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Geometric and Extra-Geometric Spatial Conceptualisation: A cross-linguistic and non-verbal perspective

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Geometric and Extra-Geometric Spatial Conceptualisation: A cross-linguistic and non-verbal perspective.

by

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Geometric and Extra-Geometric Spatial Conceptualisation:
A cross-linguistic and non-verbal perspective

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Almost all past empirical work exploring the Functional Geometric Framework (FGF) proposed by Coventry and Garrod (2004) for spatial language use has been based on a single language – English. Therefore the extent to which the framework applies across languages has not been established. The current thesis investigated whether geometric and extra-geometric factors affect production and comprehension of spatial language across three languages; English, Finnish and Spanish. Eight cross-linguistic appropriateness rating studies identified similarities and differences in the factors that underlie our verbal conceptualisation of space across three classes of spatial relations/terms: 1) topological relations (e.g., *in/on),* 2) vertical axis projective terms (e.g., *above/below*), and 3) horizontal axis projective terms (e.g., *in front of/behind*) and their Finnish and Spanish counterparts. There was support for the FGF cross-linguistically, and many of the results were in line with what has been previously discovered in research on English, although extra-geometric factors, such as conceptual knowledge and dynamic kinematic-routines, were revealed to often have different weightings in different languages.

Given the importance of extra-geometric factors across languages, the second part of the thesis asks whether extra-geometric factors also influence (non-linguistic) memory for spatial object relations. This question was addressed by two non-verbal spatial memory experiments which revealed that this was the case in some circumstances. Horizontal shifts in position by a potentially horizontally mobile object were more accurately remembered in specific conditions, i.e. when the located object was positioned along the diagonal axes of the reference object rather than cardinal axes, and when the movement was against the direction of expected movement of the located object. However, location memory for vertical shifts of position, was not affected in such a way by potentially vertically mobile objects in any circumstances.

In the closing chapter of the thesis the generalisability of the FGF for cross-linguistic and non-linguistic relations is discussed.

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At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee.

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Chapter One

1.0 Introduction

One of the most important and obvious skills for species survival is the ability to find objects in the environment. Furthermore, the ability to communicate to one another where to find objects in the surrounding space, and for a person to be able to do so successfully by following simple locative descriptions, can also be regarded as important for human survival. Spatial language is, therefore, a prominent and essential part of the daily language we use and hear. This thesis endeavours to investigate what affects how people speak about space, and also what influences non-verbal spatial categorisation. The effects of geometric factors and extra-geometric factors on both spatial language and spatial memory, are inspected in the paradigms employed in both the linguistic and non-linguistic sections of this thesis. By geometric factors we mean the visual spatial relationship perceived between two objects; whereas throughout this thesis non-geometric factors entail people's knowledge about the nature of the object(s), their functional relationship, and understanding of how they interact with each other. First, however this chapter examines what prepositions are, before focusing on the factors that underpin their use.

1.1 Spatial Language Classified

As a syntactic category prepositions comprise a relatively small set of words, somewhere between 80-100; in contrast there are around 10,000 count nouns in the standard lexicon (see Table 1.1 for English prepositions). However, these prepositions can be used in many different ways, both semantically and syntactically. For example, not only do terms such as *up* and *down* allow us to understand where an object is or in what direction an object is moving (*spatial uses* of preposition), but they can also describe the type of mood we are in (e.g. John was feeling *down* because the day was cold and rainy).

Under the banner of *local uses* of prepositions come spatial uses (the focus of this thesis) and *temporal uses* (see Figure 1.1). 'See you *in* an hour', is an example of the temporal use of a preposition indicating a point in time. Spatial prepositions are divided further into *locative* and *directional* prepositions. Locative terms describe where an object (*located object*) is located in space relative to another object (*reference object*) i.e. 'the car is parked *in* the garage'. In contrast, directional terms describe the path an object is taking i.e. 'the cat walked *to* her food bowl'. Locative terms can then be further divided into two categories: *topological* and *projective* terms. Some examples of projective prepositions are: *in front of, behind,* and *to the right of,* which depict the direction in which an object is located in reference to another object (the boy sat *in front of* the T.V.). There are two types of topological terms; *simple topological terms* such as *in* and *on* and *proximity terms* such as *near* and *far*. The current thesis focuses on investigating purely the spatial-locative domain of prepositions including the topological and projective branches.

Table 1.1 The prepositions in English (Landau & Jackendoff, 1993)

About	Above	Across	after
Against	Along	amid(st)	around
At	Atop	Behind	below
Beneath	Beside	Between	betwixt
Beyond	By	Down	from
In	Inside	Into	near
Nearby	Off	On	onto
Opposite	Out	Outside	outwith (SE)
Over	Past	Through	throughout
To	Toward	Under	underneath
Up	Upon	Via	With
Within	Without		
Compound prepositions			
far from	in back of (AE)	in between	in front of
in line with	on top of	to the left of	to the right of
to the side of			
Intransitive prepositions			
Afterwards	Apart	Away	back
downstairs	Downward	East	forward
Here	Inward	Left	*N*-ward (i.e.homeward)
North	Onward	Outward	right
Sideways	South	There	together
Upstairs	Upward	West	
Non-spatial prepositions			
Ago	As	because of	before
Despite	During	For	like
Of	Since	Until	

Note: AE = occurs in American English only, SE = occurs in Scottish English only.

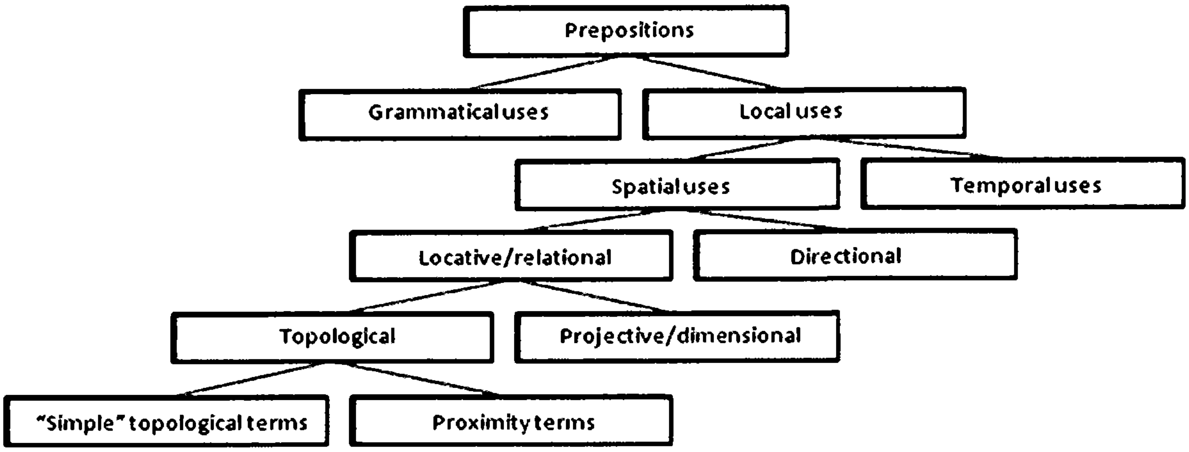


Figure 1.1 Prepositions classified (adapted from Coventry & Garrod, 2004)

This PhD thesis aims to investigate the relative influence of key sets of constraints for spatial language comprehension – geometric constraints ("where" objects are in relation to one another) and extra-geometric constraints ("what" those objects are and "how" they are interacting with each other). More specifically the thesis examines topological terms (i.e. *in* and *on*), vertical axis projective terms (i.e. *above, over, under* and *below*) and horizontal axis projective terms (i.e. *in front of* and *behind*) across the English, Finnish and Spanish languages. The intention is to answer two core questions: 1) To what extent are the different factors influencing spatial language the same cross-linguistically? 2) Do these factors only influence spatial language, or do they also affect memory for spatial object relationships? In this thesis evidence is provided showing that geometric and extra-geometric variables affect both spatial language across languages, and also have some influence on (non-linguistic) spatial memory, consistent with the functional geometric framework (Coventry & Garrod, 2004).

Prior to considering how different languages carve up space, we first overview the functional geometric framework, which details the parameters that affect the comprehension and production of spatial prepositions in English.

1.2 The Functional Geometric Framework (Coventry and Garrrod, 2004)

In the past (before 1988/89) spatial prepositions have been treated largely in terms of geometric relations. However, problems arise in some situations in which objects even in the most appropriate geometry cannot be described using for example the preposition *in*. For instance, scenes given in Figure 1.2 (a) can be appropriately described as *in* the bowl, whereas the pear depicted in 1.2 (b) and 1.2 (c) would not normally be described this way. There seems to be a contradiction in geometry in the latter two scenes: 1.2 (b) and 1.2 (c) enclosure without containment; 1.2 (a) containment without enclosure. Hence it is clear that it is not only the geometric relations between the located object (pear) and reference object (bowl), but also the functional relations between pear and bowl that have an influence on spatial comprehension in this example.

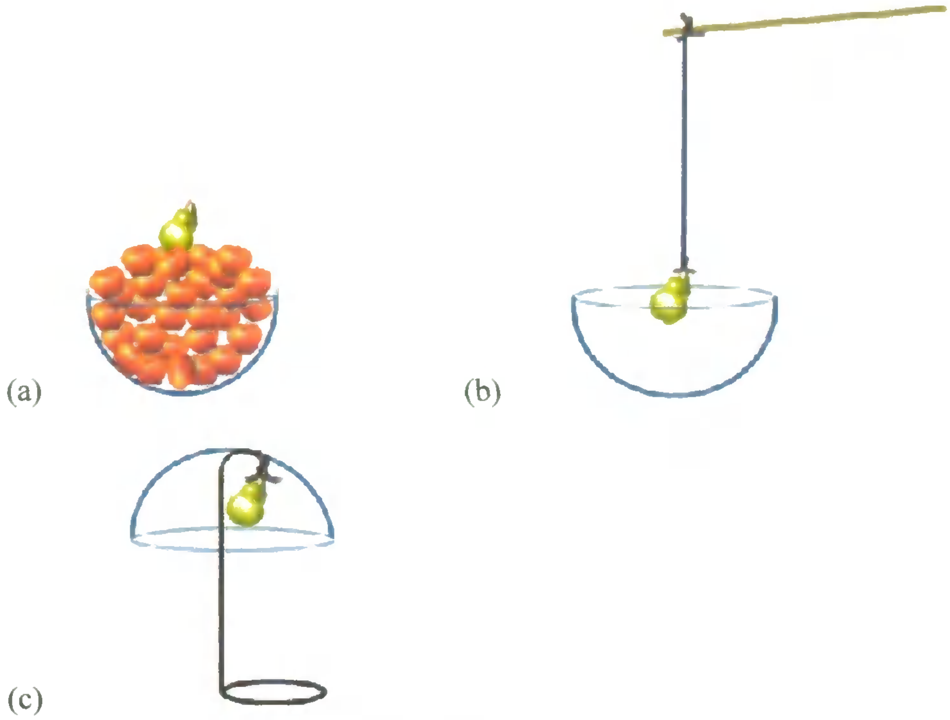


Figure 1.2 Different configurations of a pear and a bowl: (a) pear can be described as *in* the bowl, (b) and (c) the preposition *in* is less appropriate.

According to Coventry and Garrod (2004) comprehension and production of spatial language involves geometric and extra-geometric constraints, consisting of the knowledge of the forces objects exert on each other over time. This is termed the *functional geometric framework (FGF)* which incorporates the notion that spatial conceptualisation not only deals with how viewers *see* a spatial relationship, but also in terms of how they act on the world they see, and how objects interact meaningfully in that world (see Figure 1.3). First, as has already been discussed, there is the aspect of the geometry of the scene being described. In other words, *where* objects are located is a core issue that influences what spatial language is employed when describing object relations. Second, there are two sources of extra-geometric factors that influence spatial comprehension: dynamic-kinematic routines and object knowledge. Dynamic-kinematic routines such as location control refer to the knowledge people have about actual or potential forces that operate between objects in the world. In contrast, object knowledge refers to the general knowledge of the functions of objects and how they usually interact with each other. Therefore, knowledge of *what* objects are and how they usually function and interact with each other is also important in spatial language production and comprehension. Hence, *what* objects are, influences how people describe *where* they are located; for example, a golfer may have a golf club *in* his hand and his hand is *in* a glove, but we would not say that the golf club is *in* the glove. Equally, a book that is set *on* a table which is *on* the floor would not allow one to say that the book is *on* the floor.

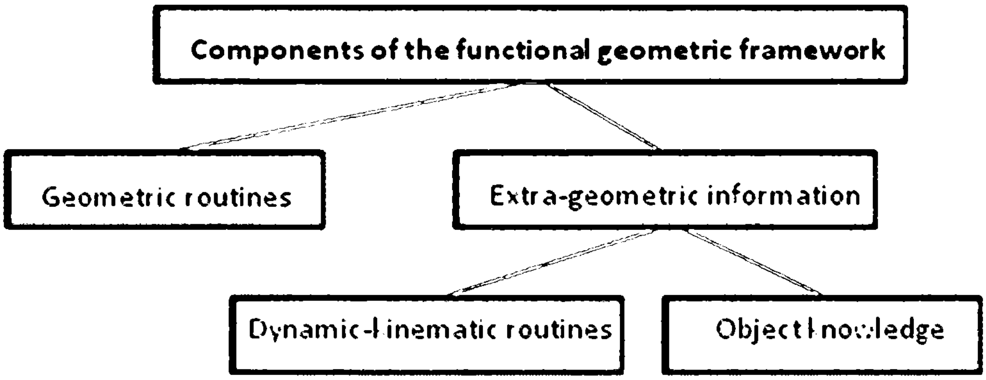


Figure 1.3 Component parts of Coventry and Garrod's functional geometric framework (adapted from Coventry & Garrod, 2004)

It is clear that while spatial language relates to the visual scenes being described it is also influenced by acting in the real world, and that the salience of the functional interaction between objects has an important effect on how we describe object relations. The *functional geometric framework (FGF)* for comprehension and production of spatial language plays a central role in directing the designs of the current thesis.

The classification of spatial language has been briefly overviewed and the functional geometric framework has been identified as the core theory of this thesis. Next the component parts of the FGF are considered in relation to the topological terms: *in* and *on*.

1.3. Topological Terms

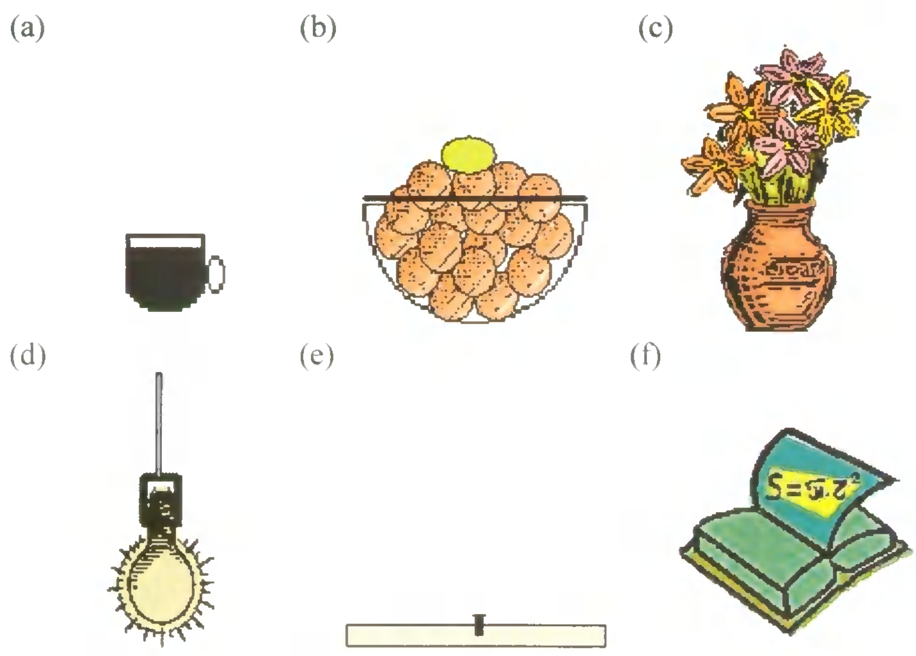
The prepositions *in* and *on* are amongst the earliest acquired by children across languages, and have therefore been accorded much attention in the FGF. First, geometric influences on the terms *in* and *on* are considered followed by a more detailed inspection of extra-geometric factors such as the dynamic-kinematic routine of 'location control' and conceptual knowledge.

