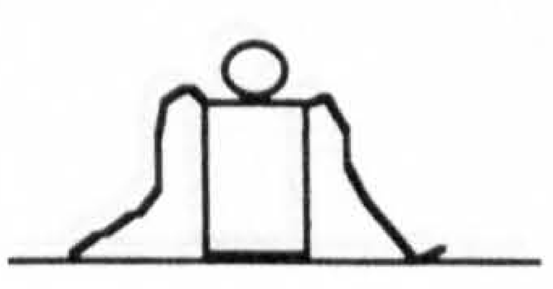
SCENE 12



RESULT A

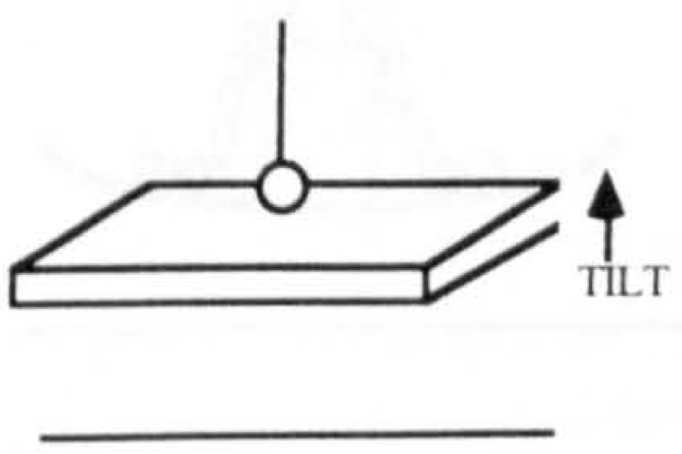


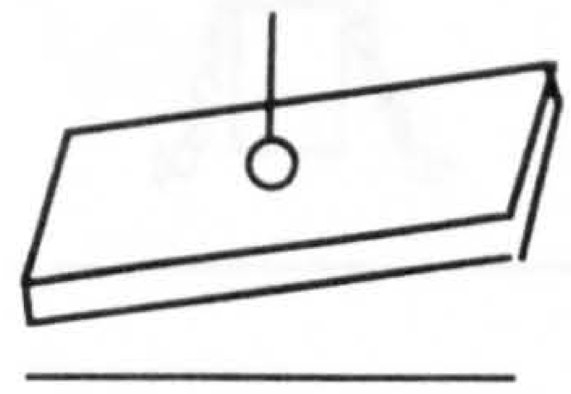
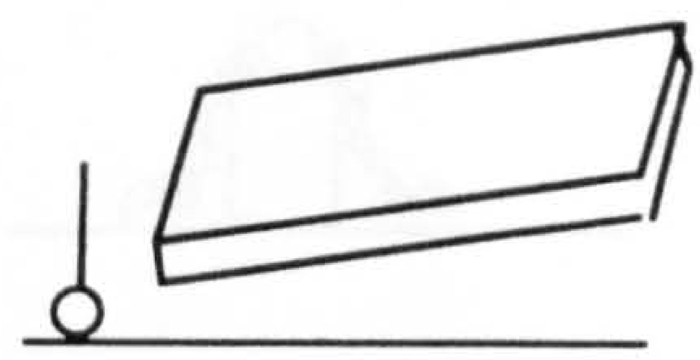
RESULT B



(13) What do you think would happen if the **plank of wood** was tilted, as illustrated?

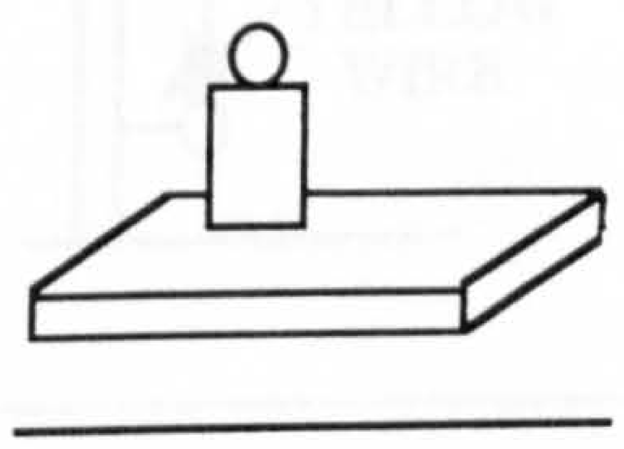
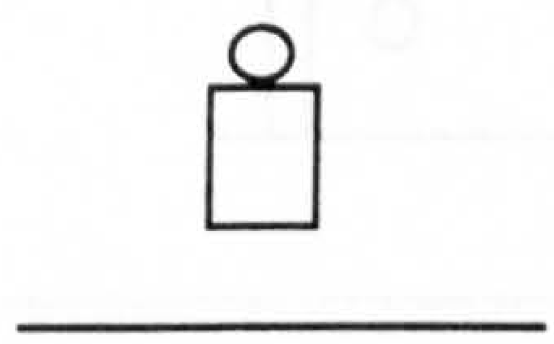
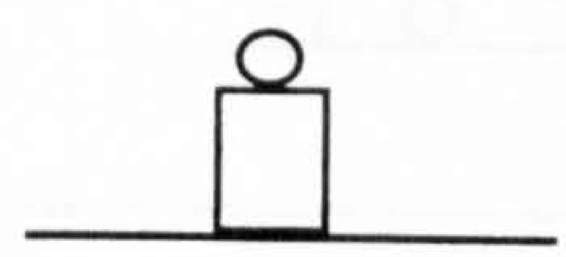
SCENE 13 RESULT A ☐ RESULT B ☐



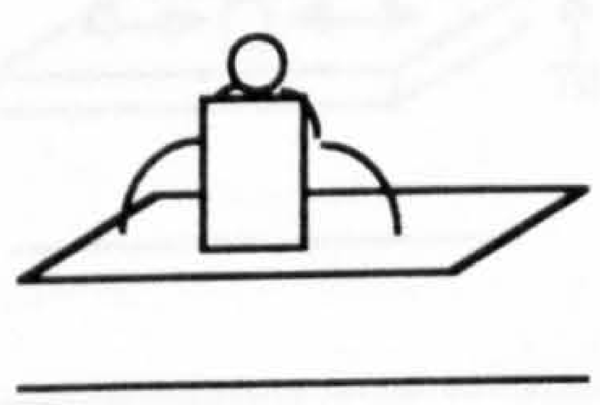
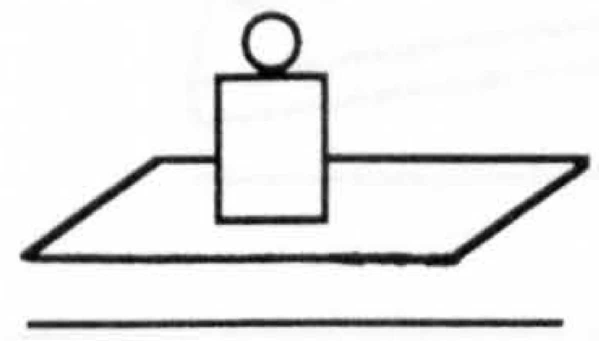
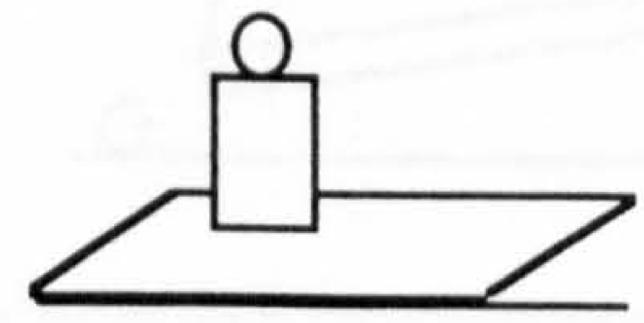
(14) What do you think would happen if the **plank of wood** was removed?

SCENE 14 RESULT A ☐ RESULT B ☐

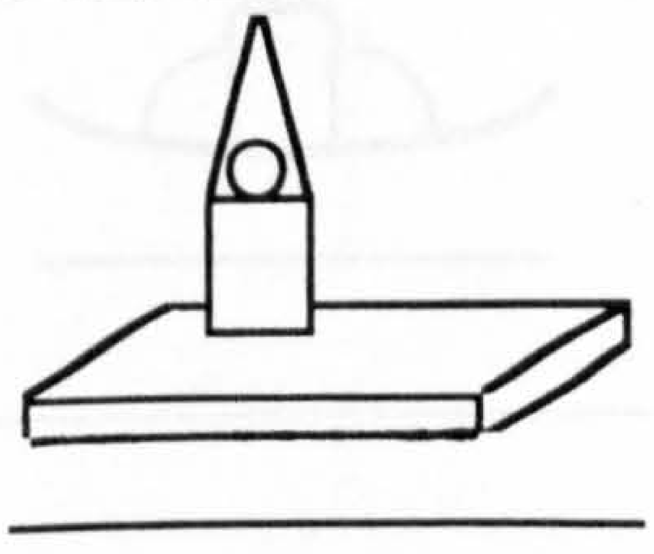
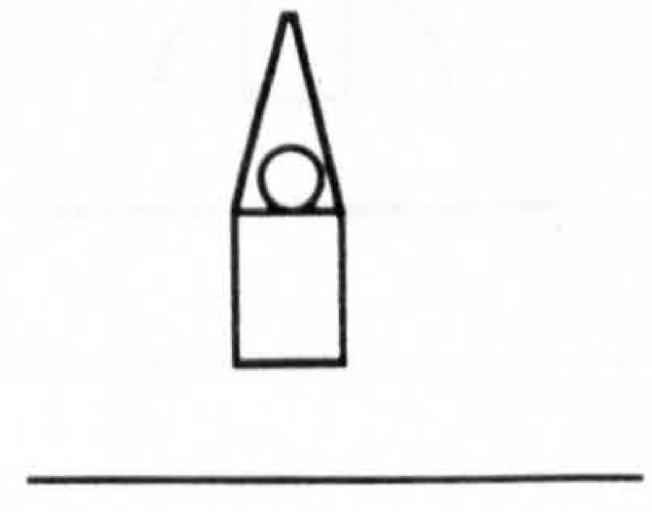
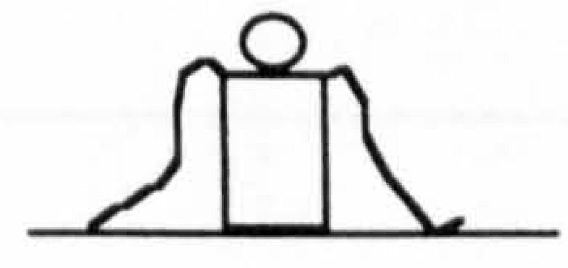
(15) What do you think would happen if the **thread** was removed?