1.3.1. Influences of Geometry on the Semantics of *in* and *on*

There are several factors affecting the comprehension and production of the preposition *in*. Firstly, for a located object to be considered to be *in* a container (reference object) the relationship between the two objects is of enclosure/inclusion, whereas an object relationship of support can be described by *on*. To understand these types of spatial relationships we need a geometric routine allowing the calculation of degree of enclosure or support, and Coventry and Garrod (2004) turn to **Cohn's region connection calculus** (1996; Cohn et al., 1997) as the most sophisticated means of dealing with 3D space, allowing for gradation of different forms of containment and connection between objects. The strongest form of containment/enclosure is when one region is completely surrounded by another, as in *The ketchup is in the closed bottle*; whereas a weaker form of enclosure is when an object is a subpart of, or overlaps with the other's convex hull, as a part of its scattered inside. A bird in a tree can be considered an example of this type of weaker relationship. Again as with *in*, *on* can be specified in terms of Cohn's region connection calculus even though at first sight contact appears to be an all or none type of relationship (e.g. The book is on the table; it either is or is not). There are, however degrees of variation in support relationships. The preposition *on* can sometimes be used even when there is no direct control/contact between two objects if the relationship with the indirect controller object is salient enough. For example, a specific book on top of a pile of books can still be considered on the table as it one of many books all distinct from the table. Salience is the crucial element of the relationship; for instance a book that is on the table can not be described as on the floor even though the table is on the floor. So, using the region connection calculus for example, geometric routines can be specified for *in* and *on*.

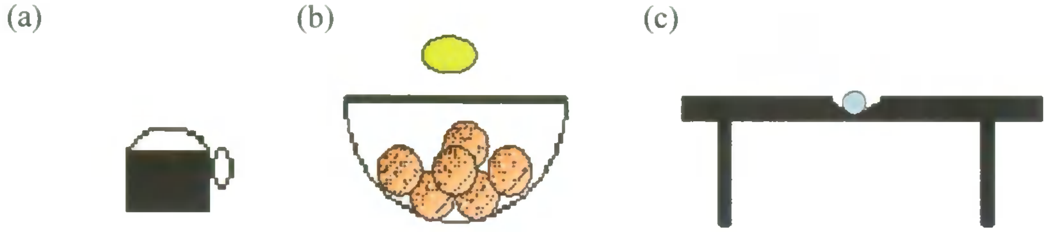
However, it is not possible to simply map geometric regions of appropriateness with any spatial term without taking into account non-geometric influences; geometric regions of appropriateness alone underdetermine the appropriateness of *in* and *on* to describe spatial relations. As Coventry (1998) noted, there are a large number of spatial relations that are appropriate for *in* and *on*, and even region connection calculus, or other geometric formulations, fail to cope with the diversity of uses of each term (Figures 1.4 and 1.5).

Figure 1.4 Different spatial relations for which *in* is appropriate (adapted from Coventry, 1998). (a) The coffee is *in* the cup, (b) The lemon is *in* the bowl, (c) The flowers are *in* the vase, (d) The lightbulb is *in* the socket, (e) The nail is *in* the board, (f) The page is *in* the book.



The varying array of spatial relationships where *in* and *on* are appropriate suggests a more complex interplay of underlying influences. So even when a specific relation is kept constant, but the surrounding environment is manipulated, the perceived appropriateness of *in* is affected. For example, compare 1.4(a) to 1.5(a) where the objects are the same, and convex hull applies in both cases, but *in* is appropriate in one case and *under* is appropriate in the other.

Figure 1.5 Different spatial relations for which *in* is not appropriate (adapted from Coventry, 1998). (a) The coffee is *in* the cup, (b) The lemon is *in* the bowl, (c) The ball is in the table.



This example suggests that when the reference object no longer fulfils its purpose (or function) despite no changes in the relative spatial relationship, the term *in* is perceived as less appropriate when describing the scene. Therefore, one of the most important issues for the understanding of what affects the appropriateness of a spatial term in a specific situation is the functional relationship between the depicted objects. Hence, in addition to geometric mapping of spatial relations to spatial terms we must understand how objects interact with one another. Following Coventry and Garrod (2004) two types of extra-geometric factors will be considered in turn; the dynamic-kinematic routine of 'location control' and conceptual knowledge.

1.3.2 The Dynamic-kinematic routine of Location Control

'in'

The notion of Location Control emerges from Garrod and Sanford (1989) originally, and is an important non-geometric influence on the use of the term *in*, meaning that the located object is contained (or expected to continue to be contained) by the reference object over a period of time (see also Vandeloise, 1989). Location control goes beyond geometry in that gravity allows one object to control the location of another over time. So for '*in*' to hold, a reference object must be able to control the location of a located object over time.

Coventry (1998) suggests that both geometric and non-geometric variables are equally influential in the comprehension and production of spatial terms. Visible location control is displayed when the reference object fulfils its function of containment successfully. Previous work (Coventry, 1992, 1998; Richards, Coventry & Clibbens, 2004) has found that contiguity of movement of the located object with the reference object increased the use of *in.* For example, Coventry (1998) and Richards, Coventry and Clibbens (2004) have tested directly whether manipulations of location control do exert any influence on the use and rating of *in*. Participants were presented with scenes where a located object was shown at various heights on top of a pile of objects in a container. When the located object was shown to move from side to side together (at the same rate) with the rest of the contents and container (thus demonstrating location control), *in* was rated a more appropriate descriptor than when the whole scene was stationary. However, when the located object was shown moving on independently (wobbling from side to side, but still in contact with the rest of the stationary contents), acceptability ratings for *in* were reduced compared to stationary scenes.

Feist and Gentner (1998; Feist 2000) demonstrated that location control can also be manipulated by varying the animacy of located and reference objects. In general when the located object was an animate object (a fire-fly) *in* was rated lower than when it was a static object (a coin). It is likely that a fly is perceived by viewers as less inclined to stay *in* the reference object than a coin.

Location Control, which is the control a reference object has over a located object's position, has also been indicated to be affected negatively when an interfering external source of control was introduced to a spatial relationship (Garrod et al, 1999). Static scenes of ping-pong balls in a bowl were depicted with or with out a wire suspended from the top of the target object (see Figure 1.6). When one group of participants was given a rating task in which they were asked to judge whether the located object would stay in the bowl if the bowl was moved from side to side, they gave more negative judgements when a wire (external source of location control) was present than when it was not. Also, in a sentence rating task administered to another group of participants, *in* was found to be rated lower in conditions where an external source of control (the wire) was present. Hence, there are clear indications that when the container is fulfilling its function of controlling the position of the located object over time, the use of *in* as a descriptor increases. Moreover, there was a correlation between ratings of *in* and ratings of control.

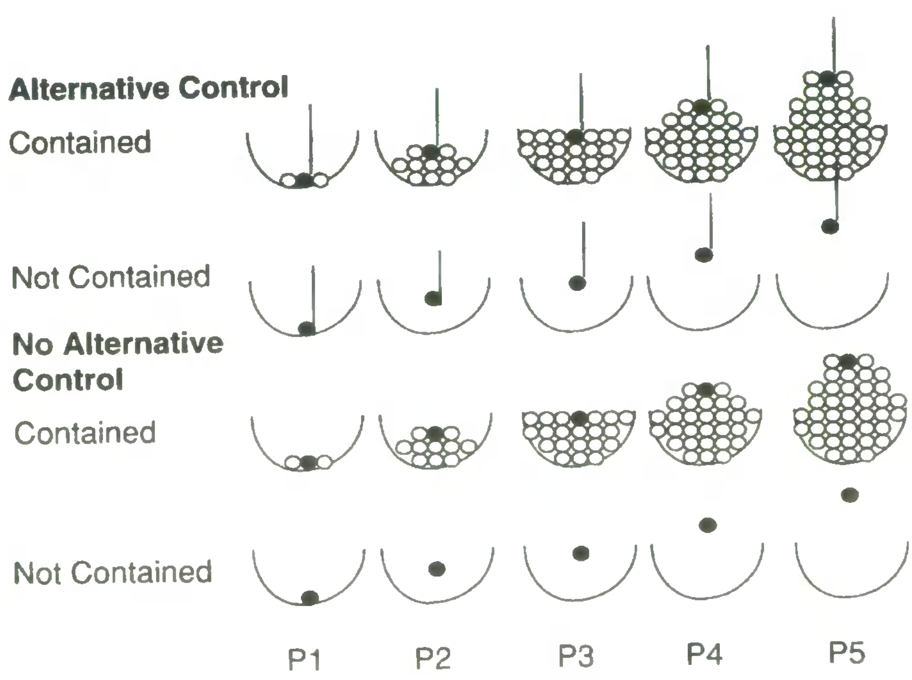


Figure 1.6 Diagram of scenes used by Garrod and colleagues (adapted from Garrod et.al, 1999). P1-P5 show the relative positions used in the experiment.

'on'

The dynamic-kinematic routine of Location Control underlying *on* is very similar to that of *in*. The constraint of location is also a key feature of supporting surfaces affecting the appropriateness of *on* as a descriptor. Garrod and colleagues (1999) found that when alternative external control of the located object was present ratings of *on* dropped. Participants were again shown scenes in which a string or chain was attached to the located object (a weight) and a beam over head at varying degrees of tightness or not at all. In the judgement condition they were asked, if the plank on which the located object was situated were removed, whether the weight would remain in the same position or fall. Again the more the external control was seen to impinge on the amount of control exerted by the reference object over the located object, the less likely the weight was judged to stay in its original position. The same effect was found in the rating condition in which a deterioration of reference object control over the location of the weight was reflected by lower rating levels of the preposition *on*.

Coventry (1992) found intruding effects of animacy on location control. Pictures of a ring that was either the correct size or too large were shown around a finger. The ring was also either shown in a static position or moving up and down the finger (although never taken off). There were lower ratings of *on* in scenes where the ring of a correct size was moving than when the correct sized ring was stationary. This effect was found only for the conditions in which the ring was a correct size and therefore in contact with the surface of the finger.

Location Control influences for *on* ratings were also found by Coventry and Prat-Sala (2001). They manipulated the angle (canonical/45°/90°) at which the scene was displayed and found that the gravitational axis has significant influences on location control. There were clear indications that when the objects were tilted away from the gravitational plane, there was a decrease in the reference object's location control of the located object over time which deflated the ratings of *on*. In another experiment the located object was either centred on the reference object or placed on its edge. When the located object was placed on the edge of the reference object *on* was rated significantly lower than when it was centred (see Figure 1.7). This suggests that location control is perceived to be less powerful in such cases because it would be more likely for the located object to be dislodged if the reference object were to move.

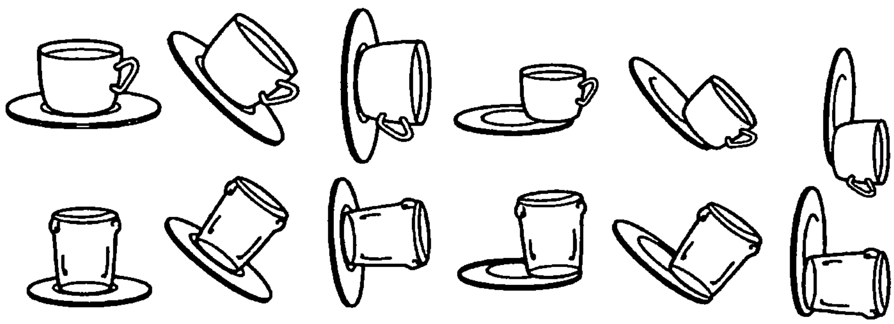


Figure 1.7 Examples of scenes used by Coventry and Prat-Sala (2001)

1.3.3 Conceptual Knowledge

In addition to location control, there has also been a good deal of research which has found that people's conceptual knowledge about the function or purpose of objects also affects the spatial language they use to describe object relationships. Coventry et al. (1994) looked into the effects of object-specific function of the container on the use and comprehension of *in*. They found that *in* was perceived as more appropriate when describing a scene where solid objects (apples) were located in a reference object which was a bowl rather than a jug. Additionally, rating and use of *in* decreased in the scenes where liquid was added to the jug holding located solid objects. However, in the case of scenes with a bowl holding solids the addition of liquid had no influence on ratings or use of *in* (see Figure 1.8). This seems to suggest that the addition of water into the jug emphasized that its specific function is primarily as a container of liquids rather than of solids. This line of research by Coventry et al. (1994) was further developed by

Coventry and Prat-Sala (2001) to include several more variations of located objects as well as reference objects and found that Coventry's (1994) findings generalise across containers of other solids and liquids. In that study half of the containers (reference objects) used were objects that are primarily considered containers of solids (e.g. a suitcase) and half were considered containers of liquids (e.g. an aquarium). The located objects were manipulated so that half had a strong association with the container and half did not.

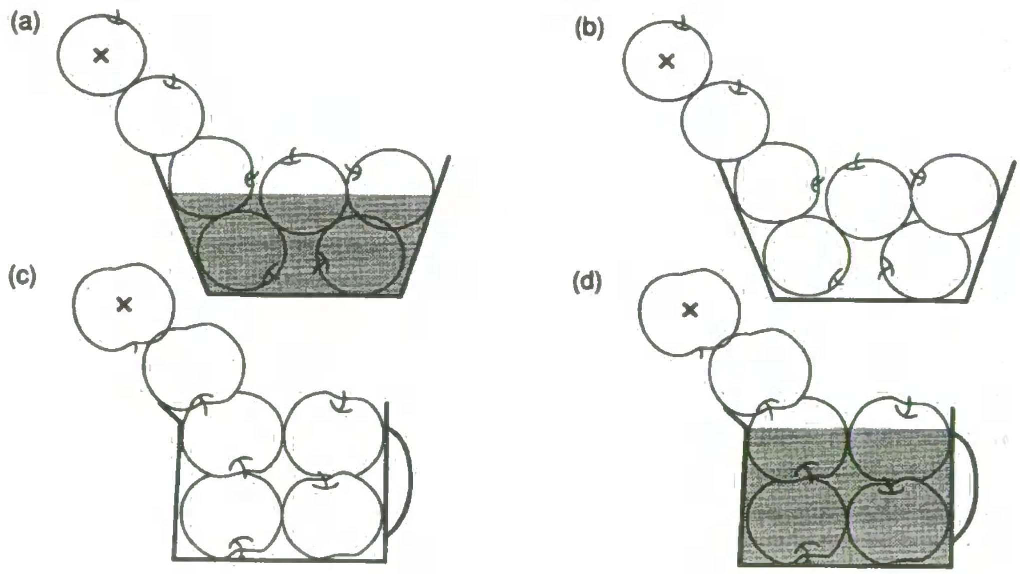


Figure 1.8 Example scenes from Coventry et al. (1994).

Coventry et al. (1994) also found that the label given to the reference object influences the appropriateness of the preposition used. For instance, a shallow container can be labelled a plate or a dish. When the same reference object was called a plate *on* was higher rated, whereas when the reference object was labelled a dish *in* received the highest ratings. Feist and Gentner (1998; Feist, 2000) have conducted research which provides more evidence for the reference object labelling effect. They found that not only were reference objects of different concavity levels labelled accordingly (high concavity – bowl, low concavity – plate), but there was also a clear influence on preposition ratings relating to object labels. Similar object knowledge effects were discovered by Ferenz (2000) who used novel stimuli. Ferenz found that novel containers labelled with novel words with a definition provided referring to the function (i.e. container-like object was called a 'blicket' and defined to have a function of carrying food to picnics), were more often considered appropriately described as having another object *in* it (function of containment). In contrast, when that same container-like object was simply labelled according to the material it was made out of (i.e. the 'ceramic'), it was considered to be more naturally described as having another object *near* it rather than *in* it.

Conceptual knowledge goes beyond knowledge of individual objects. How objects are conceptualised is also affected by context. Coventry (1999) has shown that context indeed affects the comprehension of *in*. Scenes were presented showing a pear with a string attached which extended above it to a frame. This pear was suspended centred over a bowl but not touching it or enclosed by it. The participants were asked to complete a sentence of the form: "The pear is ___ the bowl". They were either provided a context which helped them make sense of the situation or not. In the context condition they were told that they were playing a game in which they needed to shout out their response when the target position was achieved. The preposition *in* was produced more often and rated as more appropriate in an equivalent rating task, when the participants were in the game context condition rather than in the non-context condition. A weaker geometry of 'containment' was accepted for the production of *in* responses when the context effect of the game was present.

Conceptual knowledge and context effects have a similar influence on the production of the preposition *on* as they do with the preposition *in*. For example, if a marble were placed *in* a crevice on a table top (see Figure 1.5 (c)), it would still be more natural to say that the marble is *on* the table simply because we see the main function of the table to be as that of support. This type of effect was revealed by Coventry and colleagues (Coventry et al., 1994; Coventry & Prat-Sala, 2001) in a series of experiments in which they manipulated labelling of objects. The results seemed to suggest that even if object shape or concavity level was not ideal for support, when the label 'plate' was provided versus 'dish', there was a tendency for the preposition *on* to be preferred compared to *in* when describing the scene.

So there is much evidence that the three components of the FGF, geometric routines, dynamic-kinematic routines, and conceptual knowledge of objects, are all important for the comprehension and production of *in* and *on*. Next, background literature of the geometric and extra-geometric constraints influencing the comprehension and production of vertical axis projective terms such as *above*, *over*, *under*, and *below* will be considered in context of the FGF.

1.4 Vertical Projective Terms

Projective terms require the instantiation of reference frames before direction can be assigned to space. First, general reference frame background is provided from the literature followed by an overview of previous research which has looked into extra-geometric effects such as conceptual knowledge and dynamic-kinematic routines on the perceived appropriateness of inferior and superior lexical items.

1.4.1. Reference frame assignment

In order to thoroughly understand the geometric and extra-geometric factors affecting projective terms for both the horizontal and vertical axes, it is crucial to have an understanding of reference frame assignment. The three types of reference frames which have been identified across languages are: 1) *intrinsic*, 2) *absolute* and 3) *relative* (Levinson, 1996a). The *intrinsic* frame of reference utilizes features or axes of the reference object (as in 'the girl is in front of the car'), whereas the *relative* frame of reference utilizes angles derived from the body co-ordinates of the viewer (as in 'the child is to the left of the football'). The relative frame of reference may also involve a spatio-temporal process such as the process of motion in which the front/back of an object (e.g. football) becomes aligned with the direction of motion, and the left/right is perceived as relative to the front/back. There is, however a third solution used, the *absolute* frame of reference, in which angles on the horizontal plane are found by utilizing fixed bearings such as cardinal directions (north, south, east, west) or gravity. This is used more extensively in some languages than others. For example, Tzeltal uses cardinal directions for small scale space, such as the equivalent of *The TV is North of the sofa* (more detail can be found in Levinson, 1996a).

The three reference frames can be best distinguished from each other through variable patterns under **rotation** (Levinson, 1996a). Rotational influences have been outlined in Figure 1.9. In the first scene of Figure 1.9 where the intrinsic reference frame is active, the ball (located object) is related to the intrinsic front of the cat (reference object). Therefore the description (the ball is in front of the cat) is still true even if the viewer or whole array is rotated. However, rotating only the cat 180 degrees (and not the ball) would cause the ball to change from being *in front of the cat* to being *behind the cat.* In the middle scene of Figure 1.9, the relative reference frame locates the ball with reference to the viewer (the ball is to the right of the cat). Here rotating the viewer or the whole visual array influences the description so that it is no longer appropriate, whereas simply rotating the reference object would cause no conflict. Finally, in the last scene adopting an absolute reference frame the sentence *the ball is north of the cat* is an appropriate description even after rotation of the viewer and the reference object. However, rotating the whole array influences the appropriateness of the spatial description which would then have to be adapted accordingly. We will come back to the topic of reference frame assignment in chapter Four. Now that reference frame assignment has been briefly overviewed, we will move onto vertical axis projective terms and consider them in greater detail in relation to the FGF.

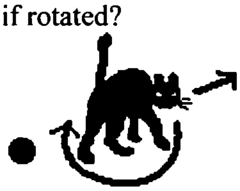
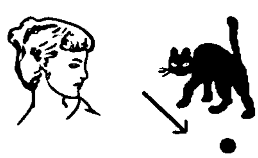
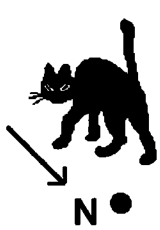
	Rotation of:		
	Viewer Same description?	**Reference object** Same description?	**Whole array** Same description?
Intrinsic "ball in front of cat"  if rotated? 	Yes	No	yes
Relative "ball to right of cat" 	No	Yes	no
Absolute "ball to north of cat" 	Yes	Yes	no

Figure 1.9 Frames of reference properties when rotated (adapted from Levinson, 1996a).

1.4.2. Vertical Axis Terms: Superior – Inferior Spatial Relationships

Levelt (1984) claims that spatial terms involved in describing the vertical dimension (i.e. above, over) differ and are somewhat more restricted in reference frame instantiation than spatial terms used when describing the horizontal dimension (i.e. in front of, behind). According to Levelt, the speaker's vertical orientation is not the only factor influencing the way a vertical dimension spatial relationship is described. Levelt states that viewers perceive verticality when a scene is aligned with the retina's vertical meridian and the orientation is derived in part from the alignment of a visual frame such as the horizon with the vestibular vertical. Levelt suggests that the intrinsic frame of reference when using prepositions such as *above* and *below,* is restricted to scenes in which the object relationship can be described as canonical in orientation.

Thus, the absolute frame of reference predominates with projective terms operating on the vertical or gravitational axis. This was supported by Carlson-Radvansky and Irwin (1993) who ran an experiment involving scenes in which reference frames either coincided or conflicted with each other. The participants were put into the positions depicted in Figure 1.10 and asked to name the spatial relation between the located object and reference object. Figure 1.10 illustrates the percentage of *above* responses given for coinciding or conflicting reference frames when the viewer described the relationship between the ball and chair. It is clear that the absolute reference frame is predominant for *above* utterances, but still in some instances *above* was used as a descriptor when the reference frame was intrinsic but not absolute.

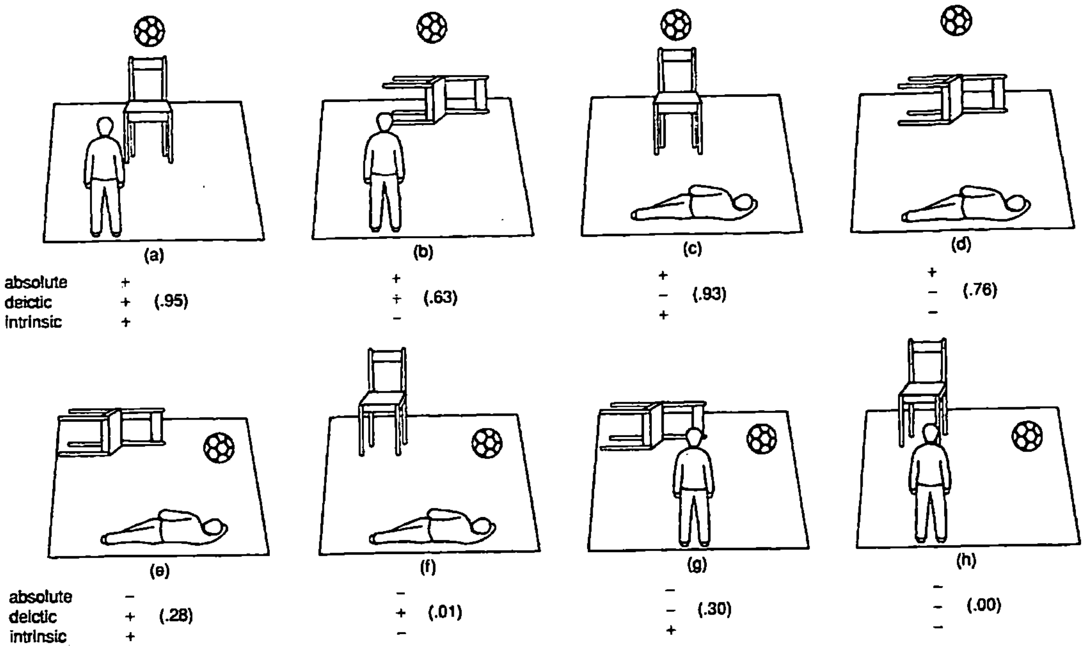


Figure 1.10 Percentage of *above* responses given for each scenario (adapted from Carlson-Radvansky & Irwin, 1993).

1.4.3. Geometric influences

The obvious factor underlying spatial term production and comprehension is the geometric relationship between the objects in the visual array. According to Logan and Sadler (1996) the spatial template is a representation of the regions of acceptability associated with a given spatial relation and/or term. A spatial template centred on the reference object and aligned with its reference frame, specifies the goodness with which located objects in different positions exemplify an associated relation. In line with this view, different spatial relations have different spatial templates and the assumption is also that similar relations have similar templates.

Several researchers (Crawford, Regier, & Huttenlocher, 2000; Hayward, & Tarr, 1995; Carlson-Radvansky and Logan, 1997; Munnich, Landau, & Dosher, 2001) have found that certain axes of reference objects are strongly influential on the locative terms used when describing a scene. Crawford et. al. and Munnich et. al. found similar geometric influences in relation to the reference object axes in that the prepositions *above* and *under* were perceived as most appropriate when the located object was positioned in alignment with the central vertical axis of the reference object. Therefore, the highest ratings for these terms were found when the figure was within the region extending directly higher or lower than the reference object's outside boundaries (see example Figure 1.11).

A	A	A	G	A	A	A
A	A	A	G	A	A	A
A	A	A	G	A	A	A
B	B	B	■	B	B	B
B	B	B	B	B	B	B
B	B	B	B	B	B	B
B	B	B	B	B	B	B

Figure 1.11 Example of a spatial template for *above* (e.g., Carlson-Radvansky and Logan, 1997). G = Good region, B = Bad region, A = acceptable region.

1.4.4 Dynamic-kinematic routines

The importance of extra-geometric factors such as dynamic-kinematic routines on the comprehension of topological terms (*in* and *on)* has already been discussed. Several studies (Carlson-Radvansky, Covey, & Lattanzi, 1999; Coventry, Carmichael & Garrod, 1994; Coventry, & Mather, 2002; Coventry, & Prat-Sala,1998; Coventry, Prat-Sala, & Richards,2001) show that such influences also affect the comprehension and production of projective terms on the vertical axis. A few researchers (Logan & Sadler, 1996; Regier, 1996; Regier & Carlson, 2001) claim that according to a purely geometric stance the optimal rating for *above* should be directly higher than the centre of mass of the reference object. However, Carlson-Radvansky and colleagues ran a study in which they asked participants to rate the appropriateness of *The coin is above the piggy bank* when describing a spatial scene and found an interesting interaction between geometric and non-geometric factors. The scenes involved a piggybank in which the slot was either located directly at the centre of mass higher than the back of the pig or slightly misaligned with a coin positioned somewhere above them (see Figure 1.12). Contrary to previous expectations the highest ratings did not fall in cases where the coin was positioned directly according to the centre of mass regardless of slot position, but rather when the coin was aligned with any slot no matter where it was located. This suggests that participants are using a dynamic-kinematic routine to predict whether the coin would fall into the piggy bank if it were dropped. Hence, the most optimal location to be described as *above* the piggy bank is when the coin can be predicted to fall into a slot. Support for this is provided by Coventry et al. (1994) also in regard to the use of *over* in an experiment with scenes of a jug displayed higher than a glass. When the jug and glass were shown to contain liquid *over* was considered more appropriate than when both were empty. Again, this indicates that when a viewer is making predictions according to dynamic-kinematic routine they prefer scenes in which they are able to draw the conclusion that it is possible to pour the liquid into the jug.

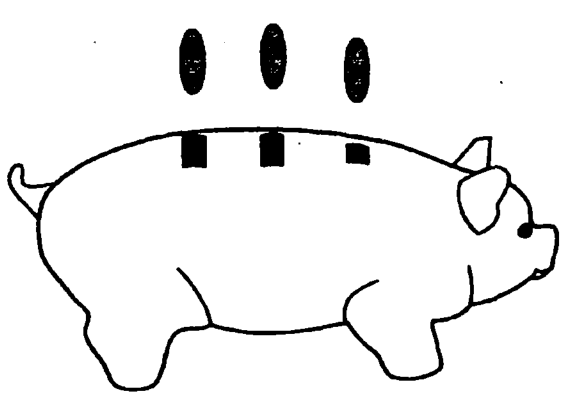


Figure 1.12 Diagram of slot and coin positions from Carlson-Radvansky, Covey & Lattanza (1999).

Coventry and Mather (2002) conducted further investigations on whether the comprehension of the preposition *over* would be influenced by knowledge of how objects in the physical world interact with one another over time. A building was displayed in the centre of a page which was sectioned into three segments (Figure 1.13), and an aeroplane was illustrated higher and to the left of the building. In one experiment using a between participants design, participants were asked to indicate which segment the plane should be in for *The plane is over the building/target* to be most appropriate. Three experimental conditions were used, and two of these conditions included telling the participants that the plane was on a mission to bomb a building (condition one) or a target (condition two). In the third control condition, they were provided with no context. The results of this study suggest that again a dynamic-kinematic routine was utilised to predict where the bomb should be dropped to ensure that it was likely to hit the intended target. Hence, when participants were given a context to help evaluate the scene they were more likely to select the first segment as the most appropriate for depicting the sentence 'the plane is *over* the reference object' (see Figure1.14).

Also, in another part of this investigation Coventry and colleagues asked where participants thought the bomb needed to be dropped to hit the building, judgements correlated significantly with segment choice of the previous study. Thus, we can infer that naïve physical knowledge of how objects fall to the ground influences the appropriateness ratings of *over*. However, the clear context effect found for *over* was not mirrored by the effects discovered in another experiment when participants were asked to rate the preposition *above* for the same scenes. Therefore, it would seem that *above* was not as influenced by dynamic-kinematic routines as *over* was.

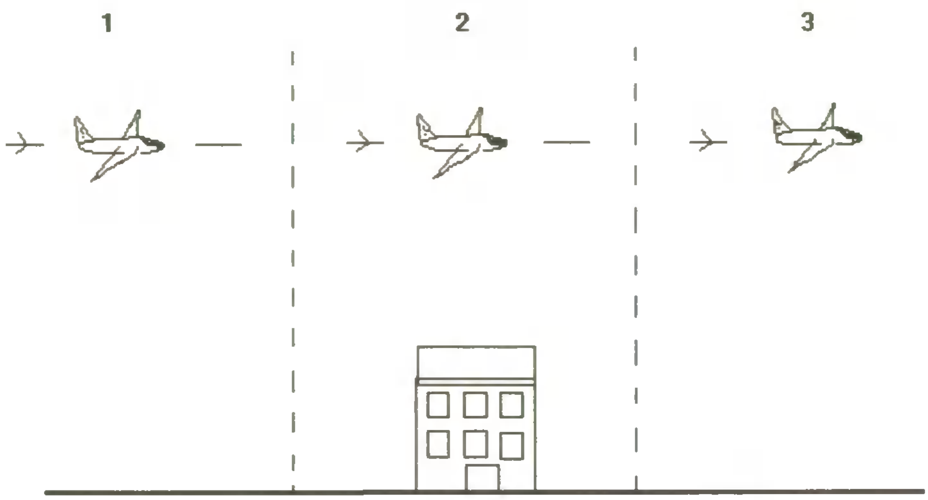


Figure 1.13 Example of scene from Coventry and Mather (2002).