SCENE 15 RESULT A ☐ RESULT B ☐

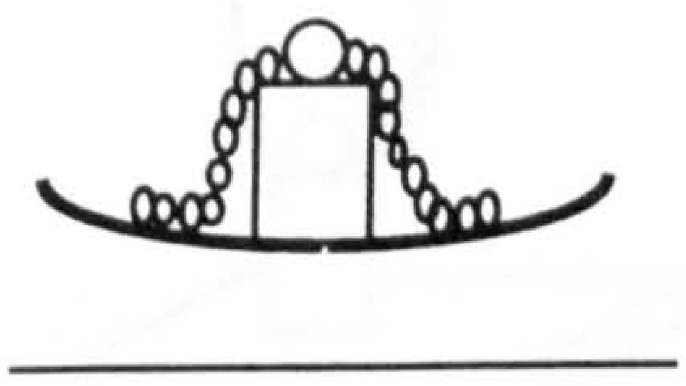
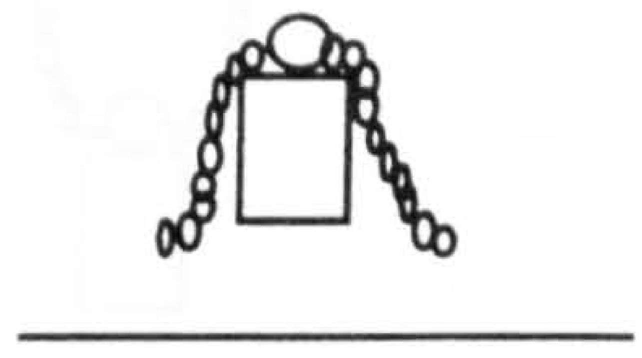
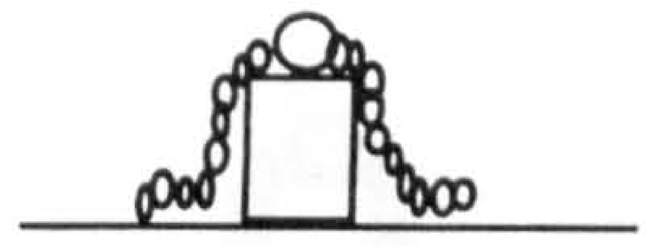
(16) What do you think would happen if the **plank of wood** was removed?

SCENE 16 RESULT A ☐ RESULT B ☐

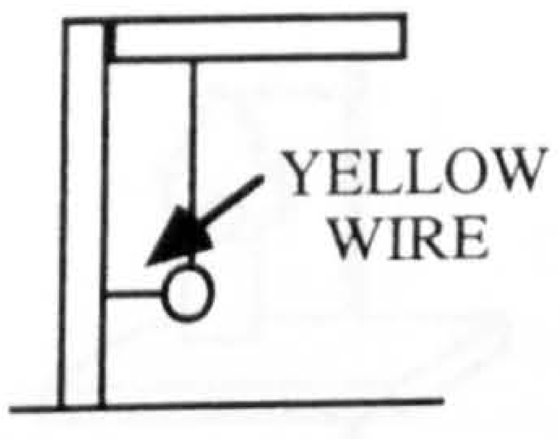
(17) What do you think would happen if the **plywood** was removed?

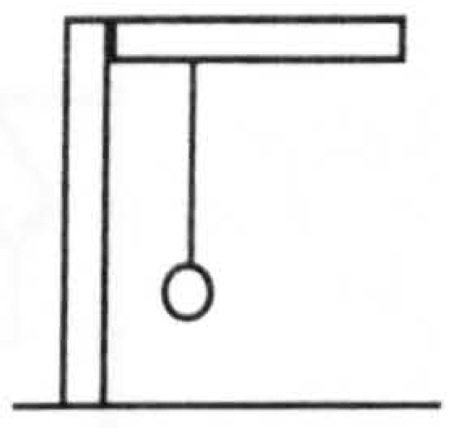
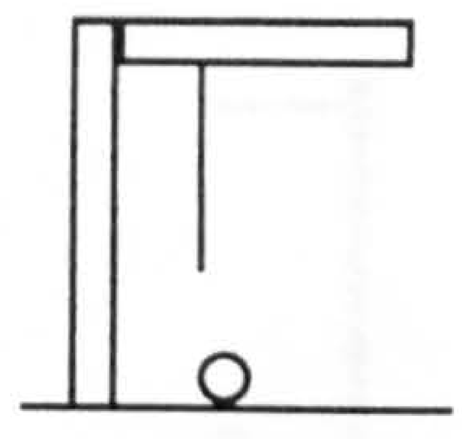
SCENE 17 RESULT A ☐ RESULT B ☐

(18) What do you think would happen if the **yellow**, (shorter) wire was removed?

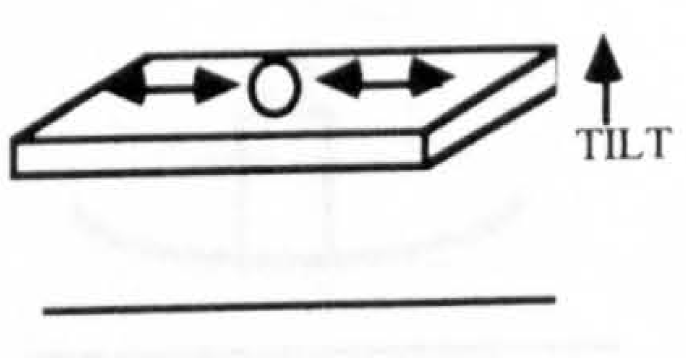
SCENE 18 RESULT A ☐ RESULT B ☐

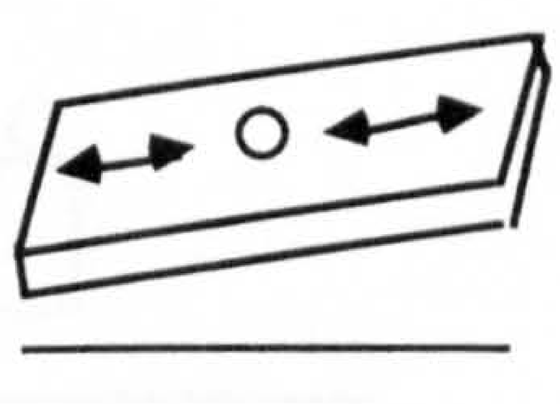
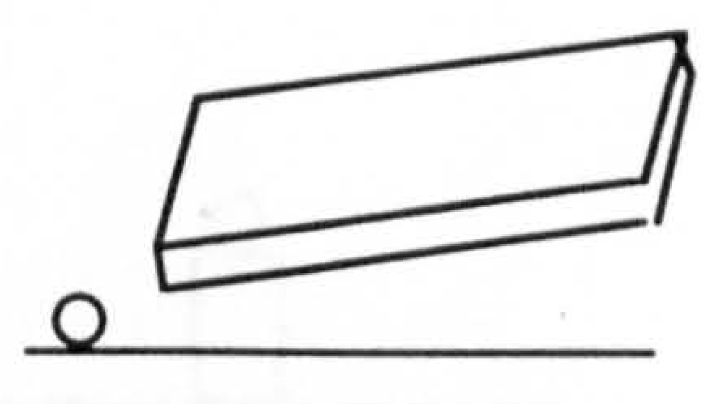


(19) What do you think would happen if the **plank of wood** was tilted, as illustrated?

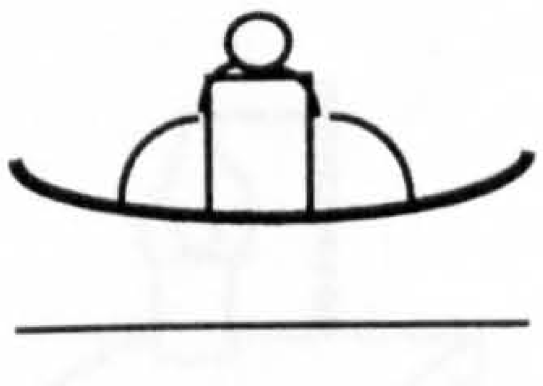
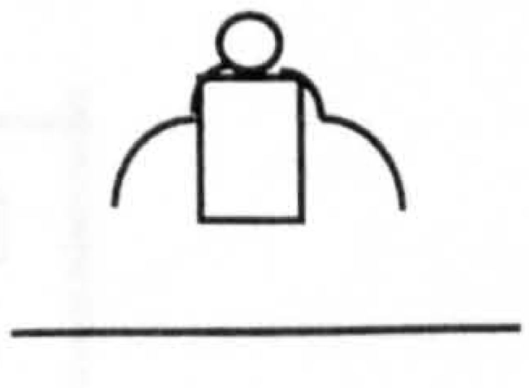
SCENE 19 RESULT A ☐ RESULT B ☐



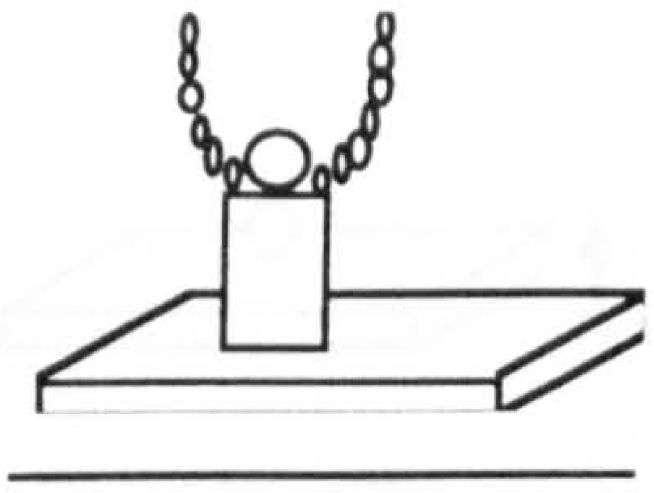
(20) What do you think would happen if the **plywood** was removed?

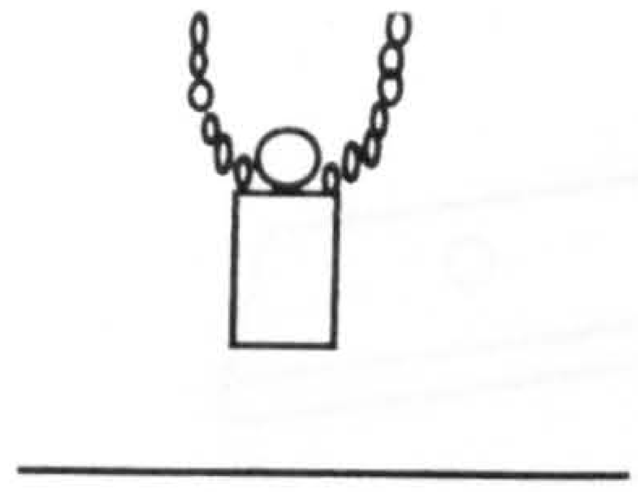
SCENE 20 RESULT A ☐ RESULT B ☐

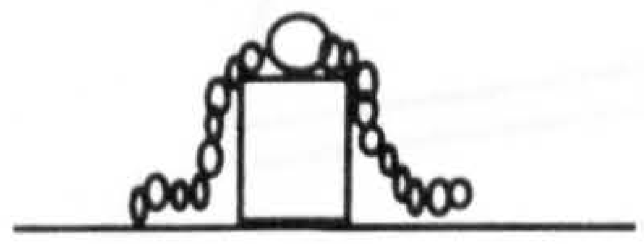




(21) What do you think would happen if the **plank of wood** was removed?