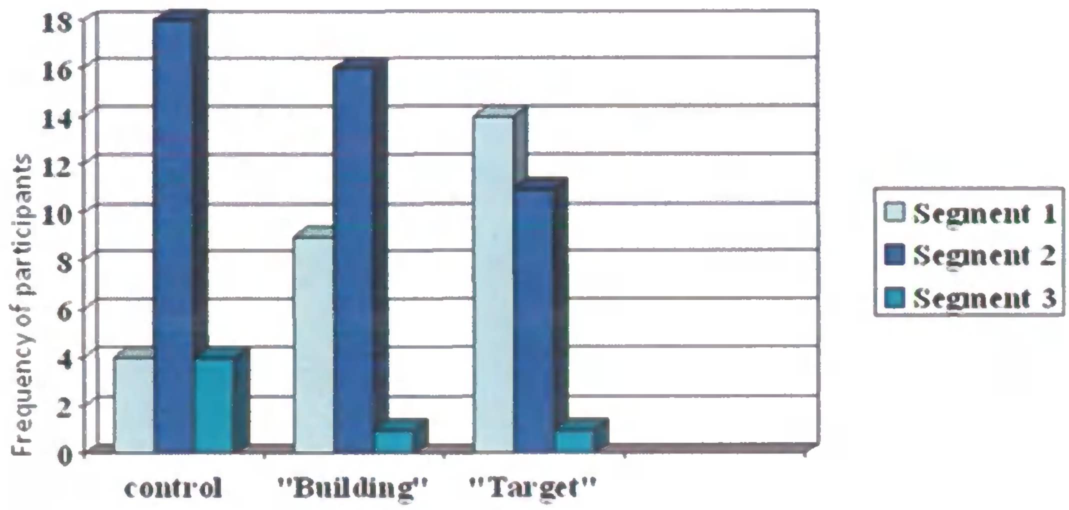


Figure 1.14 Effects for "the plane is *over* the building/target" in Coventry and Mather (2002).

Coventry, Prat-Sala and Richards (2001) carried out further research examining effects of dynamic-kinematic routines versus geometric relations. The stimuli included sets of objects in which one object (e.g., an umbrella) was shown protecting the other object (e.g., a man) from falling objects (e.g., rain) in which the function was fulfilled to varying degrees (Figure 1.15). The columns in the example scenes (Figure 1.15) display the three different levels of located object positions, whereas the rows illustrate the different levels of functional fulfilment. Participants were asked to rate the appropriateness of sentences such as *The umbrella is over/above the man* or *The man is under/below the umbrella.* Coventry and colleagues found that geometric and functional factors displayed a differential influence on a selection of spatial terms. Acceptability ratings for sentences containing *over/under/above/below* were affected by both the position of the umbrella (the geometry in the scene) and the position of the rain (the extent to which the umbrella is fulfilling its function). Moreover, prepositions were differentially affected by these manipulations in that there was evidence of an interplay between the factors in which *over* and *under* were found to be more sensitive to functional manipulations than *above* and *below*, whereas *above* and *below* were effected more by geometry (see Figure 1.16).

Figure 1.15 Example of scenes used by Coventry et al. (2001)

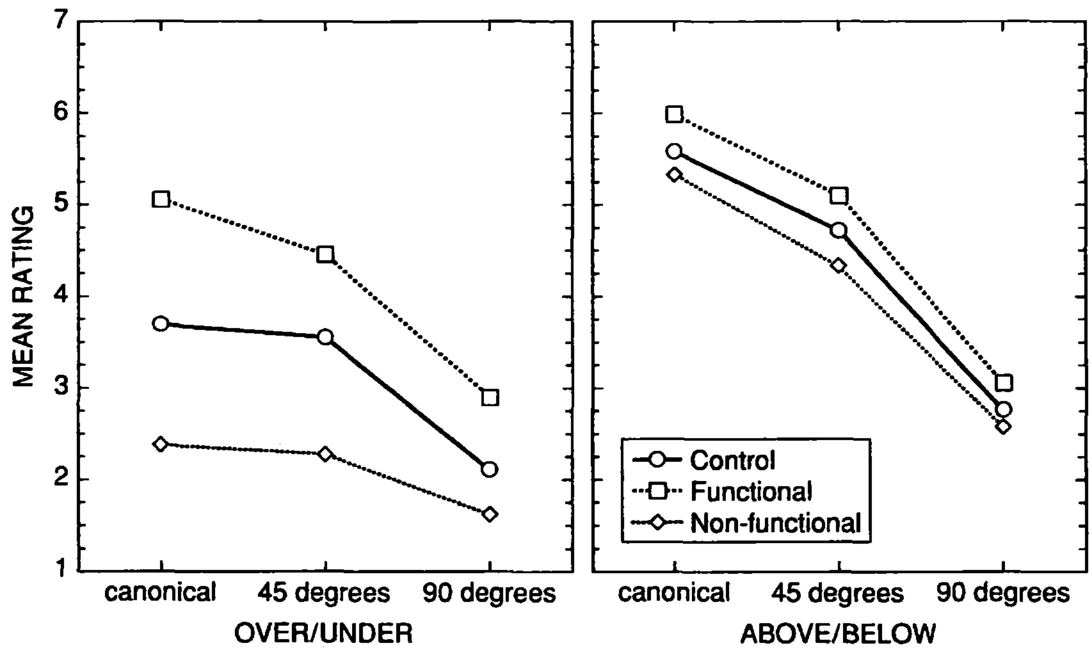


Figure 1.16 The three-way interaction between function, geometry and *over/under* versus *above/below* (Coventry et al., 2001)

In another study, Coventry et al. (2001) have examined the effects of function and frames of reference on the appropriateness of preposition set: 1)*over/under* and 2)*above/below*. In some of the scenes the relative, absolute and intrinsic frames of reference were all aligned, whereas in some scenes they were in conflict (see Figure 1.17). One set of their materials consisted of pictures of a Viking with a shield at different orientations and arrows either falling on the Viking or on the shield, and the control scenes had no arrows at all. Although no significant interactions were found between function and reference frame (orientation) a significant interaction between functionality and preposition set revealed that *over/under* were strongly influenced by function while no functionality effects were found for *above/below*. Additionally, a slightly less straight forward interaction between geometry and preposition set illustrates a conflict of frame of reference effect for *above/below*; the more the reference object deviates from the canonical orientation the lower the appropriateness ratings are for these prepositions. In other words, when the reference object is rotated 90° and 180° this creates a conflict between the intrinsic and absolute frames of reference. However, for *over/under* a significant drop in ratings is apparent for the 90° orientation in comparison to the fairly similar rating levels found for the canonical and 180° orientations between which there was no significant difference. Coventry et al. claim that if this is interpreted from a functional perspective it makes sense in that when the reference object is laying horizontally the surface area of the located object (shield) is not large enough to protect the reference from the arrows. Thus, it can be concluded that the located object was unsuccessful at fulfilling its functional purpose.

The dynamic-kinematic routines affecting the production and comprehension of vertical axis projective terms has been overviewed above. The following section examines the influences of conceptual object knowledge on vertical spatial terms.

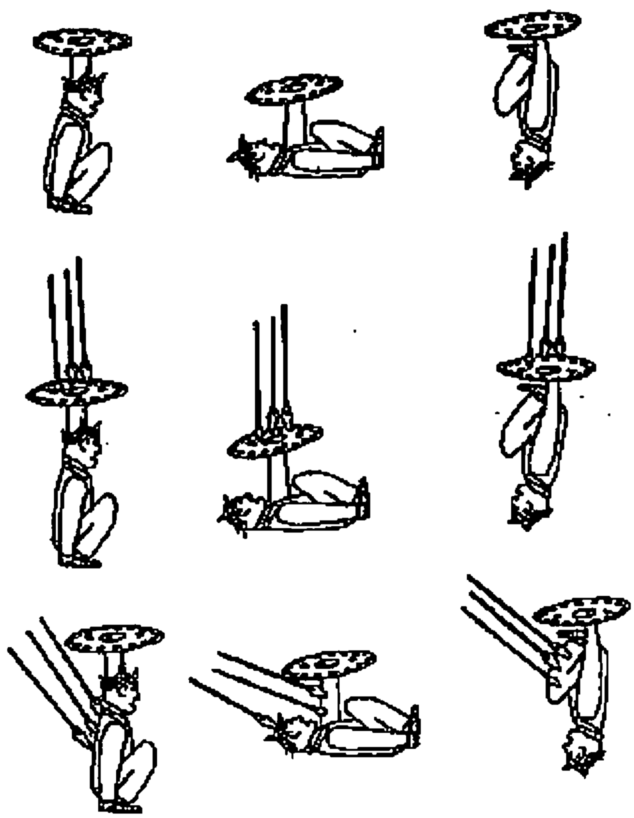


Figure 1.17 Viking scenes from *Coventry, Prat-Sala & Richards (2001).*

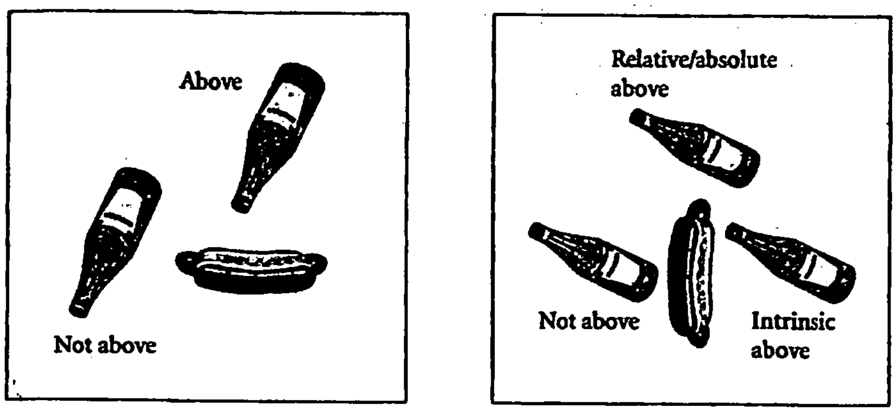
1.4.5. Conceptual knowledge

As previously discussed in the topological section there is clear evidence that object knowledge affects how we speak about a scene and which spatial terms we view as appropriate descriptors. There is also clear evidence that in addition to this being the case for projective terms as well, object knowledge also influences reference frame selection. Carlson-Radvansky and Tang (2000, as cited in Carlson, 2000) set out to test whether the knowledge of object function would affect selection of frame of reference when rating the appropriateness of a sentence containing the preposition *above*. Participants were shown scenes in which the orientation of a hotdog (reference object) was either canonical or rotated by 90° and either a bottle of mustard or ant-killer (located object) was positioned either higher than or to the left or right of the hotdog.

Acceptability ratings for *above* were the highest when the located object was positioned according to the intrinsic frame when the scene depicted objects that were functionally related (hotdog/mustard) than when they were not (hotdog/ant-killer) (see Figure 1.18). Also, interestingly the intrinsic above relation in the non-canonical scenes (see Figure 1.19) was deemed as being more appropriate when described using the sentence of the form '*The located object is above the reference object*' than either the functionally related/non-interactive scenes (Figure 1.18 b), or the un-related scenes (Figure 1.18 c). At first glance this result may seem to contradict the previous indications made by Coventry et. al. (2001) that *above* is not as sensitive to functionality as *over*. It is, however worth keeping in mind that Carlson-Radvansky and Tang did not conduct a comparison of effects on different spatial terms, but rather just manipulated functional and geometric factors in relation to the single term *above*.

a) functionally related/ Interactive
b) functionally related/ Non-interactive
c) Unrelated

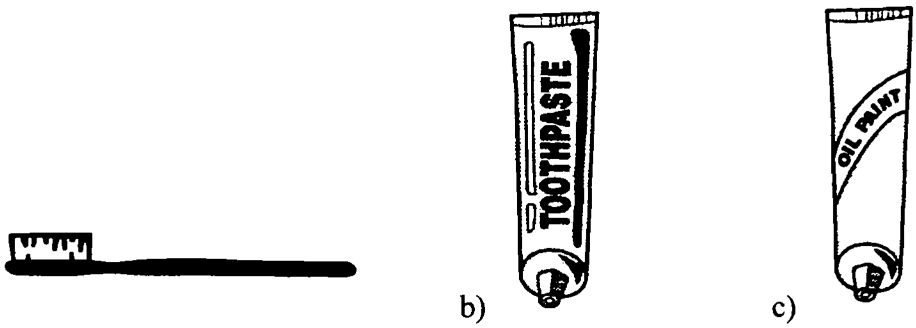
Figure 1.18 Examples of functional and non-functional conditions adapted from Carlson-Radvansky and Tang (2000)



a) Canonical reference object (hot dog)
b) non-canonical reference object (hot dog)

Figure 1.19 Five possible placements for the located object around a canonical or non-canonical reference object (hot-dog).

Carlson-Radvansky, Covey and Lattanzi (1999) also looked into the influence of knowledge about functional relations on the appropriateness of alignment and misalignment of a located object according to the centre of mass of a reference object. They discovered when objects were functionally related, such as a toothbrush and toothpaste, participants were more biased to place the located object in alignment with the functional part of the reference object (brush bristles) rather than the centre of mass when asked to place the figure *above* the reference object (see Figure 1.20). As expected this functional bias was not as evident when the tube of paint was paired with the toothbrush than when a tube of toothpaste was presented with a toothbrush.



a) b) c)

Figure 1.20 Example of scenes used by Carlson-Radvansky, Covey and Lattanzi (1999).

Context can also affect whether an object has a function, even when it does not usually have that function. Coventry et. al. (2001) looked into the effects of conceptual knowledge on perceived appropriateness of a selection of spatial terms (*above/over/under/below*). They substituted objects not generally known for their protective properties for the protecting objects in the experiments already reviewed above (e.g., the umbrella materials). Despite the fact that a suitcase is not associated with the function of protecting from the rain, *over* was still viewed as an appropriate descriptor for the situation, more so when the suitcase was shown protecting the person from getting wet than in the non-functional or control (i.e., no rain) conditions. Hence, although the non-stereotypical object (suitcase) received lower rating levels throughout (compared to the umbrella), it was still viewed as acceptably described by the preposition *over,* when carrying out the same protective function as the stereotypical object (umbrella). This suggests that the actual function an object is successfully displaying is capable of over-riding our stereotypical conceptual knowledge in some circumstances.

Next the evidence for the components of the FGF is examined with reference to horizontal axis projective terms.

1.5 Horizontal Projective Terms

1.5.1 Horizontal Axis Reference Frame assignment

As mentioned earlier, the horizontal axis differs in reference frame instantiation from the vertical axis. For example *above* has been found to be predominantly influenced by the intrinsic and absolute (gravitational) reference frames (Carlson-Radvansky and Irwin, 1993), whereas horizontal axis terms such as *in front of, behind,* and *to the left/right of* are mainly influenced by the intrinsic and relative reference frames. Hence, there is some competition between the assignment of relative and intrinsic frames and the extent to which these are instantiated depends on context. Factors, both geometric and extra-geometric, influencing horizontal axis reference frame selection are described in the following section.