SCENE 21 RESULT A ☐ RESULT B ☐

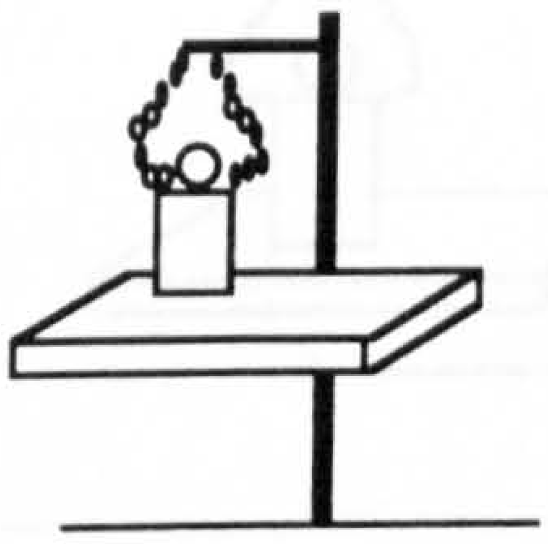


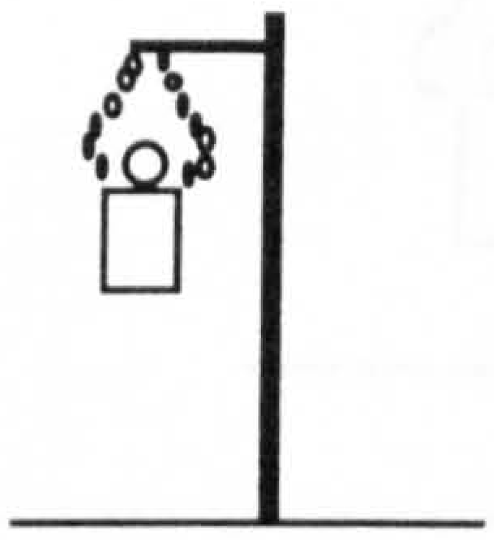


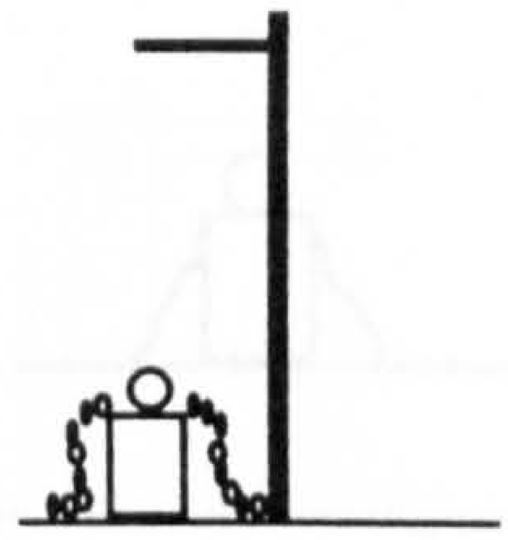


(22) What do you think would happen if the **plank of wood** was removed?

SCENE 22 RESULT A ☐ RESULT B ☐

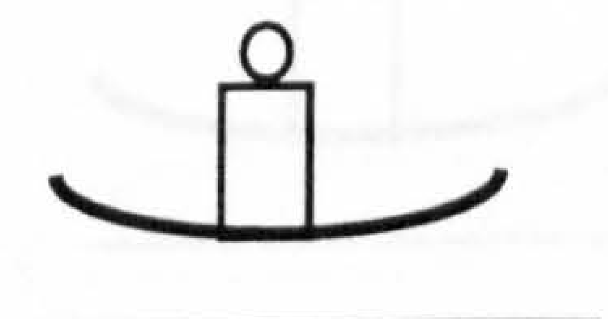


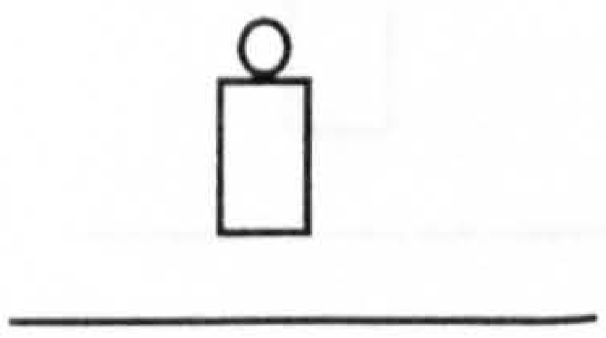


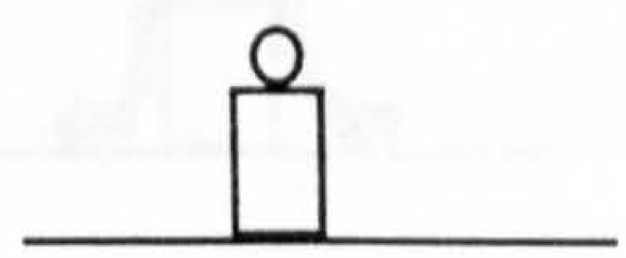


(23) What do you think would happen if the **plywood** was removed?

SCENE 23 RESULT A ☐ RESULT B ☐

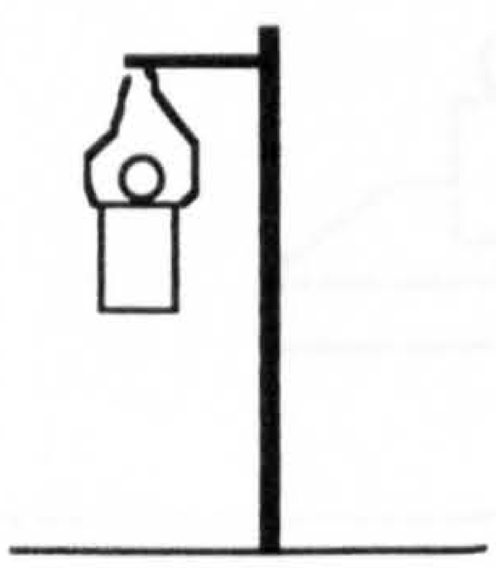


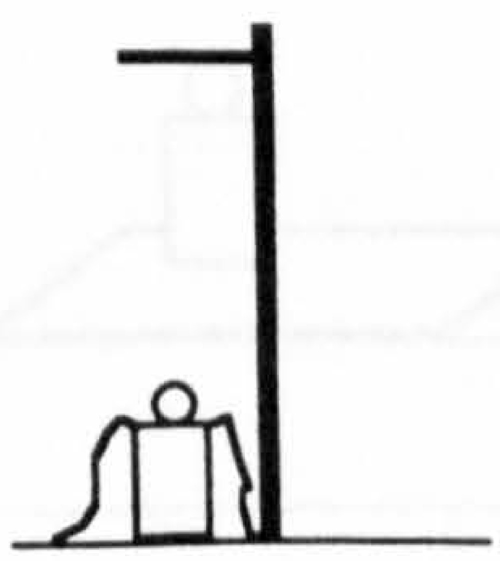




(24) What do you think would happen if the **plank of wood** was removed?

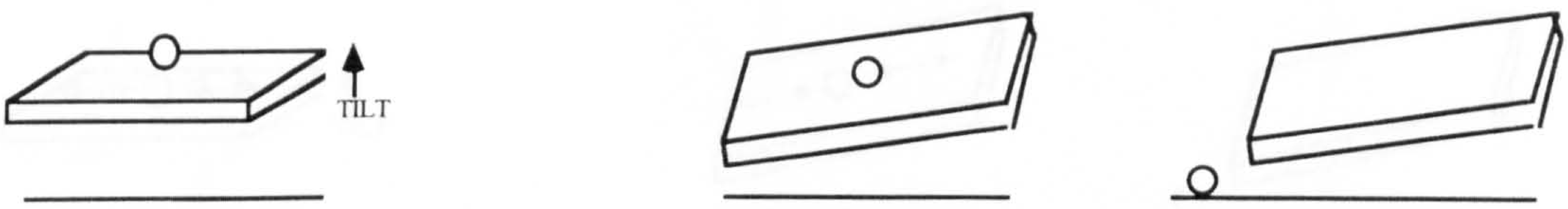
SCENE 24 RESULT A ☐ RESULT B ☐





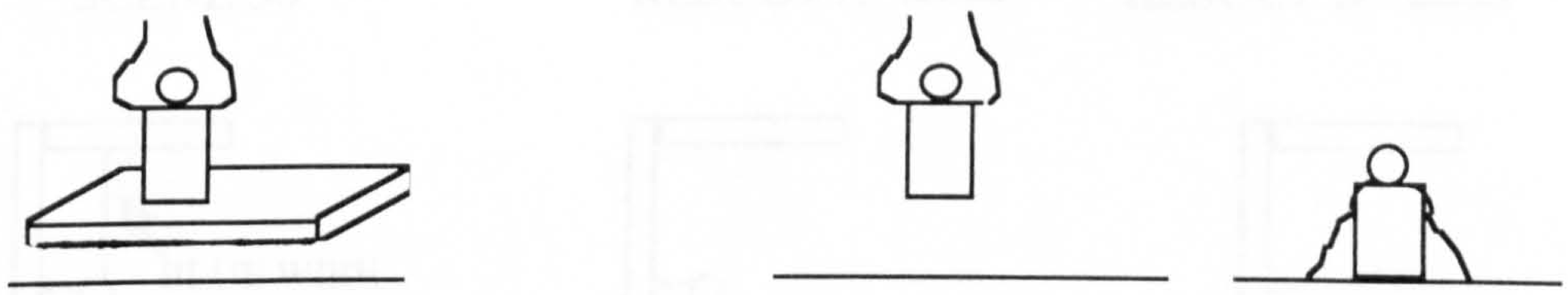
(25) What do you think would happen if the **plank of wood** was tilted, as illustrated?