1.5.2 Geometric influences and Dynamic-kinematic routines

In comparison with work on the terms thus far considered, horizontal spatial terms have received less attention in the spatial language literature. However, Harris and Strommen (1972) found that by the time children are 5 years of age they show a preference to place a located object in accordance with the intrinsic frame of reference if the reference object has a clear front and back. Landau (1996) also conducted studies in this line of investigation. Their intention was to look into the nature of the representations children (three and five year olds) and adults have underlying the spatial relationships encoded by *in front of* and *behind* in English. The participants were shown three different reference objects (see Figure 1.21) and asked to complete a yes /no task in which they were shown a located object placed in a variety of locations around the reference object, and were asked to make judgments of whether the located object was *in front of* or *behind* the reference object. In another task they were asked to place an object in front of or behind the reference object. The reference objects were a flat disc, a

U-shaped object and a flat disc-shaped object with eyes and a tail. The results showed that when the reference object had an intrinsic front (i.e. the disc-shaped object with eyes and tail) the adults placed the located object directly 'in front of' or 'behind' the half-axes extending directly from the eyes (for *in front of*) or the tail (for *behind*) of the reference object according to its the intrinsic axes. Also, regions extending to the right or left of the intrinsic axis of the reference object but outside the 'bounding box' (i.e. regions within the boundaries of the reference object) were also considered appropriate by adults. The acceptability was, however, not as strong away from the axes of the reference object when the reference object did not have an intrinsic front. Therefore, it can be concluded that reference frame assignment is also important for horizontal axis terms such as in front of and behind.

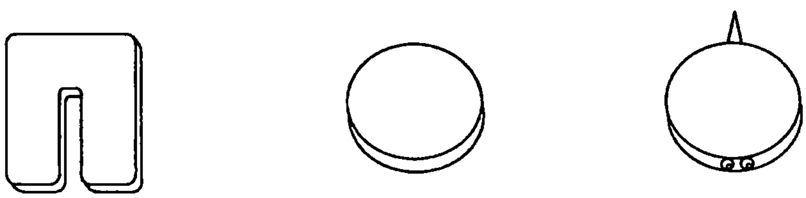


Figure 1.21 The reference objects used by Landau (1996).

Work by Carlson-Radvansky and Radvansky (1996) shows that it is not simply geometry that determines reference frame selection; it is also influenced by presence of a functional relation between objects (see Figure 1.22). For example, participants adopted an intrinsic reference frame more readily when a postman was shown oriented facing towards a post-box (A 'the postman is *in front of* the post-box' was rated as most acceptable), than when the postman was facing away from the post-box. In the latter case an extrinsic/relative frame of reference was preferred (B 'the postman is *to the left of* the post-box'). Therefore, facilitation of a dynamic interaction between the two objects has an effect on the choice of reference frame and associated spatial terms used to describe a scene.

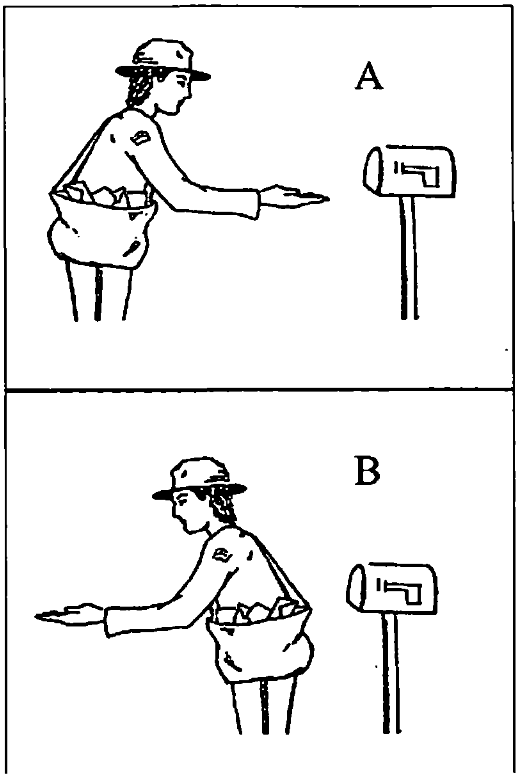


Figure 1.22 Example of scenes from Carlson-Radvansky & Radvansky (1996).

Richards (2001) expanded on the previous paradigm by investigating whether blocking the interaction between two objects would reduce the effect of the orientation of the located object (e.g. postman; Figure 1.23). She indeed found that there was no difference in the appropriateness of intrinsic frame terms as a function of orientation when an obstruction was presented between the postman and postbox (thus blocking the postman's interaction with the postbox), although they replicated the Carlson-Radvansky at al. results when the obstruction was absent.

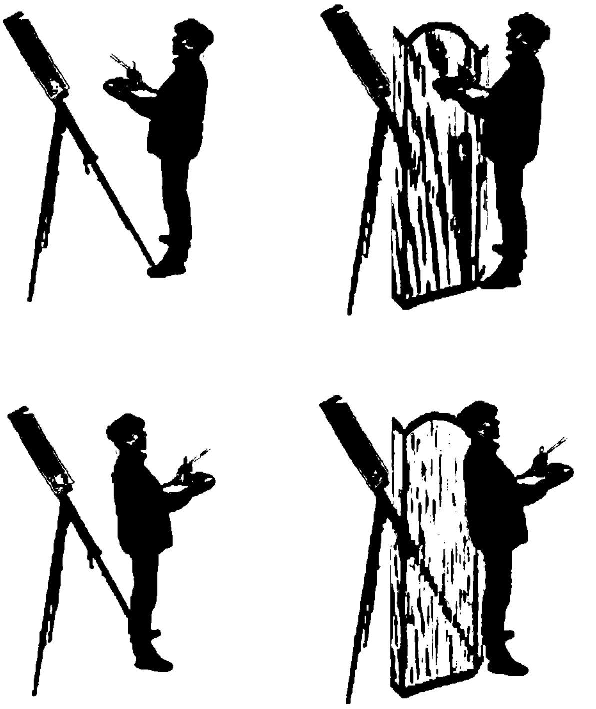


Figure 1.23 Example of scenes from Richards (2001).

Coventry and Frias-Lindqvist (2005) ran a cross-linguistic experiment examining the effects of motion and geometry on the English and Finnish languages. They found that Finnish, having more terms for the English *in front of (edessä, edellä)* and *behind (takana, perässä, jäljessä),* showed some discrepancy between scenes that were static and scenes that involved motion. The scenes shown involved two cars travelling around a round-about which were either static scenes or depicted actual clock-wise vehicle movement. The reference frame manipulation involved having the located object either travelling with its front facing forward or its back facing forward in relation to the reference object which always had its front facing forward. Additionally, proximity was manipulated as well as orientation. There were cross-linguistic indications that when there was a reference frame conflict present then the ad-positions were rated higher for moving scenes. For example, when the scene displayed two cars oriented towards one another instead of with their fronts pointing in the same direction motion seemed to provide an additionally needed cue for the appropriateness of adopting an intrinsic frame of reference (i.e. 'the blue car is in front of the white car).

This suggests that instead of an ideal functional relationship being presented by objects facing one another to allow interaction as revealed in the work of Carlson-Radvansky and Radvansky (1996) and Richards (2000) i.e. postman- post-box (Figure 1.23), two potentially mobile cars would instead be considered more appropriately positioned when they were oriented so that following one another would be enabled (i.e. vehicle fronts pointing in the same direction). The Coventry and Frias-Lindqvist study shows that the awareness of actual or potential dynamic-kinematic routines plays an important part in determining how people speak about spatial relations.

We have outlined the different geometric and dynamic-kinematic factors influencing the production and comprehension of horizontal axis projective terms in the above section. Next the effects of conceptual knowledge on horizontal axis terms will be outlined.

1.5.3 Conceptual knowledge

Carlson-Radvansky and Radvansky (1996) also found that conceptual knowledge of object function influenced reference frame selection when functionally related objects (postman/ post-box) were compared with functionally unrelated objects (postman/birdhouse). Again the intrinsic frame of reference (*in front of*) was produced significantly more often for related objects than for unrelated objects.

Grabowski and Miller (2000) review a range of contextual factors which are shown to influence how projective terms are interpreted. Manipulation took place in scenes showing a (German) road, on which a car with a driver and front-seat passenger were situated in the right-hand lane (see Figure 1.24). The scenarios involved the passenger saying to the driver "Could you please drop me off/stop *in front of/behind* the white car/tree". One of the contexts involved asking the participant to imagine that he/she is the driver of the car and that the passenger is a driving instructor, whereas the other context that was used portrayed the passenger as a friend who wants a lift home instead. They found that depending on whether a car or tree were used as reference object the spatial terms *in front of* and *behind* were interpreted (and their German counterparts) very differently. When the reference object was a car (with a clear front and back) the intrinsic frame of reference was readily adopted (subspace 3 for *in front of* and subspace 1 for *behind*) regardless of the context. However, when the reference object was a tree (with no inherent front and back) there was a context effect. In the driving test scenario the *in front of* was allocated according to the direction of movement of the car (subspace 3). However, in the giving friend a lift home context both the direction of motion (subspace 3) and temporal interpretation (subspace 1) of *in front of* were used. Therefore, from Grabowski and Miller's work it can be concluded that use of a non-oriented reference object like a tree causes ambiguity in both producing a meaningful description and interpretation of such a descriptor. Also, this study shows that context interacts with people's knowledge of dynamic-kinematic routines.

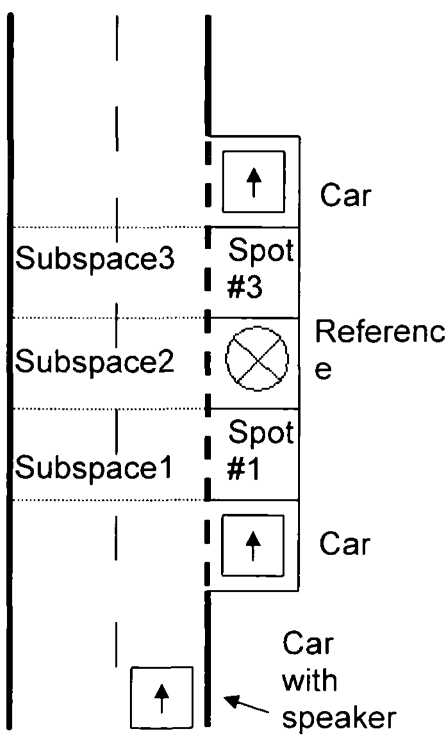


Figure 1.24 Scene adapted from Grabowski and Miller (2000)

1.6 Summary

A general overview has been provided outlining the influences of geometric routines, dynamic-kinematic routines and object/conceptual knowledge across a range of preposition types (topological terms and projective terms). However, there has been a focus on using mainly data from English language studies. It has been clearly indicated that conceptual knowledge and knowledge of dynamic-kinematic routines interact with geometry having an influence on our comprehension of horizontal and vertical axis projective terms and topological terms. One of the two central questions in this thesis is whether the FGF can apply to other languages, and indeed eight of the experiments reported later in the thesis examine whether this is the case across a range of languages. The above mentioned studies have provided a basis from which to ask whether the FGF can be expanded across a range of languages. As a precursor to this, we next consider differences in how languages carve up space.

1.7 Spatial Language Across Languages

From the literature reviewed in the previous sections it is clear that extra-geometric as well as geometric constraints manifest in the production and comprehension of spatial expressions in the English language. However, languages differ in how they carve up space, leading to the underlying question of whether space and our perception of it structures spatial language, or whether language itself structures the way we categorise space.

One does not have to travel far geographically, or in terms of language families, to find considerable differences in how languages carve up space. For instance, Dutch has two sub-types (*op* and *aan*) for the English support term *on*, whereas Spanish collapses across the English support (*on*) and containment (*in*) linguistic categories with only a single term (*en*, see Figure 1.25). So a natural question to ask is whether extra-geometric variables may help explain some of this language variation. This section aims to provide some background of what has previously been revealed on such influences across different languages, and the diversity in which languages carve up the spatial world.

There is evidence that whilst infants are in the process of acquiring language, the specific language they are exposed to affects the way in which space is conceptualised and categorised. Choi and Bowerman (1991) argued that the extent to which languages differ in the ways they structure space cannot be explained by children's pre-verbal understanding of space alone. Rather, there seems to be evidence that linguistic input in combination with built-in perceptual sensitivities *both* influence infants at a very young age. Choi and Bowerman (1991) compared how children talk about spontaneous and caused motion in English and Korean. English is considered a 'satellite-framed' language, characteristically expressing path notions (movement into, out of, up, down, off, on etc.) in a constituent which is 'satellite' to the main verb such as a particle or preposition (e.g. Mark ran in.). On the other hand, Korean is a 'verb-framed' language, expressing path in the verb itself, as Korean lacks a class of spatial particles or prepositions entirely (e.g. Mark entered running). In their research they found that children's spatial semantic categories are quite different and in alignment with the categories of the input languages. English infants were found to distinguish between putting things *into* containers and putting them *onto* surfaces, but they were indifferent to whether the figure fit the container tightly or loosely. In contrast, Korean children distinguished between put tightly in (*kkita*; e.g. put hand in glove) and put loosely in (*nehta*; e.g. put an apple in a bowl); and they also discriminated between attaching things onto (tighter fit again) a surface (*kkita*; put lid on jar) and setting things on a surface (*nohta*; e.g. put toast on plate).

Extending their past work Choi and Bowerman collaborated with McDonough and Mandler (Choi, McDonough, Bowerman, and Mandler, 1999) using a preferential looking task to assess generalisations made by children acquiring either Korean or English. They found that on hearing the word *in* English children looked more at containment scenes than scenes in which containment was absent. In contrast, when Korean children heard the word *kkita* they looked more at tight-fit scenes than loose-fit scenes. Thus, Choi et al. (1999) conclude that by the time children are aged 1.5-2 years they pay more attention to language-appropriate aspects of spatial relations showing a clear cross-linguistic difference. Further investigations into this by McDonough, Choi and Mandler (2003) uncovered, however, that at 9-14 months both Korean and English children seemed to have larger and less differentiated semantic spatial categories than adults. Again a preferential looking task was used but this time looking preferences to purely non-verbal stimuli was the design of choice, enabling the comparison of the results from such young infants to those of adults.

The indications from a series of three experiments were that not only did the Korean adults and infants discriminate between tight-fitting support scenes and loose-fitting support scenes, but so did the infants being raised in an English home environment. As was expected English adults did not show such differentiation between loose and tight-fitting scenes. McDonough et al. state that due to the fact that infants cross-linguistically categorised such contrasts, it could be suggested that when they are still pre-linguistic at a very young age they have conceptual readiness for learning spatial semantics in line with either language that they happen to be raised with. Results from this adult-infant comparison support the Whorfian (1956) view that the language we learn actually influences and guides thought. Certainly as described above (Choi, McDonough, Bowerman, and Mandler, 1999) no more than a couple of months older English infants no longer present differentiation between tight-fitting and loose-fitting support, which clearly indicates that the language environment they are being brought up in has influenced their non-verbal spatial conceptualisation. In fact, according to Bowerman (1996; Bowerman & Choi, 2001) children learn to structure space for language, as the language being learned actually structures the building of spatial semantic categories.