SCENE 25 RESULT A RESULT B



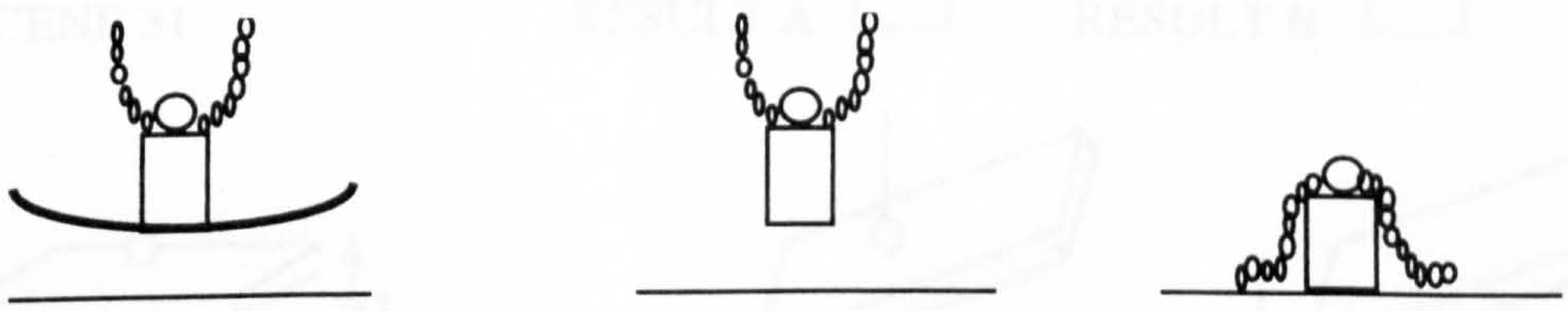
(26) What do you think would happen if the **plank of wood** was removed?

SCENE 26 RESULT A RESULT B



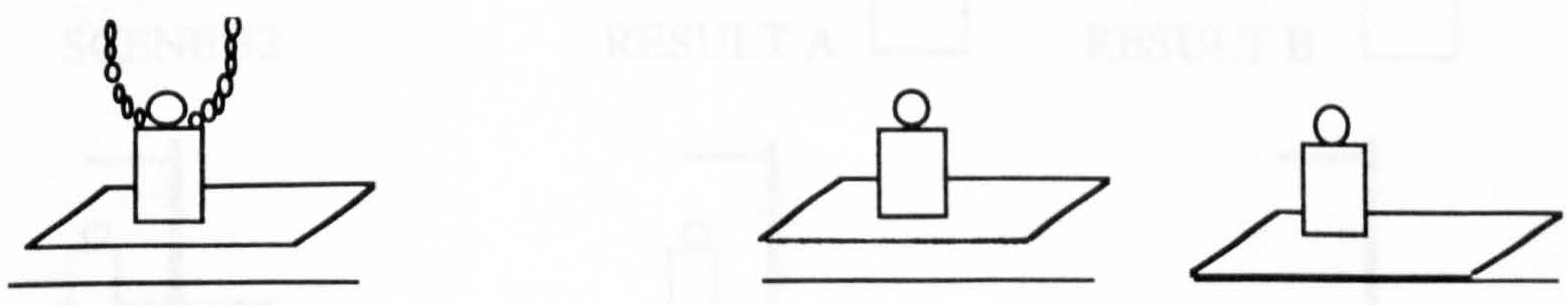
(27) What do you think would happen if the **plywood** was removed?

SCENE 27 RESULT A RESULT B



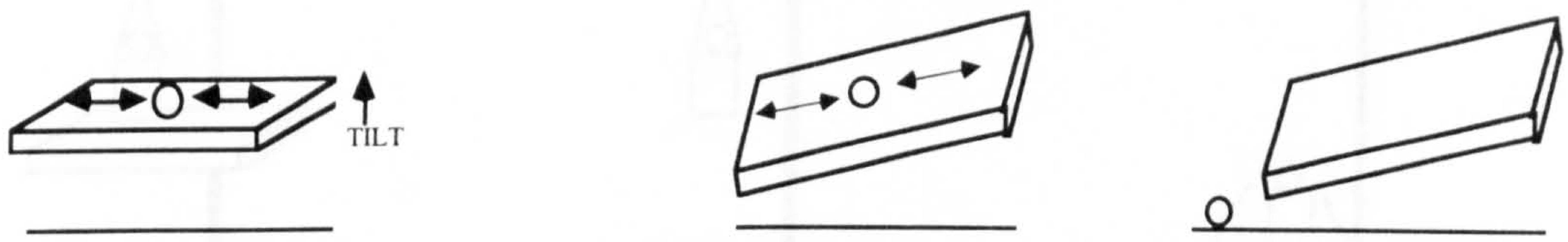
(28) What do you think would happen if the **chain** was removed?

SCENE 28 RESULT A RESULT B



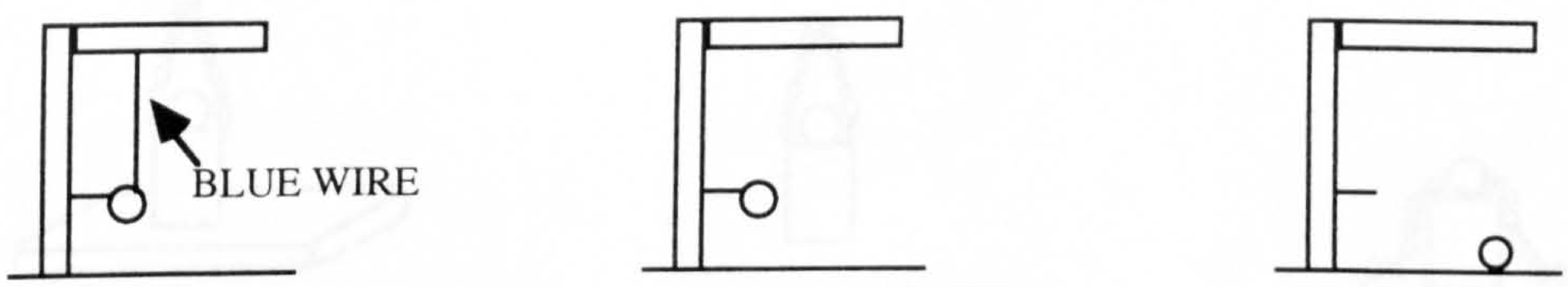
(29) What do you think would happen if the **plank of wood** was tilted, as illustrated?

SCENE 29 RESULT A ☐ RESULT B ☐



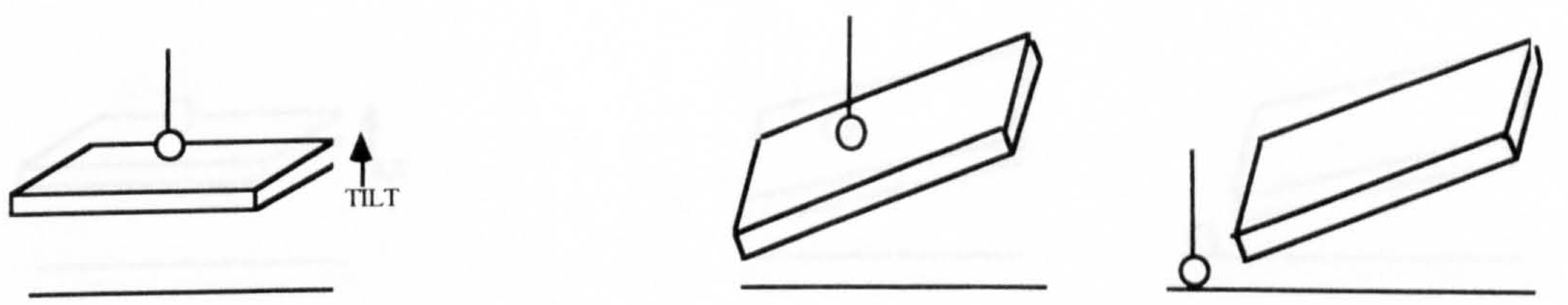
(30) What do you think would happen if the **blue**, (longer) wire was removed?

SCENE 30 RESULT A ☐ RESULT B ☐



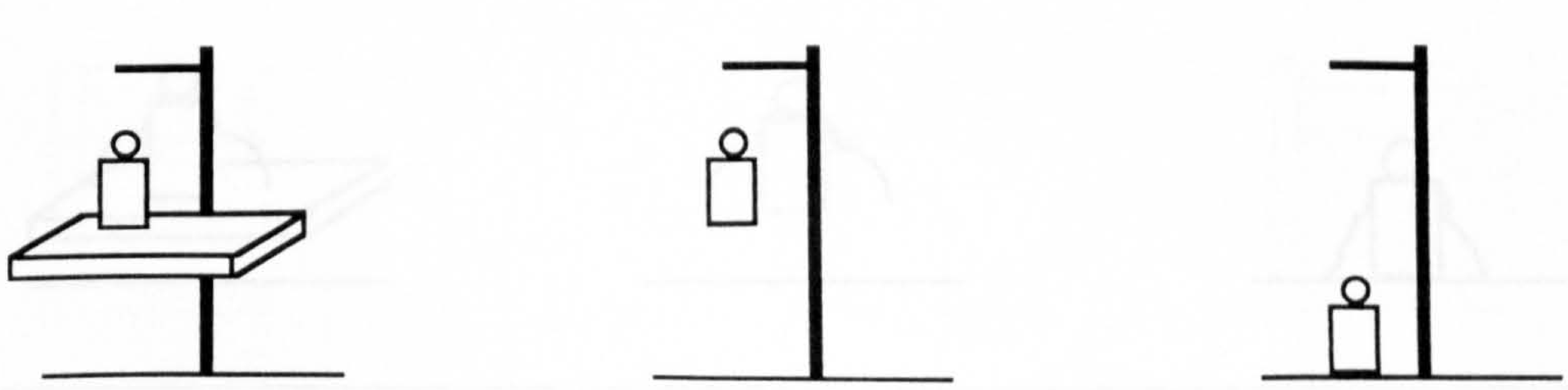
(31) What do you think would happen if the **plank of wood** was tilted, as illustrated?

SCENE 31 RESULT A ☐ RESULT B ☐



(32) What do you think would happen if the **plank of wood** was removed?

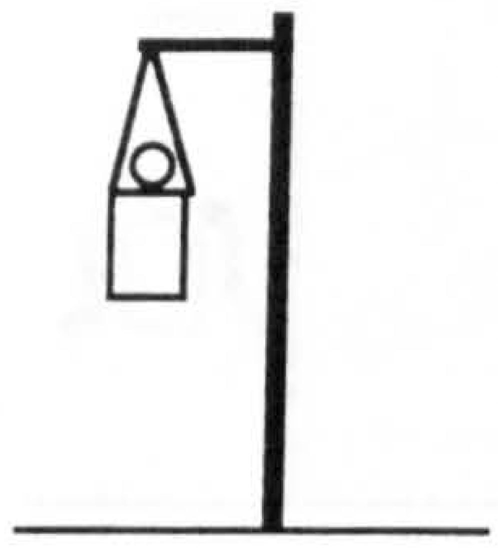
SCENE 32 RESULT A ☐ RESULT B ☐



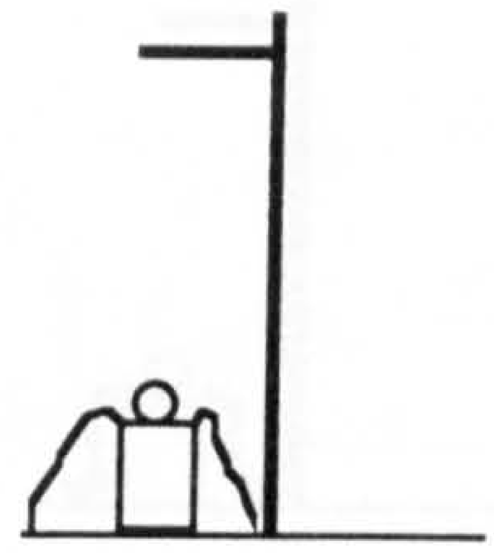
(33) What do you think would happen if the **plank of wood** was removed?