A different perspective on this topic is proposed by Mandler (1996); according to her language is structured in spatially relevant ways. Therefore, the reliance of prior non-linguistic spatial categorisation of concepts such as support and containment leads to difficulties making certain linguistic distinctions later on. In line with this view Mandler claims that this prior organisation of non-linguistic spatial schemas, in particular those for support and containment, may make some linguistic discrimination more complicated for children to learn than others. According to Coventry and Garrod (2004), Dutch which has two subtypes of support (*op*, and *aan*) compared with English (*on*) is such a distinction which children take longer to learn; in contrast, Spanish in which there is no linguistic distinction between support and containment (only one preposition used: *en*) is easier to learn (Figure 1.25). Coventry and Garrod (2004) and Mandler (1992) are all in agreement that the Korean tight-fit/loose-fit (*kkita/nehta*) distinction may be an easy one for children to learn due to the dynamic-kinematic routines of location control having an influence very early on in life (Bowerman & Choi, 2001), since the tight fit/loose fit distinction seems to be the same as varying degrees of location control. Furthermore, evidence was found that both Korean and English infants (9-14 months) had the readiness for learning location control (i.e. tight-fit/loose-fit) aspects in either language.

Bowerman and Choi suggest that difficulties in learning to distinguish between terms such as the Dutch *op* and *aan* (both translating to *on*) generate from the fact that these are perhaps not natural conventions and must therefore be learned by children (see

Figure 1.25). According to Bowerman the term *aan* is used to depict situations in which gravity must be counteracted for the object to stay in contact with the surface, whereas *op* is used when the figure is seen to be resting comfortably on the surface. Therefore, the difficulty infants experience when learning to differentiate between when to use *op* or when to use *aan* in Dutch, may be founded in the fact that this more complex understanding of force dynamics is unlikely to be part of the preverbal categorisation of spatial relations.

Another study which produced results that were in accord with the research reported above (Bowerman & Choi, 2001) was conducted by Richards, Coventry and Clibbens (2004) in which they studied four groups of young English children, and did indeed find that the extra-geometric factor of location control significantly increased the use of the spatial preposition *in*. Children between the ages of 3 years and 4 months to 7 years and eight months were administered a language production task in which they were presented video images of scenes displaying object piles in and on containers and supporting surfaces. Location control was manipulated in three different ways: 1) scenes were shown in which the located object and reference object moved together, 2) scenes were presented in which the located object moved independently of the reference object (compromising location control), and 3) scenes were displayed in which both the located and reference objects were static. Even the youngest children seemed to use *in* more often for the scenes in which location control was not compromised.

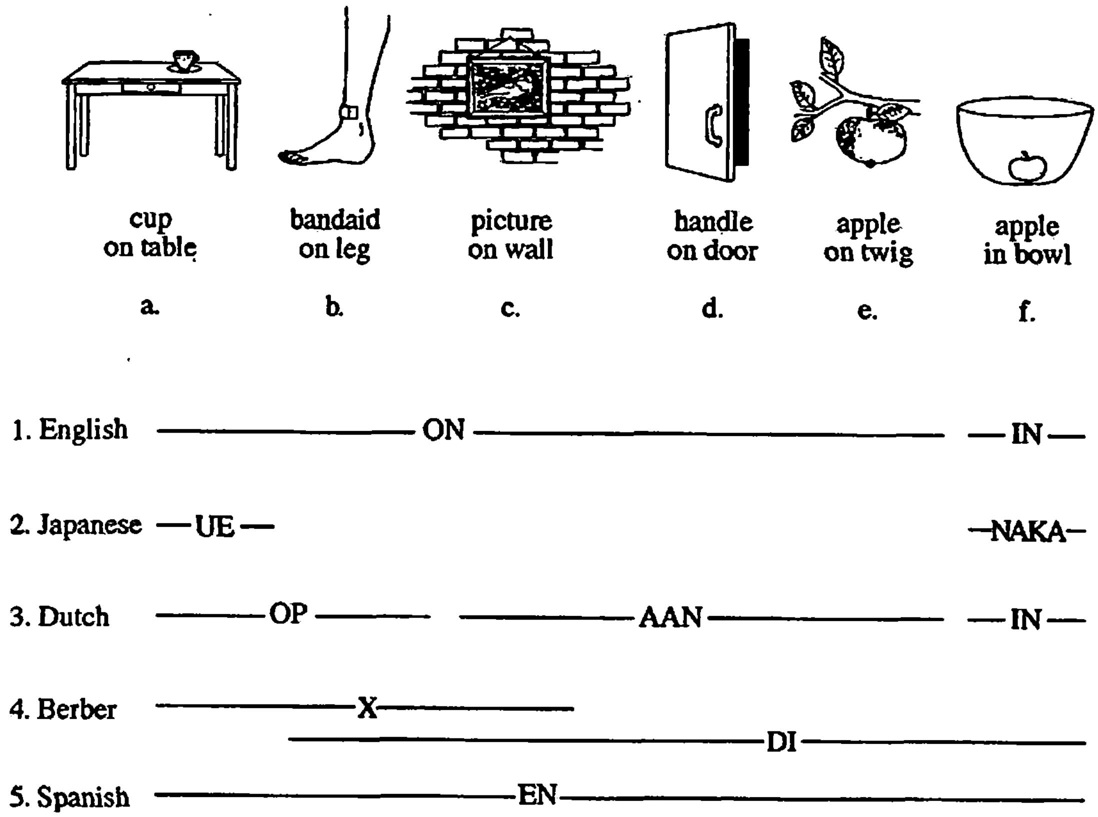


Figure 1.25 Cross-linguistic differences in categorizing spatial relationships (from Bowerman & Choi, 2001)

There has been some research examining cross-linguistic patterns of *in* and *on* term usage between English and Spanish. Coventry (1992) states that he has found preliminary data suggesting that when a container is tilted away from the canonical orientation the appropriateness ratings were considerably decreased for the Spanish preposition *en*. In such situations for English '*on* the bowl' would become more appropriate than '*in* the bowl', whereas in Spanish there is only one lexical item which reacts with decreased appropriateness.

Coventry and colleagues have also investigated whether languages other than English show differing geometric and extra-geometric influences on spatial terms such as those found for *over/above* and *under/below* in English. The English results indicated that the comprehension of *over* and *under* was more influenced by extra-geometric routines; in contrast *above* and *below* were more sensitive to geometric manipulations (Coventry et. al, 2001; a more detailed account of this research can be found in the background section for Experiments Four and Five). In fact, similar patterns have been found for Spanish (Coventry & Guijarro-Fuentes, 2004) and French (Vandeloise, 1991, 1994). The Spanish equivalents for *over* and *above: sobre* and *encima de* displayed a similar effect pattern to English. The spatial term *sobre* was more sensitive to extra-geometric manipulations than *encima de,* in that *sobre* was rated as more appropriate if there was a functional relationship present (umbrella fulfilling its function) regardless of geometry. However, there was no clear functional/geometric discrimination present for the terms *debajo de* and *bajo.* Another difference between Spanish and English was also that the influence of geometric manipulation was generally weaker on all Spanish superior and inferior terms than it was for their English counterparts.

Clearly there is evidence that both extra-geometric and geometric factors have an influence on the understanding of spatial terms for languages other than English. However it is also clear that the systematic studies conducted in English carefully manipulating components of the FGF have not been conducted in other languages. Given the marked variation in how languages carve up the spatial world, it could be the case that the FGF only applied for some languages. Moreover, we know little regarding the relative importance of components of the FGF across languages. A major aim of the thesis is to investigate these issues across three languages that vary in how they carve up space; English, Spanish, and Finnish.

The second question the thesis asks is whether extra-geometric variables also influence (non-linguistic) spatial memory. We next consider literature suggesting that there may well be considerable overlap between spatial language representation and (non-linguistic) spatial representation more generally.

1.8 Non-verbal Spatial Conceptualisation

As described above, according to McDonough et al. very young infants cross-linguistically (Korean – English) categorised certain spatial contrasts which (dependant upon their language environment) they no longer did as they grew older. This was interpreted as suggesting that when infants are still pre-linguistic they have conceptual readiness for learning spatial semantics in line with the specific language environment they are in, supporting the Whorfian (1956) notion that the language we learn actually influences and guides thought. However, linguistic or cross-linguistic research and developmental research are not the only areas which endeavour to shed light upon how people conceptualise space both linguistically and non-linguistically. More recently, spatial organisation in non-linguistic memory tasks has been contrasted with the verbal categorisation resulting from linguistic tasks (Hayward & Tarr,1995; Munnich, Landau & Dosher, 2001). In general, it would seem that spatial language and spatial memory rely on similar structuring. For instance, Hayward and Tarr (1995) compared results from language generation and rating tasks with non-verbal location recall tasks. They found that vertical terms such as *'above'* and *'below'*, were most often produced and received highest appropriateness ratings when the located object was situated along the vertical axis of the reference object. Also, horizontal terms such as *'left'* and *'right'*, were preferred along the reference object's horizontal axis. This effect pattern was mirrored for the non-verbal task in which accuracy of location memory was found to also be highest when the object relationship was the same, as when spatial terms were considered most applicable.

Munnich and colleagues (2001) went a step further using a similar paradigm in which they compared verbal and non-verbal performance of not only English speakers, but also of Japanese and Korean speakers as well. They found similar results cross-linguistically for the verbal task involving terms for axial structure, whereas there were differences between contact terms. While Japanese speakers used contact terms symmetrically around all sides of the reference object, English speakers used contact terms more frequently on the top side of the reference object. This variability across languages for the scenes depicting contact in the verbal task was not, however, mirrored in the results from the memory task. The memory task was found to have similar patterns of results across languages regardless of some linguistic differences. Therefore, Munnich et al. conclude that although there are similarities in the structuring of space for both memory and language systems, they also seem to be partially independent in that differences in spatial language did not necessarily lead to differences in non-linguistic spatial encoding. More details on non-linguistic research of spatial categories can be found in Chapter Five.

Above we have outlined some of the differences and correspondences between verbal and non-linguistic spatial conceptualisation that have been found in past research. However, such correspondences and differences, between the verbal and non-verbal domains have mainly focused on manipulating geometric relations, whereas the extra-geometric factors outlined previously have never been examined in relation to the non-verbal domain. It has become clear that geometric relations interacting with various other factors, such as conceptual object knowledge and dynamic-kinematic routines influence how we speak and comprehend spatial language. Therefore, this thesis endeavours to explore such extra-geometric influences in addition to geometric effects on non-verbal spatial memory.

1.9 Overview of the Thesis

Chapters 2-4 of this thesis address the issue of whether variables in the FGF operate across a range of languages, and not just English. The motivation for the language choices of the cross-linguistic research in this thesis was to select languages that are from differing language families to allow for an interesting comparison of linguistic differences and similarities. **English** was chosen as a representative of the Germanic languages which is a branch of the Indo-European language family. **Finnish** was selected because it is a member of the Baltic-Finnic subgroup of languages which in turn is a member of the Uralic family of languages. Finally, **Spanish** was considered an interesting choice because although it is also a member of the Indo-European language family, it is part of the branch which is called the Romance languages. This diverse selection of languages allows for broader investigations and aims to provide fresh information to work conducted on verbal spatial conceptualisation.

In Chapter 2, two experiments are described which investigated geometric and non-geometric influences on topological terms across the English, Finnish and Spanish languages. Experiment One has been inspired by the work carried out by Feist et al. (1998; Feist, 2000), while Experiment Two has been motivated by the research produced by Garrod et al. (1999).

Chapter Three describes a series of three experiments examining the geometric influences, and also the dynamic-kinematic and conceptual constraints on vertical projective terms across the English, Finnish and Spanish languages. Experiment Three was an adaptation of the work done previously by Carlson-Radvansky et el. (1999). Experiments Four and Five of the vertical projective chapter were modelled on work conducted by Coventry and colleagues (Coventry et al., 2001).

Chapter Four contains descriptions of three experiments designed to provide further information about geometric and non-geometric effects on horizontal projective terms across the English, Finnish and Spanish languages. Experiments Six and Seven were strongly influenced by the findings of research by Carlson-Radvansky and Radvansky (1996) and studies by Richards (2000). However, Experiment Eight was inspired by the work previously produced by Coventry and Frias-Lindqvist (2005).

The last section of research in this thesis is in Chapter Five, which tackles investigations into the geometric and extra-geometric constraints influencing non-verbal spatial conceptualisation through two experiments. Experiment Nine looks into geometric and non-geometric effects on accuracy of location memory when there are potentially horizontally mobile objects present or absent. Experiment Ten aims to reveal whether there are influences of not only geometry but also non-geometric factors on the accuracy of location memory, when the object is or is not potentially vertically mobile. These experiments were motivated by past work produced by Hayward & Tarr (1995), Munnich, Landau & Dosher (2001) and Crawford, Regier, & Huttenlocher (2000).

Finally Chapter Six overviews the findings of the thesis, and implications they have for theories of spatial language and spatial memory.

Chapter Two

2.0 Examining Topological terms

This chapter examines the influences both geometric and extra-geometric factors have in the production and comprehension of topological terms cross-linguistically. As already mentioned in the first chapter, languages differ in the way they carve up space, so it is clear that it is not just our visual perception of spatial scenes which guides us in conceptualising it verbally. This leads us to ask the question whether extra-geometric variables may help explain some of the variation found in language. In this chapter the first experiment endeavours to examine the effects of object knowledge and dynamic-kinematic routine, such as location control of the located object by the reference object on the comprehension of *in* and *on* and their equivalents across three languages. The second experiment investigates the issue of location control from a slightly different angle, examining the possible effects of an alternative source of location control (following the study of Garrod, Ferrier and Campbell, 1999) on the comprehension of the same terms.

This chapter begins with a consideration of containment and support relations across the target languages. As discussed earlier the language selection was motivated by the intention to find interesting representatives of different language families and/or different branches within those families. Therefore, English has been chosen as the representative of the Germanic languages, (branch of the Indo-European language family), Finnish because it is a member of the Baltic-Finnic subgroup of languages (member of the Uralic family of languages), and Spanish was selected because it is part of the branch which is called the Romance languages (another branch of the Indo-European language family). The selection of languages differ from one another considerably also in that while English lexicalises a difference between containment (*in*) and support (*on*), Spanish has a single lexical item (*en*) for both sets of relations.

However, the closest Finnish alternatives are communicated through case conjugation rather than preposition i.e. the inessive case *–ssa* is the closest lexical equivalent to *in,* and the adessive case *–lla* is the closest equivalent to *on.* The spatial terms whether preposition, post-position or case conjugation will all be referred to by the umbrella-term ad-position throughout the thesis.

2.1 Rationale and Design for Experiment One

The previous chapter overviewed some of the work that has looked at the interplay between geometry and function and the influences on the prepositions *in* and *on.* There was also a brief mention of the assessment of object knowledge influences and the important role of the potential animacy of both the figure and reference objects in enhancing the understanding of the underlying semantics of spatial terms. This section provides more details about the work carried out by Feist et al. (1998; Feist, 2000), as it forms the main basis for Experiment One.

Feist and colleagues have looked at the importance of geometry, function and what they call 'nature of the object' influences. They ran an experiment using only English speaking participants in which they showed static scenes of a located object placed centrally and in contact with the reference object. The reference object was either a hand or an ambiguous dish-like tray, which would most closely be described as appearing to be like a sheet of plastic. The intention was to compare a reference object that is able to exert location control over another object (a hand can close over an object), with a reference object that was permanently static (dish-like tray), and therefore unable to actively exercise control over the located object. Furthermore, Feist and colleagues manipulated the geometry of the scene by varying the concavity of the reference objects at three increasingly concave levels (from approximately flat, medium, and deeply curved). The intention was to portray a reference object with a deeper interior exemplifying an object suitable for containment (Figure 2.1 a) or a flatter surface more ideal for support (Figure 2.1 b). In addition to two reference objects they used two different located objects which were either a firefly or a coin. This was done to compare the influences of an animate object, (the firefly) which was thought to be less ideal for containment with the influences of a static object (coin) thought to be more ideal for containment. By varying the located object and reference object the aim was to tap onto people's object knowledge about the potential animacy in the scene. It was thought that when a located object was able to exert control over its own position it would be less suitable for containment than when it had no independent control over its positioning. Functional influences were being tapped into by using different labelling conditions for the reference object when it was an ambiguous sheet of plastic (the hand was simply called a hand). The ambiguous container was either called a plate, dish or bowl. Thus the function of containment was thought to be emphasised by labelling the container as a bowl. The participants were simply presented sentences of the form: The figure is *ON/IN* the reference object after which they were asked to choose the term which best described each scene.

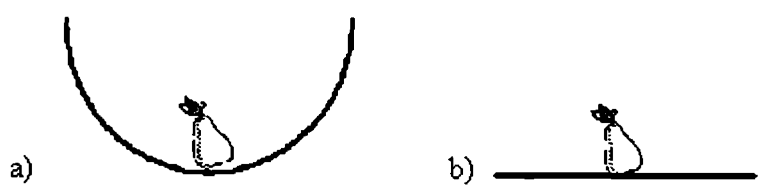


Figure 2.1 Examples depicting ideal concavity levels for a) containment and b) support.

The results of Feist's work confirmed that there were influences of geometry and function and also the importance of object knowledge on the use of English spatial prepositions. Greater concavity produced a higher proportion of *in* responses, which led Feist et al. (1998) to infer significant influences of geometry. Another way of putting this is that the greater the concavity of reference object was, the more it was perceived to have location control of the located object; hence exemplifying a relationship of containment which is ideally described by the term *in*. Also, functional influences were indicated by the higher proportion of *in* responses when the reference object was labelled a bowl than when it was called a plate or a dish (Feist, 2000). The labelling effect can also be interpreted as the influence of existing conceptual knowledge. Additionally, the nature of the located object was confirmed as influential because the inanimate coin received a higher proportion of *in* responses than the scenes depicting the potentially animate firefly (Feist & Gentner, 1998). Therefore, the potential animacy of the located object was perceived as a threat to location control. Finally, the potentially animate reference object (the hand) produced higher rates of *in* than the inanimate ambiguous reference object, suggesting an effect due to the nature of the reference object (Feist, 2000). Hence, the potentially animate hand is viewed as being capable of elevating location control of its own accord over the located object.

Experiment One in the present thesis has been mainly inspired by the previously discussed work by Feist et al (1998; Feist, 2000). The manipulations of three levels of concavity, and the two levels (animate/inanimate) of located object and two levels (animate/inanimate) of reference object were replicated. However, instead of the ambiguous 'sheet-like' static object the reference object was replaced by a dish. Also, rather than manipulating the participants' knowledge of object function by using different labels for the container the inanimate object was simply called a dish (which is a superordinate term for both plate and bowl) and the hand was just called a hand. The idea was that the reference object's function would be inferred by the different degrees of concavity rather than from the linguistic labels assigned to the object. This also allowed for a more balanced design where both reference objects (dish and hand) were only provided one label each. Additionally, rather than forcing the participants to choose between *in* and *on* responses, they were given the opportunity to rate two sentences containing each preposition for each scene. The intention was to avoid pressuring participants to give an 'all or none' response for a particular preposition. Finally, the most notable alteration in design was that this experiment has been extended to include not only English but also the Finnish and Spanish languages.

The experimental predictions of the present investigation were in agreement with the experimental results provided by Feist's (1998, 2000) work. However, the hypotheses were extended across three languages. As mentioned earlier, function was not manipulated through a separate labelling factor. In this thesis the author's view was that providing unambiguous objects with different levels of concavity would allow the participants to draw upon their own knowledge of object function which would be reflected in their ratings. The prediction was that the more concave the reference object is, the more appropriate *in* would be for describing the relationship. In Finnish, the inessive case conjugation *–ssa* is the closest lexical equivalent to *in*, and it was therefore predicted to be most appropriate when talking about more concave objects. In contrast, the less concave the reference object was, *on* was expected to be more suitable as a spatial descriptor, and the Finnish lexical equivalent *–lla* (the adessive case conjugation) would be the preferred term. The Spanish ad-position *en* was predicted to be preferred at equal levels throughout the concavity conditions in comparison to *sobre*. This is because *en,* if translated has, a joint meaning of *in* and *on* for English, whereas *sobre* corresponds most closely to *over*. However, even though *en* is really the obvious lexical candidate, effects of concavity were predicted to be present for *sobre* (*over*) since it has some relation to the word *on* in English, thus effects with a similar pattern found for *on* at different levels of concavity were expected. The hypothesis for effects of object knowledge and knowledge of dynamic-kinematic routines was that when a potentially animate located object (the fly) is viewed it would result in lower ratings for the ad-positions *in/-ssa/en* than when a static located object is presented. In contrast, the prediction for effects of the potential animacy of the reference object (the hand) was that such scenes would lead to higher rating levels of *in/-ssa/en* when compared with ratings for scenes illustrating a static reference object (dish). Furthermore, although Spanish has a single lexical item for containment/support, it is possible that this single term may nevertheless be affected discriminately by extra-geometric i.e. location control manipulations, even though the term still may be the most appropriate within that language for those relations. Such a finding would be strong evidence for FGF across languages regardless of different numbers of lexical items across languages.

2.1.1 Method

Each language group (English, Spanish and Finnish) was given exactly the same scenes to rate. However, the locational sentences that were presented under each picture were of course different for each group according to the specific language in question. Hence, the main manipulations for each experiment are the same across languages except in the ad-position factor which is reported separately for each language.

2.1.1.1 Participants

The seventeen English participants were undergraduate psychology students from The University of Plymouth and they received course credit for their participation. The seventeen Spanish paid participants from diverse parts of Spain, had been studying for no more than three years in England (also at the University of Plymouth). Therefore, although they were reasonably competent in their second language (English), it was unlikely that their native Spanish had deteriorated substantially. We also considered that due to this reason it was unlikely that their mother-tongue would have yet been substantially contaminated by English. The seventeen Finnish participants were tested in Finland and their ages ranged from 20-50. All participants were native speakers of their respective languages, although most of them were more or less proficient in at least the English language as their second language. Recruitment was achieved via the psychology department notice-board, via e-mail through the international office and through word of mouth.

2.1.1.2 Materials

Experiment One employed a total of 12 scenes (see figure 2.x) that were created by using a combination of drawings and clipart. This Experiment was part of a series of eight cross-linguistic experiments (the experiments reported below) that were all administered at once (eighty-five scenes in the full experimental series). All of the scenes consisted of simple pictures with 7-point rating-scales (1 = the sentence is totally inappropriate in describing the scene; to 7 = the sentence is totally appropriate in describing the scene) with the locational sentences to be rated underneath. The whole series of eight experiments were administered in a fully randomised order to avoid carry-over effects, and as a precautionary measure against participants falling into a habit of giving the same response across scenes.

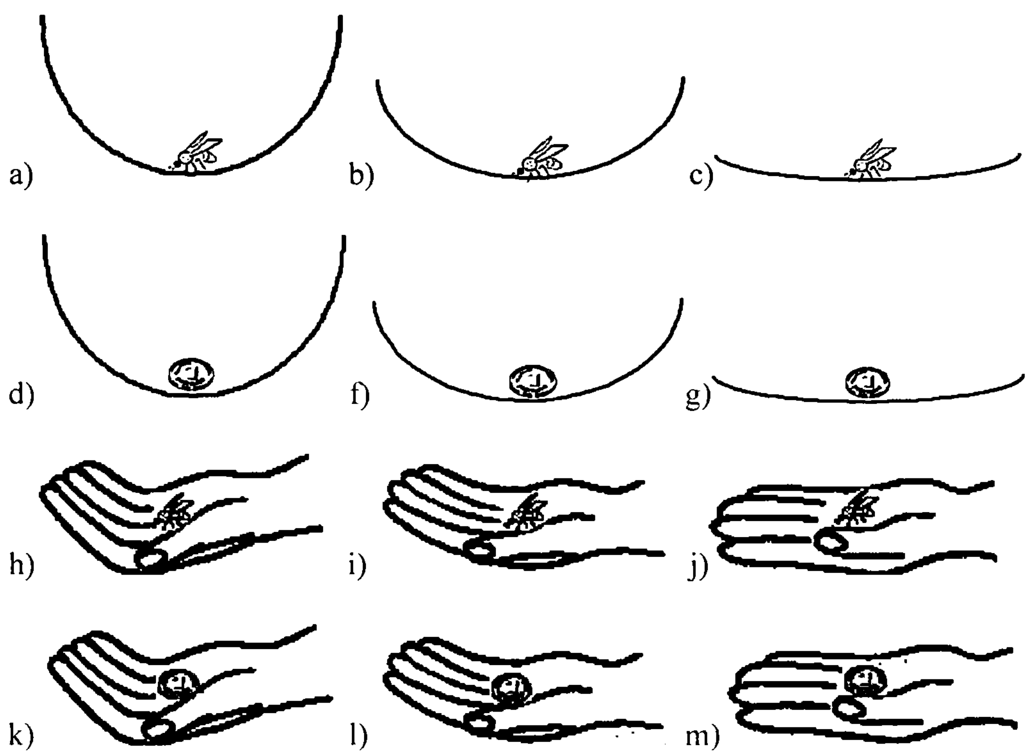


Figure 2.2 All twelve scenes from Experiment One

2.1.1.3 Procedure

Each participant received an individual test packet containing all eight experiments in their native languages. The whole test was a pencil and paper task. The English participants signed up to do the tests at a specified time-slot and location. They were monitored by the experimenter and advised not to consult with one another. The payment took place after the testing session was over. Unfortunately, it was not possible to gather all of the Spanish and Finnish participants into a joint location. Therefore, the test-packets were handed out to each participant separately for completion in their own time at home. On collection of the packet each participant was asked to read the instructions and to clarify any resulting queries. They were also advised not to discuss their ratings amongst one another if they happened to be acquainted with other participants, and urged to return their test-packets personally, and on receipt of signature were paid for their assistance.

2.1.1.4 Design

All of the three languages display a similar design of manipulated levels in all four factors. A 2 (located object) x 2 (reference object) x 3 (concavity) x 2 (ad-positions) within-participants design was used for the investigation.

2.1.1.4.1 Main Manipulations

Factor 1: Located object

Two levels of figure object animacy were used (see Figure 2.2). The located object was either a fly or a coin.

Factor 2: Reference object

Two levels of reference object animacy were manipulated (see Figure 2.2). The reference object that was displayed was either a dish or a hand.

Factor 3: Concavity of reference object

Three levels of concavity were used (see Figure 2.2).

Factor 4: Ad-position of sentence

There were two levels of ad-positions in use in which each of the three language groups (English, Finnish, and Spanish) viewed sentences in their native languages. The two English sentences under each scene were of the form: 'The fly/coin is *in* the dish/hand'. The Finnish equivalents were in the form of case conjugations as that is what is more commonly used in Finnish rather than prepositions or postpositions. The two Finnish sentences under each scene were of the form: 'Kärpänen/kolikko on astia-*lla*/käde-*llä*'. Finally, in the Spanish section of this experiment *en* is really the main focus of interest because its approximate translation is the English *in* and *on*. *Sobre* (translates to *above/over*) was added however to investigate whether as the next closest lexical item it would show an interesting effect pattern. The two Spanish sentences under each scene were of the form: 'La mosca/moneda está *en* la fuente/mano'. The specific ad-positions that were rated by the language groups are reported in Table 2.1.

Table 2.1 *The three ad-positions used for each language group in Experiment One*

English	In	On	-------------------
Finnish	-ssa	-lla	-------------------
Spanish	En		Sobre (over)

2.1.2 Results

In this experiment a repeated measures Analysis of Variance (ANOVA) was carried out separately for each language group. The chosen alpha level is .05 throughout all the statistical analyses in this thesis. Throughout the cross-linguistic section of this thesis, Tukey (HSD) was the follow-up analysis of choice when further investigation was required. The results of each separate four-way ANOVA are reported individually below for each language group in separate sections preceded by tables of Mean ratings. Furthermore, the full ANOVA tables can be found in Appendix One.

2.1.2.1 ENGLISH

The mean ratings by condition are displayed in Table 2.2.

Table 2.2 *The mean ratings of the English group for each condition in Experiment One(N=17).*

Located Object	Reference Object	Concavity	Ad-position *In*	Ad-position *On*
Coin	Dish	Least	6.47	3.24
		Medium	6.47	4.00
		Most	5.76	4.35
	Hand	Least	6.12	4.59
		Medium	6.06	5.29
		Most	4.47	5.59
Fly	Dish	Least	5.82	4.00
		Medium	5.82	4.06
		Most	5.24	5.47
	Hand	Least	5.47	5.88
		Medium	4.29	6.12
		Most	4.24	6.29

There were no significant main effects. However, there was a significant two-way interaction between Located Object x Concavity $F(2,3) = 5.28$, $p<0.05$, MSE = 0.81 (Figure 2.3). The fly seemed to receive slightly higher ratings than the coin in both the most concave (fly M =5.29; coin M = 5.10) and least concave conditions (fly M = 5.31; coin M = 5.04), whereas, in the medium concavity condition the coin (M = 5.46) was rated higher than the fly (M = 5.07). These effects were however collapsed across both the ad-position and reference object conditions.

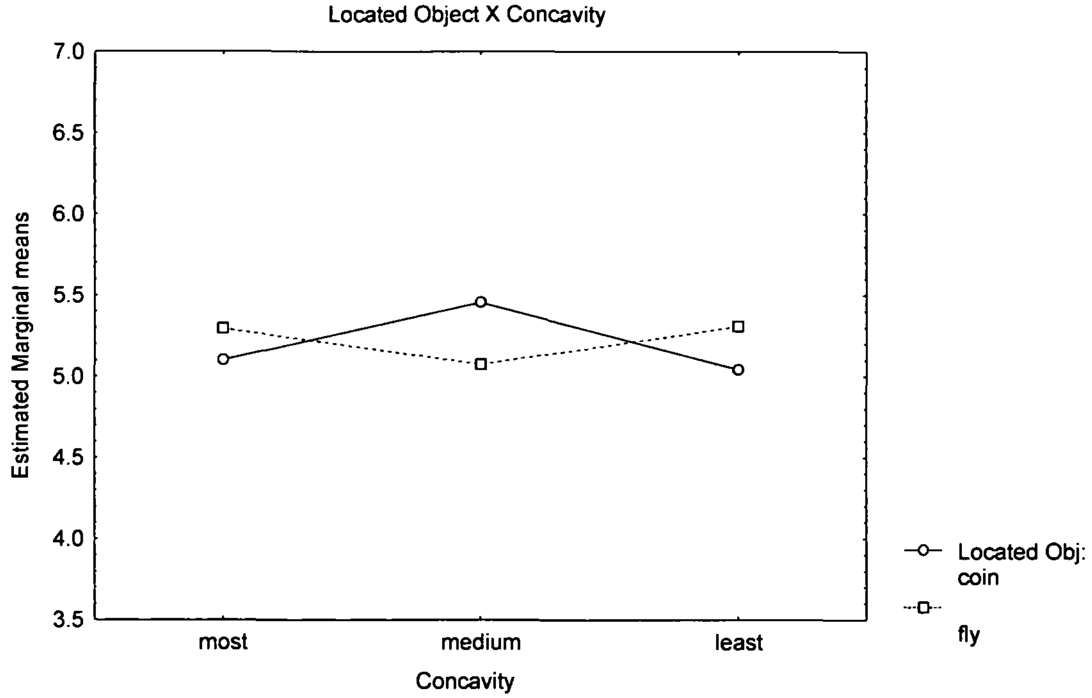


Figure 2.3 The significant English interaction between Located Object x Concavity in Experiment One.

There were also further two-way interactions which involved the Ad-position factor and these merit discussion in more detail. The significant Reference Object x Ad-position interaction $F(1,16) = 12.98$, $p<0.01$, $MSE = 10.08$, shows a significantly ($p< 0.01$) higher preference for *in* (M = 5.93) in comparison to *on* (M = 4.19) when the reference object was a dish (Figure 2.4). In contrast, when the reference object was a hand both ad-positions (*in:* M = 5.11; *on:* M = 5.63) were rated at a similar level ($p>0.05$). Importantly, there was no support for the hypothesis that *in* would be rated higher for the potentially animate reference object condition than for the static reference object condition, as the pattern is opposite to predictions although not significantly ($p>0.05$).