SCENE 33

RESULT A ☐



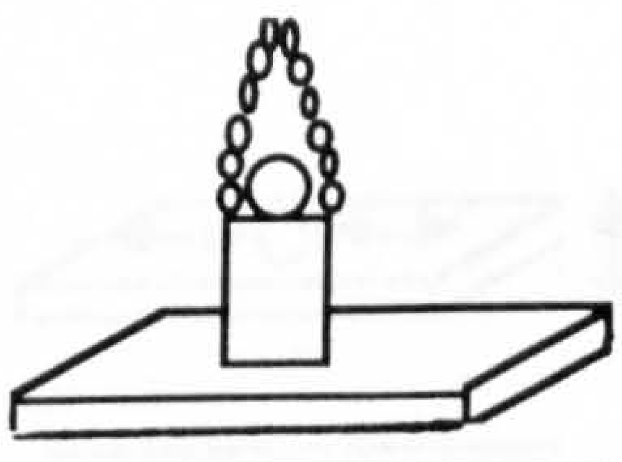
RESULT B ☐



---

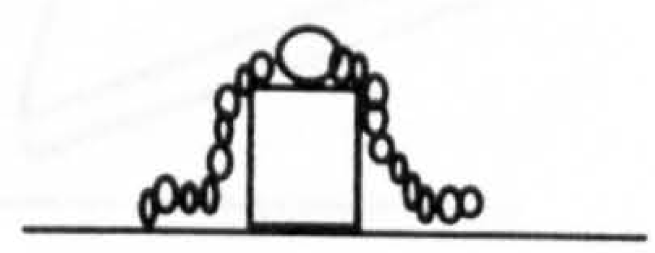
(34) What do you think would happen if the **plank of wood** was removed?

SCENE 34



RESULT A ☐

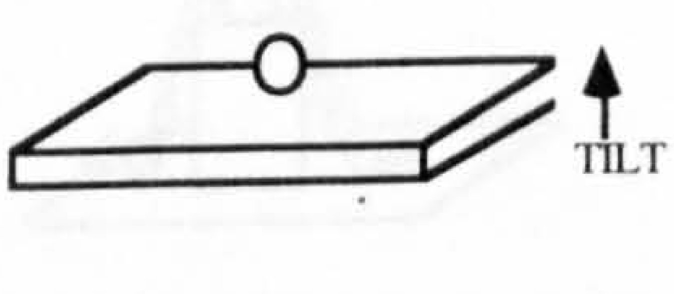
RESULT B ☐



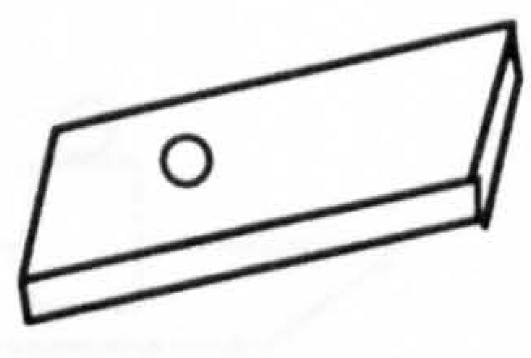
---

(35) What do you think would happen if the **plank of wood** was tilted, as illustrated?

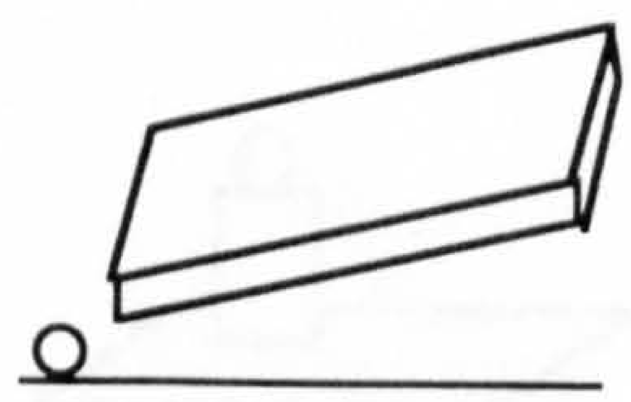
SCENE 35



RESULT A ☐



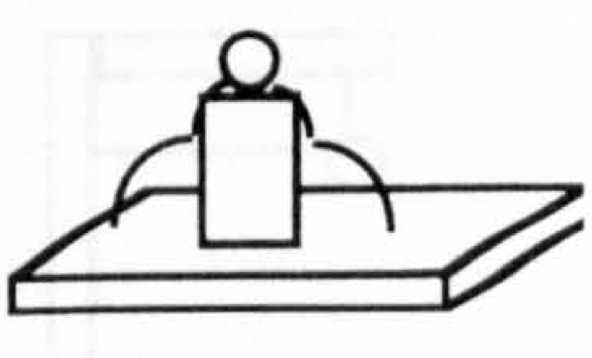
RESULT B ☐



---

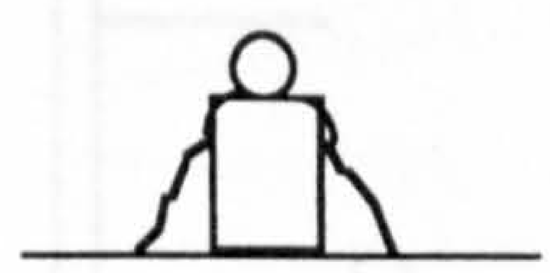
(36) What do you think would happen if the **plank of wood** was removed?

SCENE 36



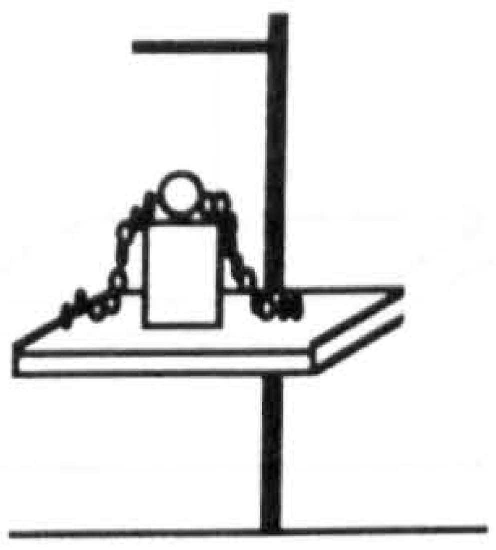
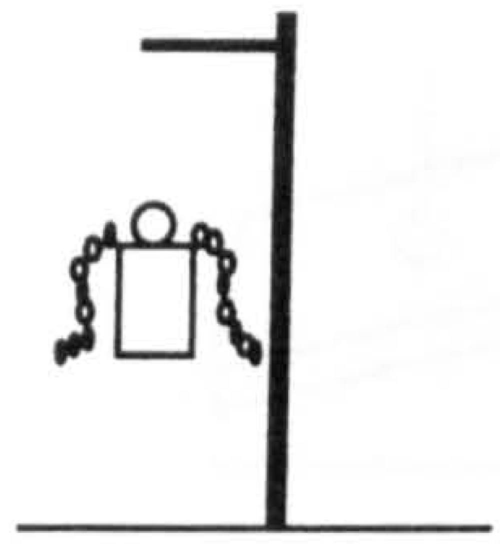
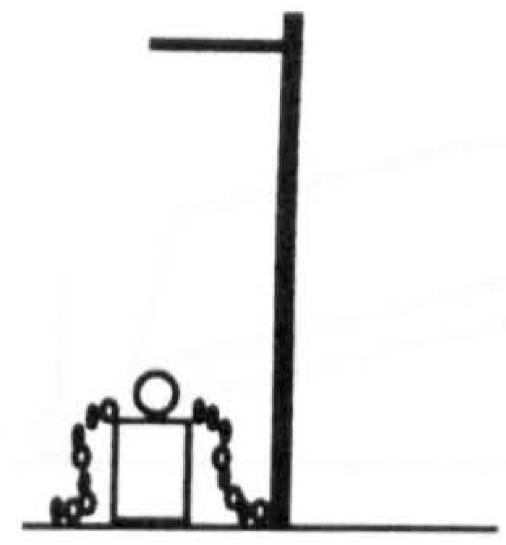
RESULT A ☐

RESULT B ☐



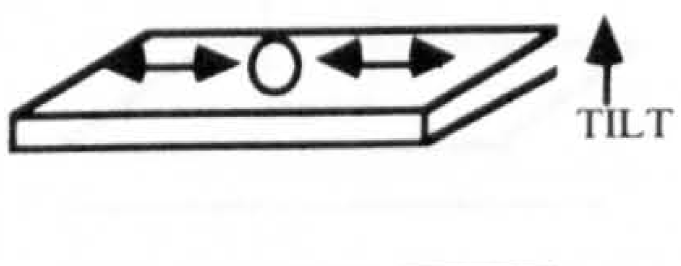
(37) What do you think would happen if the **plank of wood** was removed?

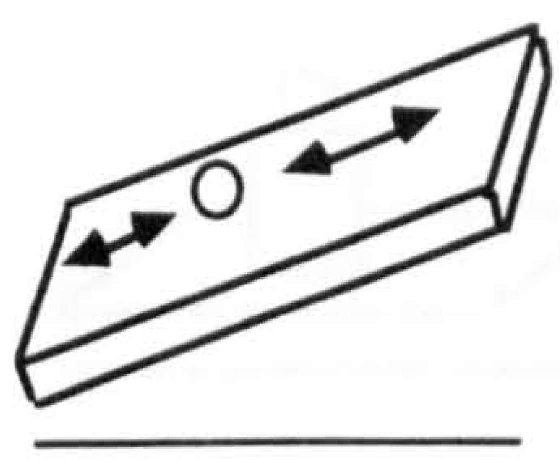
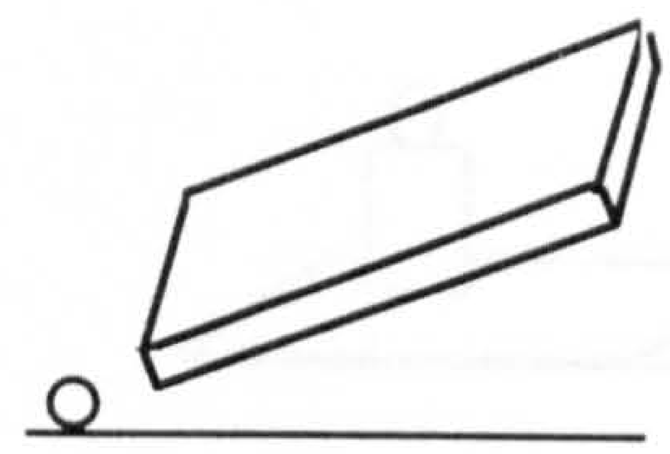
SCENE 37 | RESULT A ☐ | RESULT B ☐

(38) What do you think would happen if the **plank of wood** was tilted, as illustrated?

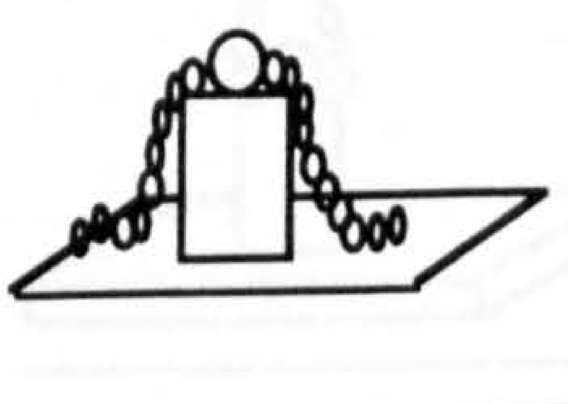
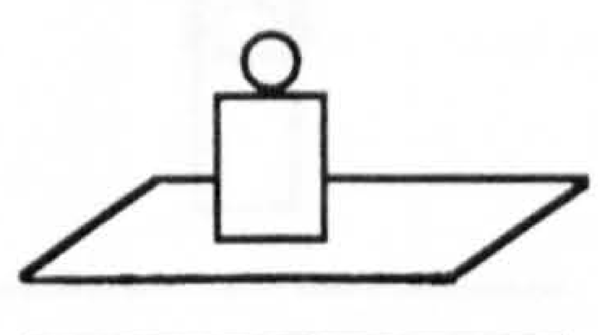
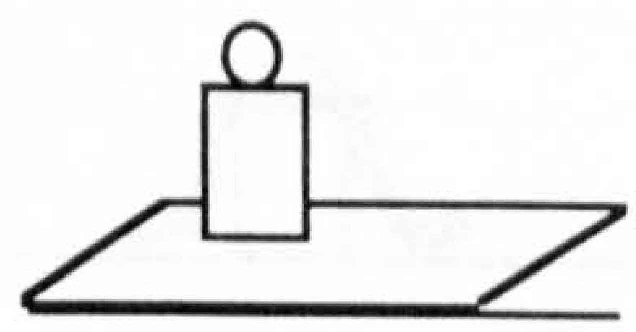
SCENE 38 | RESULT A ☐ | RESULT B ☐



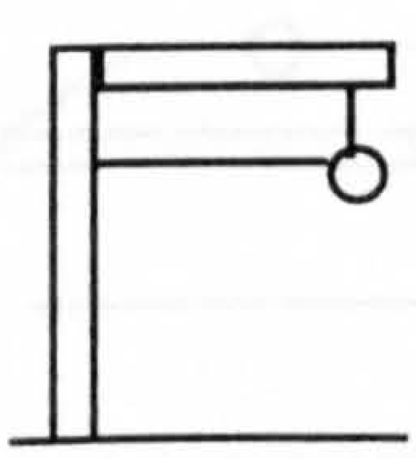
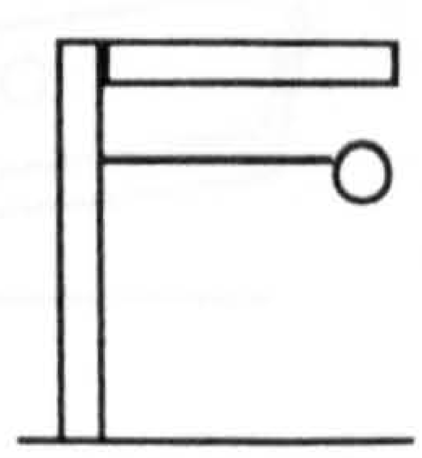
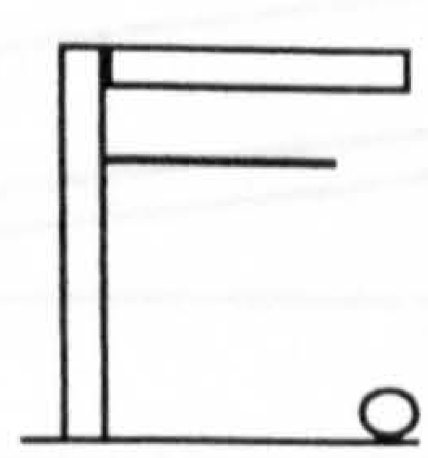
(39) What do you think would happen if the **chain** was removed?

SCENE 39 | RESULT A ☐ | RESULT B ☐

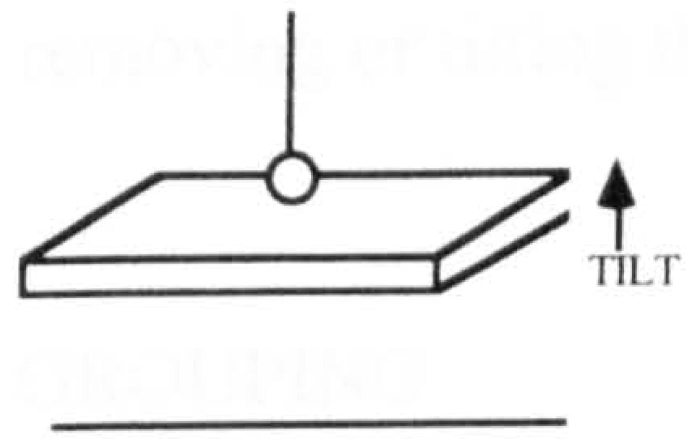
(40) What do you think would happen if the **yellow**, (shorter) wire was removed?

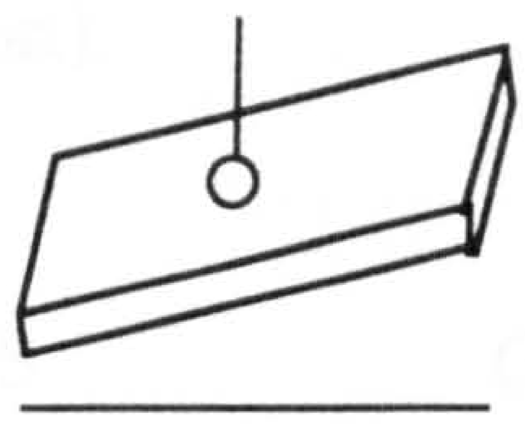
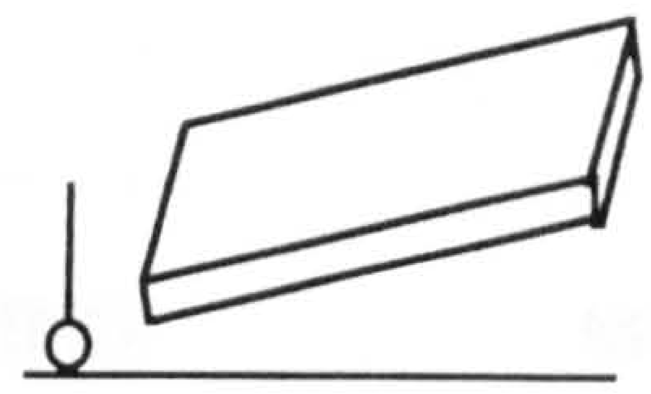
SCENE 40 | RESULT A ☐ | RESULT B ☐

(41) What do you think would happen if the **plank of wood** was tilted, as illustrated?

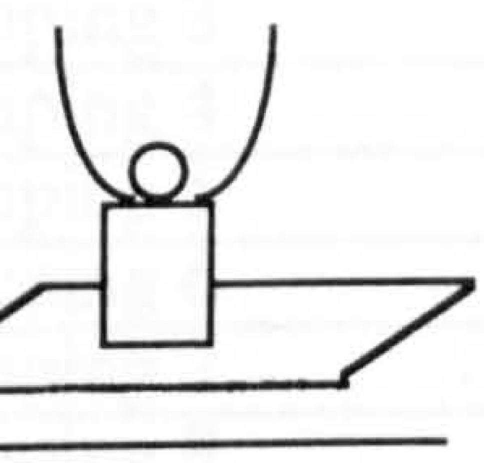
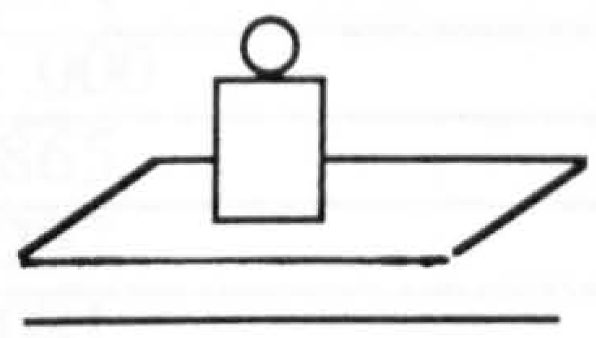
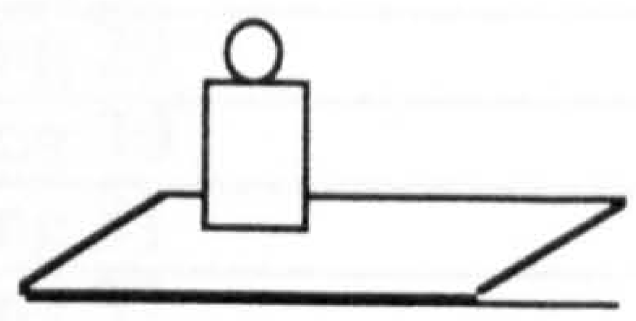
SCENE 41 RESULT A ☐ RESULT B ☐



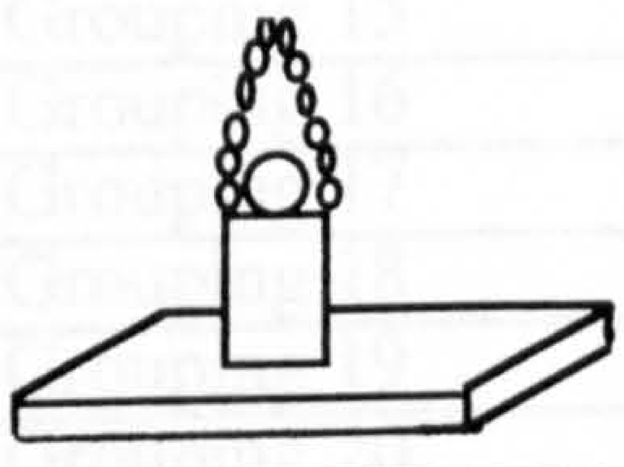
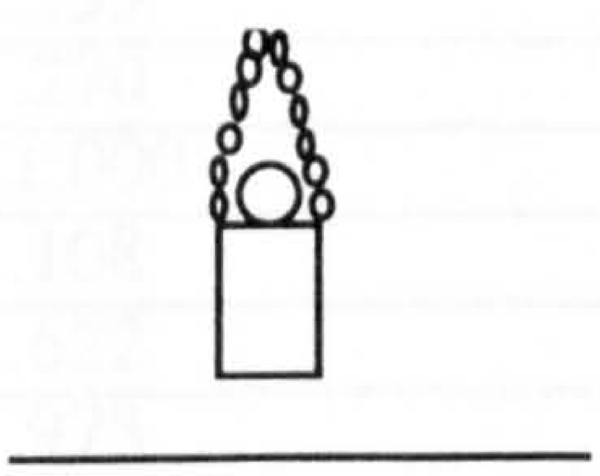
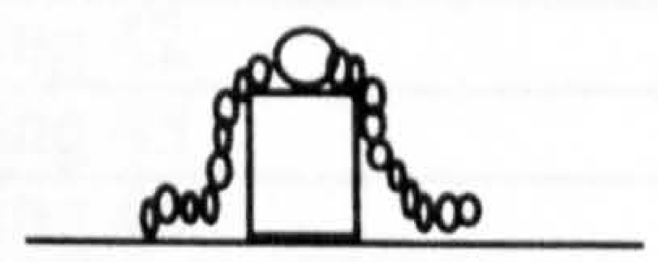
(42) What do you think would happen if the **thread** was removed?

SCENE 42 RESULT A ☐ RESULT B ☐

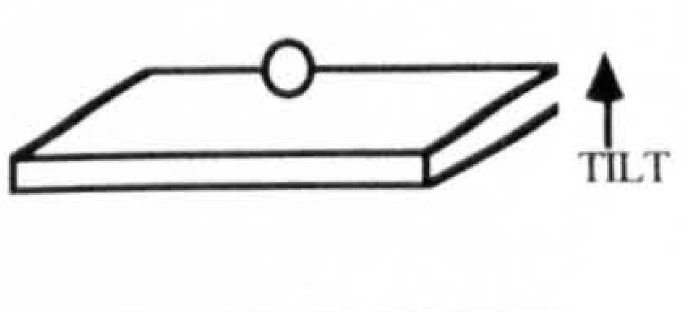
(43) What do you think would happen to if the **plank of wood** was removed?

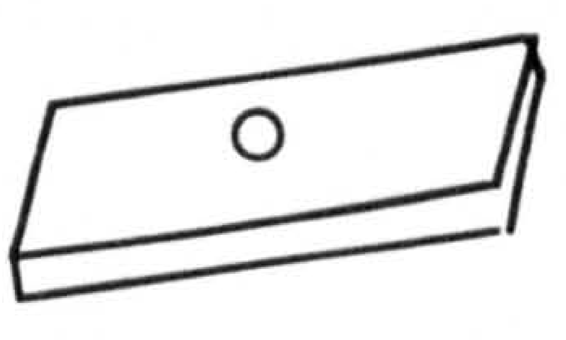
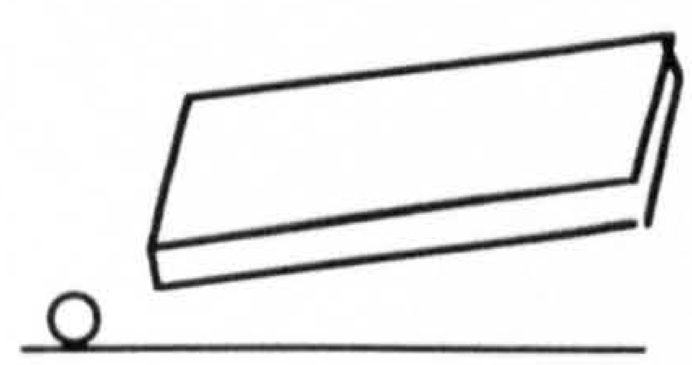
SCENE 43 RESULT A ☐ RESULT B ☐

(44) What do you think would happen of the **plank of wood** was tilted, as illustrated?

SCENE 44 RESULT A ☐ RESULT B ☐



END

Appendix T: Mean Values for IJ2

The mean values for these Groupings represent subjects' confidence that the referent (weight or ping-pong ball) would change position after the suggested movement (either removing or tilting the primary support).

GROUPING	MEANS	GROUPING	MEANS
Example 1	.135	Grouping 21	.595
Example 2	.200	Grouping 22	.351
Example 3	.108	Grouping 23	.973
Example 4	.865	Grouping 24	.622
Grouping 1	.973	Grouping 25	.865
Grouping 2	.892	Grouping 26	.838
Grouping 3	.946	Grouping 27	.568
Grouping 4	.514	Grouping 28	.622
Grouping 5	1.000	Grouping 29	.568
Grouping 6	.865	Grouping 30	.541
Grouping 7	.297	Grouping 31	.054
Grouping 8	.081	Grouping 32	1.000
Grouping 9	.351	Grouping 33	.432
Grouping 10	.973	Grouping 34	.189
Grouping 11	.027	Grouping 35	.865
Grouping 12	.919	Grouping 36	.973
Grouping 13	.027	Grouping 37	1.000
Grouping 14	.946	Grouping 38	.568
Grouping 15	.135	Grouping 39	.135
Grouping 16	.270	Grouping 40	.054
Grouping 17	1.000	Grouping 41	.649
Grouping 18	.108	Grouping 42	.081
Grouping 19	.622	Grouping 43	.162
Grouping 20	.973	Grouping 44	.838

Appendix U: The Sample Video-Tape

This video-tape contains sample scenes from Preposition Experiments and also Independent Judgement Experiments. These are included to show exactly what the pictorial representations looked like in 3D. The contents of this tape are as follows:

(1) A sample from IJ1 of an Independent Judgements Experiment (10 minutes, 11 seconds).

30 seconds of blank tape.

(2) A sample from PREP5 of a Prepositions Experiment (5 minutes).

30 seconds of blank tape.

(3) A sample from PREP3 of a Prepositions Experiments (3 minutes).

List of References

Allen, R. E. (Ed.) (1990). *The Concise Oxford Dictionary of Current English.* Oxford: Clarendon Press.

Alston, W. P. (1964). *Philosophy of Language.* New Jersey: Prentice-Hall Inc.

Armstrong, S., Gleitman, L. R., and Gleitman, H. (1983). What some concepts might not be. *Cognition*, 13, 263-308.

Aurnague, M. (1993). A three-level approach to the semantics of space. In C. Zelinsky-Wibbelt (Ed.), *The Semantics of Prepositons: From Mental Processing to Natural Language Processing.* Berlin/New york: Mouton de Gruyter.

Arnaugue, M. (1995). Orienation in French spatial expression: fromal representations and inferences. *Journal of Semantics*, 12, 239-267.

Bennett, D. C. (1972). Some observations concerning the locative-directional distinction. *Semiotica*, 5, 58-88.

Bennett, D. C. (1975). *Spatial and Temporal uses of English Prepositions: An Essay in Stratificational Semantics.* London: Longman.

Brugman, C. (1981). *The story of over.* M.A. Thesis, University of California at Berkley. Reprinted by the Indiana Linguistics Club.

Brugman, C. and Lakoff, G. (1988). Cognitive topology and lexical networks. In S. L. Small, G. W. Cottrell and M. K. Tannehaus (Eds.). *Lexical Ambiguity Resolution: Perspectives from Psycholinguistics, Neuropsychology, and Artificial Intelligence.* California: Morgan Kaufman.

Bryant, D. J., Tversky, B. and Franklin, N. (1992). Internal and external spatial frameworks for representing described scenes. *Journal of Memory and Language*, 31, 74-98.

Campbell, S. (1995). *An Investigation into the Factors that Contribute to a Functional Geometric Description of the Preposition ON.* Maxi Project, University of Glasgow.

Carlson-Radvansky, L. A. and Irwin, D. E. (1993). Frames of reference in vision and language: Where is above? *Cognition*, 46, 223-244.

Carlson-Radvansky, L. A. and Radvansky, G. A. (1996). The influence of functional relations on spatial term selection. *Psychological Science*, 7(1), 56-60.

Chomsky, N. (1965) *Aspects of the Teory of Syntax.* Cambridge, MA: MIT Press.

Cienki, A. J. (1989). *Spatial Cognition and the Semantics of Prepositions in English, Polish, and Russion.* Verlag Otto Sagner: Munich.

Clark, E. V. (1973). Non-linguistic strategies and the aquisition of word meanings. *Cognition,* 2, 161-182.

Clark, H. H. and Clark, E. V. (1977). *Psychology and Language: An Introduction to Psycholinguistics.* Harcourt Brace Jovanovich, Inc.

Cohen, L. and Holliday, M. (1982). *Statistics for Social Scientists: An Introductory Text with Computer Programs in BASIC* . Harper and Row: London.

Cohn, A. G., Gooday, J. M., Bennett, B., and Gotts, N. M. (1995). A logical approach to representing and reasoning about space. *Artificial Intelligence Review, 9*, 255-259.

Cohn, A. G. (1996a). Calculi for qualitative spatial reasoning. *Internet Manuscriptt*. Division of Artifical Intelligence, School of Computer Studies, University of Leeds.

Cohn, A. G. (1996b). A hierarchical representation of qualitative shape based on connection and convexity. *Internet manuscript*. Division of Artifical Intelligence, School of Computer Studies, University of Leeds.

Coleman, L. and Kay, P. (1981). Prototype semantics: The English verb "lie". *Language*, 57(1), 26-44.

Collins, A. M. and Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review*, 82, 407-428.

Collins, A. M and Quillian, M. R. (1969). Retrieval time from semantic memory. *Journal of Verbal Learning and Behaviour*, 8, 240-247.

Conrad, C. (1972). Cognitive economy in semantic memory. *Journal of Experimental Psychology*, 92, 149-154.

Cooper, G. S. (1968). *A Semantic Analysis of English Locative Prepositions*. Bolt, Beranek and Newman Report No: 1587. Springfield, Va.: Clearinghouse for Federal Scientific and Technical Information.

Coventry, K. R. (1992) *Spatial prepositions and functional relations: the case for minimally specified lexical entries*. Ph.D Thesis, University of Edinburgh.

Coventry, K. R., Carmichael, R. and Garrod, S. C. (1994). Spatial prepositons, object specific function and task requirements. *Journal of Semantics*, 11(4), 289-311.

Cox, M. V. and Richardson, J. R. (1985). How do children describe spatial relationships? *Journal of Child Language*, 12, 611-620.

Crangle, C, and Suppes, P. (1989). Geometric semantics for spatial prepositions. *Midwest Studies in Philosophy*, XIX, 399-422.

Cruse, D. A. (1986). *Lexical Semantics.* Cambridge: Cambridge University Press.

Crystal, D. (1995). *The Cambridge Encyclopedia of the English Language.* Cambridge: Cambridge University Press .

Cuyckens, H. (1991). *The Semantics of Spatial Prepositions in Dutch: A Cognitive-Linguistic Excercise.* Ph.D. Dissertation, University of Antwerp (UIA).

Cuyckens, H. (1993). The Dutch spatial preposition "in": A cognitive-semantic analysis. In: Zelinsky-Wibbelt, C. (ed). (1993) *The Semantics of Prepositions: From Mental Processing to Language Processing.* Berlin/New york: Mouton de Gruyter.

Cuyckens, H. (1993). Spatial prepositions in French revisited: Review Article on Vandeloise, C. (1991) *Spatial Prepositions: A case study from French.* Chicago: Chicago University Press. *Cognitive Linguistics*, 4-3, 291-310.

Ellis, H.C. and Hunt, R. R. (1993). *Fundamentals of Cognitive Psychology.* Wm. C. Brown Communications Inc.

Durkin, K. (1981). Aspects of late language aquisition: schoolchildren's use and comprehension of prepositions. *First Language*, ii, 47-59.

Ferrier, G. M. (1991). *An experimental study to investigate the factors that contribute to a functional geometry of spatial prepositions.* Masters Thesis, University of Glasgow.

Ferrier, G. M. (1994). *A Psychological investigation of the semantics of spatial prepositions.* Unpuplished Manuscript, University of Glasgow.

Franklin, N., Tversky, B. and Coon, V. (1992). Switching points of view in spatial mental models. *Memory and Cognition*, 20, 507-518.

Freyd, J. J. (1987). Dynamic mental representations. *Psychological Review*, 94, 427-438.

Forbus, K. D. (1983). Qualitative reasoning about space and motion. In Gentner, D. and Stevens, A. L. (Eds.). *Mental Models.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Freksa, C. and Zimmermann, K. (1992). On the utilisation of spatial structures for cognitively plausible and efficient reasoning, *Proceedings of the IEEE International Conference on Systems, Man and Cybernetics.*

Garnham, A. (1988). *Artificial Intelligence: An Introduction.* London: Routledge and Kegan Paul.

Garnham, A. (1990). *Psycholinguistics: Central Topics.* London: Routledge.

Garrod, S. C. (1991). *Reference and Description.* Unpublished Manuscript, University of Glasgow.

Garrod, S. C. and Anderson, A. (1987). Saying what you mean in dialogue: A study in conceptual and semantic coordination. *Cognition* , 27, 181-218.

Garrod, S. C. and Ferrier, G. M. (1996). *In, on and over and the functional geometry of spatial prepositions.* Unpublished Manuscript, University of Glasgow.

Garrod, S. C. and Sanford, A. J. (1989). Discourse models as interfaces between language and the spatial world. *Journal of Semantics*, 6, 147-160.

Gazdar, G. J. M. (1979). *Pragmatics: Implicature, Presupposition, and Logical Form.* New York: Academic Press.

Geach, P. T. and Black, M. (Eds.) (1952). *Philosophical Writings of Gottlieb Frege.* Oxford: Blackwell.

Geeraerts, D. (1988). Where does prototypicality come from? In Rudzka-Ostyn, B. (Ed.) (1993). *Topics in Cognitive Linguistics.* Amsterdam/Philadelphia: John-Benjamins Publishing Company.

Gentner, D. and Stevens, A. L. (1983). *Mental Models.* Hillsdale, NJ: Lawrence Erlbaum Associates.

Gibson, J. J. (1979). *The Ecological Approach to Visual Perception.* Boston: Houghton Mifflin.

Greene, J. (1986). *Language Understanding: A Cognitive Approach.* Milton Keynes: Open University Press.

Greene, J. and Coulson, M. (1995). *Language Understanding: Current Issues.* Buckingham/Philadelphia: Open University Press.

Harley, T. A. (1995). *The Psychology of Language: From Data to Theory.* Erlbaum (UK) Taylor and Francis.

Hawkins, B. W. (1984). *The Semantics of English Spatial Prepositions.* PhD Thesis. University of California, San Diego.

Hayes, P. J. (1979). *The Naive Physics Manifesto.* Geneva, Switzerland: Institute of Semantic and Cognitive Studies.

Hayward, W. G. and Tarr, M. J. (1995). Spatial language and spatial representation. *Cogntion*, 55, 39-84.

Herskovits, A. (1985). Semantics and pragmatics of spatial prepositions. *Cognitive Science*, 9, 341-378.

Herskovits, A. (1986). *Language and Spatial Cognition.* Cambridge: Cambridge University Press.

Herskovits, A. (1988). Spatial expressions and the plasticity of meaning. In Rudzka-Ostyn (Ed.) *Topics in Cognitive Linguistics.* Amsterdam/Philadelphia: John Benjamins Publishing Company.

Hottenroth, P. (1993). Prepositions and object concepts: A contribution to cognitive semantics. *The Semantics of Prepositons: From Mental Processing to Natural Language Processing*, Mouton de Gruyter, Berlin/New york.

Ioerger, T.R. (1994). The manipulation of images to handle indeterminancy in spatial reasoning. *Cognitive Science*, 18, 551-593.

Jackendoff, R. (1973). The base rules for prepositional phrases. In S. R. Anderson and P. Kiparsky (Eds.) *A Festschrift for Morris Halle*. New York: Holt, Rinehart and Winston, Inc.

Jackendoff, R. (1983). *Semantics and Cognition* . Cambridge, MA: MIT Press.

Jackendoff, R. (1993). *Languages of the Mind: Essays on Mental Representation.* Cambridge, Mass.: MIT Press.

Johnson-Laird, P. N. (1983). *Mental Models: Towards a Cognitive Science of Language, Inference and Consciousness.* Cambridge: Cambridge University Press.

Johnson-Laird, P. N. (1987). The mental representation of the meaning of words. *Cognition*, 25, 189-211.

Johnson-Laird, P. N. (1988). How is meaning mentally represented? *International Social Science Journal*, 1, 46-59

Katz, J. J. and Fodor, J. A. (1963). The structure of a semantic theory. *Language*, 39, 170-210.

Kintsch, W. (1974). *The Representation of Meaning in Memory.* Hillsdale, NJ: Erlbaum.

Labov, W. (1973). The boundaries of words and their meanings. In C. J. N. Bailey and R. W. Shuy (Eds.). *New Ways of Analysing Variation in English.* Washington: Georgetown University Press.

Landau, B. and Jackendoff, R. (1993). "What" and "where" in spatial language and cognition. *Behavioural and Brain Sciences,* 16 (2), 217-265.

Lakoff, G. (1987). *Women, Fire and Dangerous Things: What Categories Reveal About the Mind.* Chicago: University of Chicago Press.

Lang, E. (1990). Primary perceptual space and inherent proportion schema: Two interacting categorization grids underlying the conceptualization of spatial objects. *Journal of Semantics,* 7, 121-141.

Leech, G. N. (1969). *Towards a Semantic Description of English.* London: Longmans.

Lindkvist, K. (1950). *Studies on the Local Sense of the Prepositions IN, AT, ON and TO in Modern English.* Lund Studies in English XX. Copenhagen: Berlingska Boktryckeriet.

Lyons, J. (1971). *Introduction to Theoretical Linguistics.* Cambridge: Cambridge University Press.

Lyons, J. (1995). *Linguistic Semantics: An Introduction.* Cambridge: Cambridge University Press.

Mani, K. and Johnson-Laird, P. N. (1982) The mental representation of spatial descriptions. *Memory and Cognition,* 10 (2), 181-187.

Margolis, E. (1994). A reassessment of the shift from the classical theory of concepts to prototype theory. *Cognition*, 51: 73-89.

Marr, D. (1982). *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information.* San Francisco: Freeman.

Michotte, A. (1963). *The Perception of Causality.* Translated from *La Perception de la Causalite* (1946). London: Methuen & Co Ltd.

Miller, G. A. and Johnson-Laird, P. N. (1976). *Language and Perception.* Cambridge: Cambridge University Press.

McNamara, T. and Sternberg, R. (1983). Mental models of word meaning. *Journal of Verbal Learning and Verbal Behavior*, 22, 449-474.

Payne, S. J. (1993). Memory for mental models of spatial descriptions: an episodic-construction-trace hypothesis. *Memory and Cognition*, 21(5), 591-603.

Putnam, H. (1975). The Meaning of "Meaning". In K. Gunderson (Ed.), *Language, Mind and Knowledge.* Minnesota Studies in the Philosophy of Science, Vol. 7. Minneapolis: University of Minneapolis Press.

Quirk, R., Greenbaum, S., Leech, G. and Svartvik, J. (1985). *A Comprehensive Grammar of the English Language.* London/New York: Longman.

Rey, G. (1983). Concepts and stereotypes. *Cognition*, 15, 237-262.

Rosch, E. (1973). On the internal structure of perceptual and semantic categories. In T. E. Moore (Ed.). *Cognitive Development and the Aquisition of Language.* New York: Academic Press.

Rosch, E. (1975). Cognitive representations of semantic categories. *Journal of Experimental Psychology: General*, 104 (3), 192-233.

Rosch, E. (1977). Human categorisation. In N. Warren (Ed.) *Advances in Cross-Cultural Psychology*, Vol. 7. London: Academic Press.

Rosch, E. (1978). Principles of categorisation. In E. Rosch and B. B. Lloyd (1978). *Cognition and Categorisation.* Hillsdale, NJ: LEA.

Rosch, E. and Mervis, C. B. (1975). Family resemblances: Studies in the internal structure of categories. *Cognitive Psychology*, 7, 573-605.

Svorou, S. (1993) *The Grammar of Space: Typological Studies in Language 25.* Amsterdam/Philadelphia: John Benjamins Publishing Company.

Talmy, L. (1983). How language structures space. In Pick, H. and Acredolo, L. (Eds.), *Spatial Orientation: Theory, Research, and Application.* New York: Plenum Press (pp. 225-282).

Talmy, L. (1988). Force dynamics in language and cognition. *Cognitive Science,* 12, 49-100.

Taylor, J. R. (1993). Prepositions: Patterns of polysemisation and strategies of disambiguation. *The Semantics of Prepositons: From Mental Processing to Natural Language Processing*, Berlin/New york: Mouton de Gruyter.

Tomasello, M. (1987). Learning to use prepositions: A case study. *Journal of Child Language*, 14, 79-98.

Tversky, B. (1991). Spatial mental models. *The Psychology of Learning and Motivation*, 27, 109-145.

Valery, P. (1943). *Tel Quel.* New York: French and European Publications.

Vandeloise, C. (1991). *Spatial Prepositions: A Case Study from French.* Translated by Bosch, A. R. K. Chicago/London: The University of Chicago Press.

Waltz, D., and Boggess, L. (1979). Visual analog representations for natural language understanding. *Proceedings of the Sixth International Joint Conference on Artifical Intelligence*, 926-934. Cited in T. R. Ioerger (1994). The manipulation of images to handle indeterminacy in spatial reasoning. *Cognitive Science*, 18, 551-593.

Wilcox, S. and Palermo, D. S. (1975). "In", "on", and "under" revisted. *Cognition*, 3 (3), 245-254.

Wittgenstein, L. (1953). *Philosophical Investigations.* Oxford: Blackwell.

Wunderlich, D. (1991). How do prepositional phrases fit into compositional syntax and semantics? *Linguistics*, 29, 591-621.