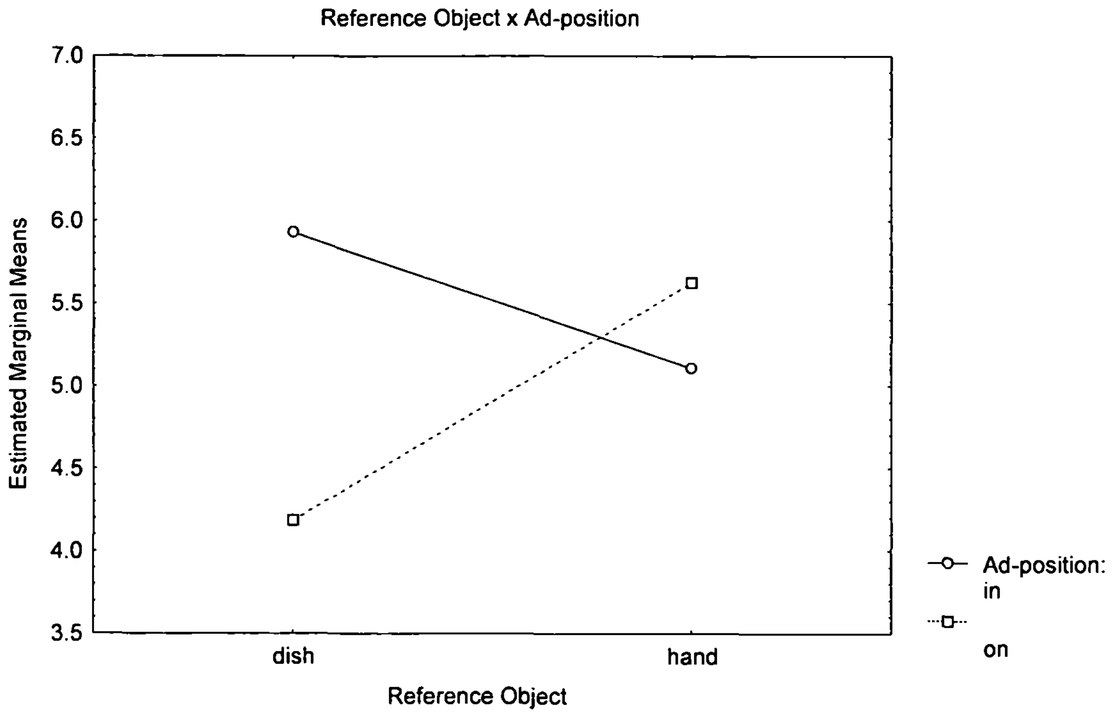


Figure 2.4 The significant English interaction between Reference Object x Ad-position, Experiment One.

There was also a significant <u>Located Object x Ad-position interaction</u> $F(1,16) = 11.47$, $p<0.01$, MSE = 5.27 (Figure 2.5). When the located object was a coin *in* (M = 5.89) received significantly higher ($p< 0.01$) ratings than *on* (M = 4.51). In contrast, when the located object was a fly there was no significant ($p>0.05$) preference between either *on* (M = 5.30) or *in* (M = 5.15) as the descriptor (Figure 2.3). Also, the difference between the rating levels for *in* when used to describe the coin in contrast to the fly did show mild support for the hypothesis, although not at a significant level ($p>0.05$), as there was an increase for rating levels when describing the static located object scenes rather than the scenes with a potentially mobile fly. Also, it may be that a fly is considered as just as appropriately described as *on* the reference object as *in* it because it will rarely be possible to exert as much location control over such a mobile object. Therefore, the uncertainty of location control allows the appropriate use of the weaker spatial relation depicted by *on* as well as the stronger descriptor *in*.

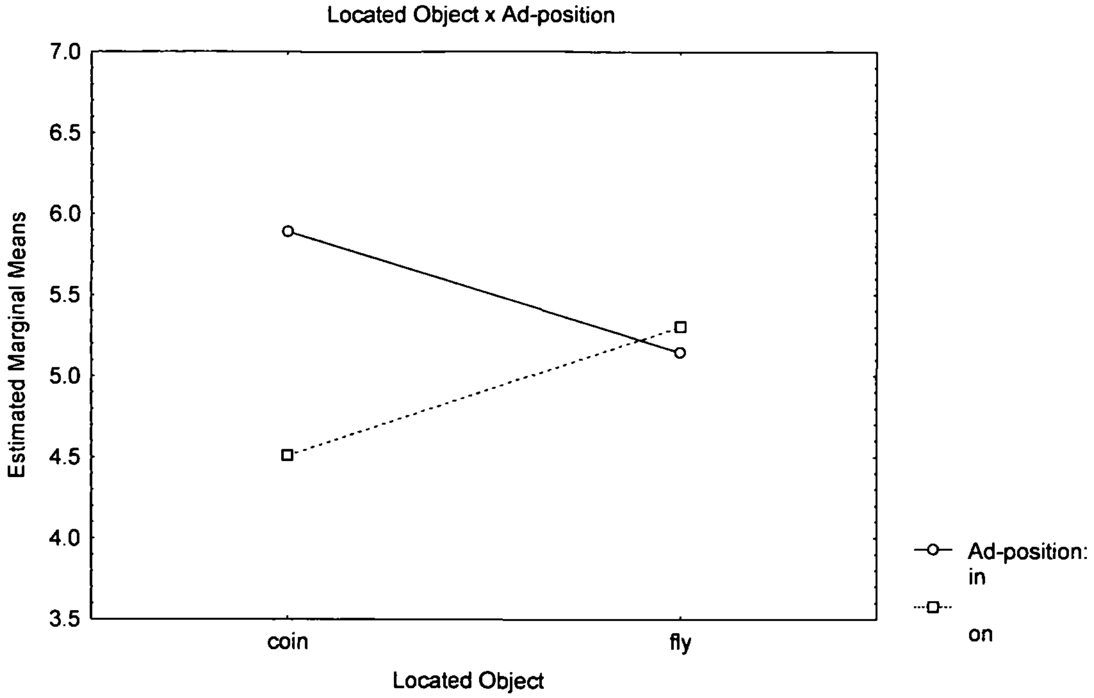


Figure 2.5 The significant English interaction between Located Object x Ad-position, Experiment One.

Finally, there was an interesting interaction between <u>Concavity x Ad-position</u> $F(2,32) = 11.11$, $p<0.001$, $MSE = 3.27$. As the concavity of the reference object *increased*, so did the rating for *in* (least concave: M = 4.93; medium concave: M = 5.66; most concave M = 5.97). The discrepancy was significant between the least and most concave conditions ($p<0.05$). Furthermore, as the concavity of the reference object *decreased, on* received increasingly high ratings (most concave: M = 4.43; medium concave: M = 4.87; least concave: M = 5.43) (Figure 2.6). Again this discrepancy was significant between the least and most concave conditions ($p<0.05$). This supports the hypothesis that when the reference object is most concave it would be perceived as more ideal for containment which is described by the ad-position *in*. In contrast, when the object is at its flattest it would be viewed as more suitable for support, therefore producing higher ratings for *on*. It should, however, be noted that only in the most concave condition is the preference of term *in* compared to *on* significantly higher ($p<0.001$).

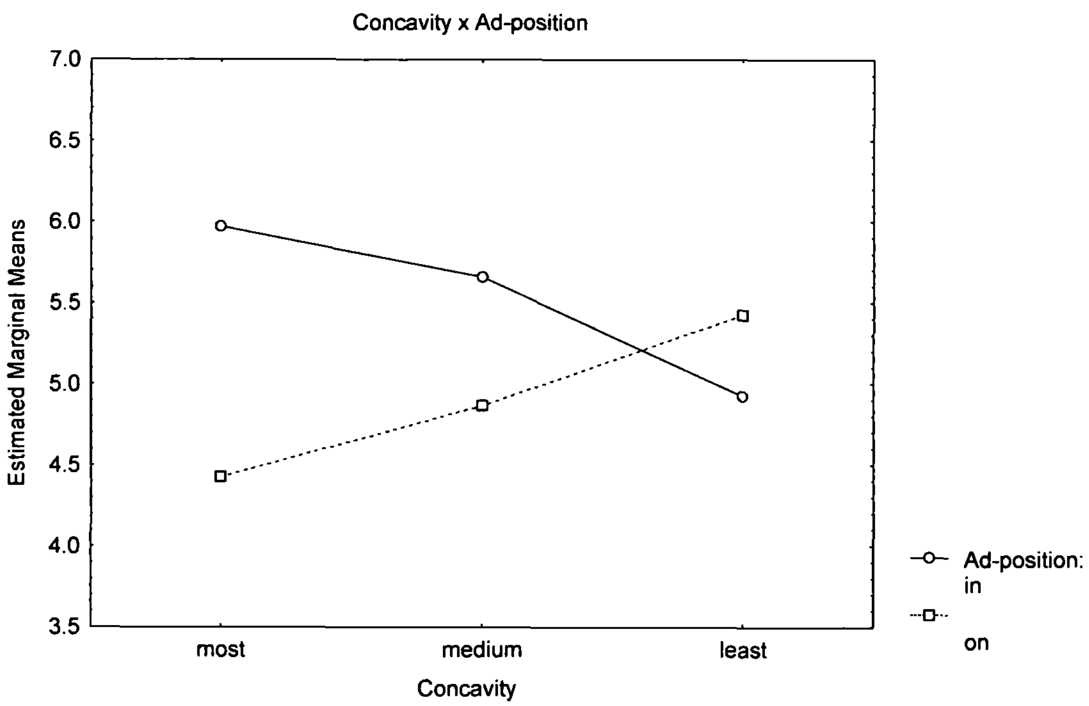


Figure 2.6 The significant English interaction between Concavity x Ad-position, Experiment One.

None of the other interactions were significant.

2.1.2.2 FINNISH

The mean ratings by condition are displayed in Table 2.3.

Table 2.3 *The mean ratings of the Finnish group for each condition in Experiment One(N=17).*

Located Object	**Reference Object**	**Concavity**	**Ad-position** *Ssa*	*Lla*
Coin	Dish	Least	6.65	3.41
		Medium	6.88	3.76
		Most	5.88	3.82
	Hand	Least	6.18	5.65
		Medium	6.35	5.94
		Most	5.94	5.76
Fly	Dish	Least	6.59	3.82
		Medium	6.76	4.18
		Most	6.29	4.29
	Hand	Least	6.29	5.82
		Medium	6.12	6.24
		Most	5.47	6.18

The significant main effect of Reference Object $F(1,16) = 6.85$, $p<0.05$, MSE = 9.51 was present, in which the hand (M = 6.00) was rated higher than the dish (M = 5.20) collapsed across all conditions.

There was also a significant main effect of Ad-position $F(1,16) = 8.25$, $p<0.05$, MSE = 23.47, where *–ssa* (*in* M = 6.28) was rated more highly across all conditions than *–lla* (*on* M = 4.91).

Furthermore, there was a significant interaction between Reference Object x Ad-position $F(1,16) = 25.59$, $p<0.001$, MSE = 6.23 (Figure 2.7). When the reference object was a dish there was a significant ($p<0.001$) preference to rate *–ssa* (M = 6.51) more highly than *–lla* (M = 3.88). However, when the reference object was a hand both *–ssa* (M = 6.06) and *–lla* (M = 5.93) had similar ($p>0.05$) rating levels which are more in line with the ratings given to *–ssa* in the dish condition. Importantly, there is no significant difference ($p>0.05$) in rating levels of –ssa between either the dish or hand conditions. This again would appear to be against the hypothesis predicting that the ad-position *-ssa* *(in)* would receive higher ratings when the reference object is potentially mobile enabling it to exert control over the location of the located object, rather than when it is static. Interestingly, the ad-position *–lla*, however, displays the significant (p<0.001) preference for describing the hand scenes in contrast to the dish scenes which was expected from *-ssa*.

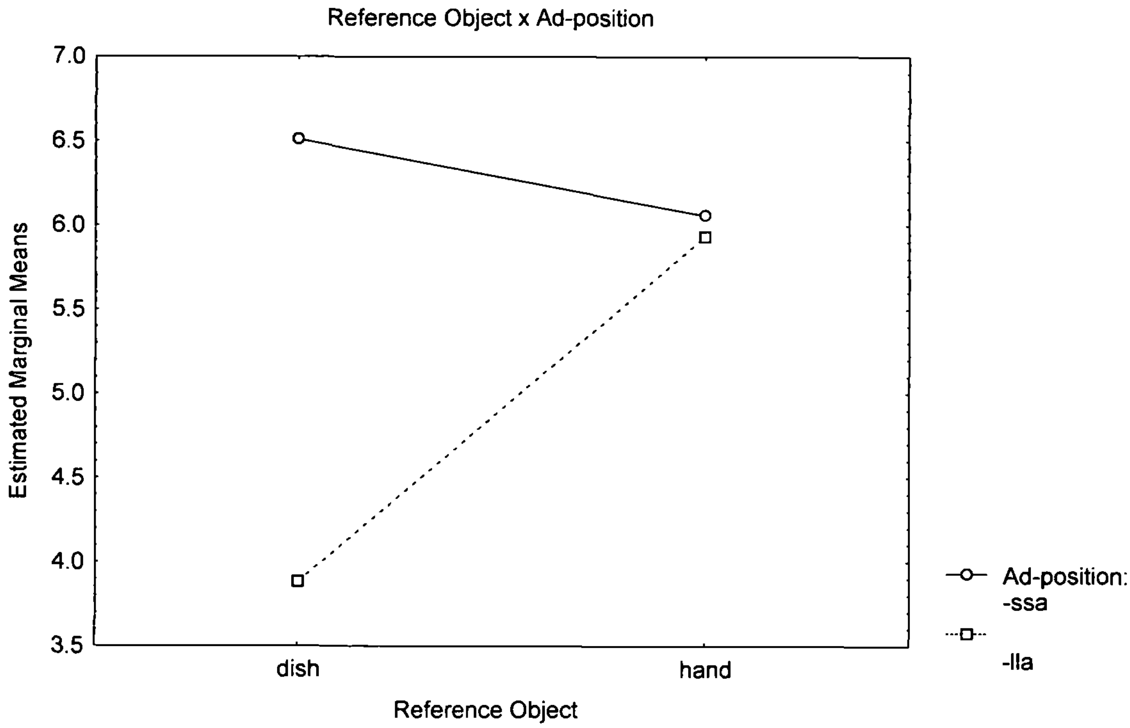


Figure 2.7 The significant Finnish interaction between Reference Object x Ad-position, Experiment One.

There was also a significant interaction between <u>Concavity x Ad-position</u> F(2,32) = 4.19, p<0.05, MSE = 1.62 (Figure 2.8). In the Most and Medium levels of concavity *-ssa* received similar ratings (most: M = 6.43; medium: M = 6.53), whereas in the least concave level *–ssa* (M = 5.90) was rated lower but not at quite a significant level (p=0.067). This provides some support for the prediction that *–ssa* would be most appropriate for describing spatial relationships that depict containment. Furthermore, a reverse pattern was found for the ad-position *-lla* . In the least (M = 5.01) and medium (M = 5.03) concave conditions the ratings for *–lla* were similar, while *–lla* was rated lower (but not significantly; p>0.05) for the most concave level (M = 4.68). This also provides some tentative support for the hypothesis that *–lla* would be most suitable for describing a relationship in which the reference object supports the located object. It is worth noting though that this interaction mirrors the main effect of Ad-position in which *–ssa* is rated more highly than *–lla* overall, therefore somewhat buffering the effects of concavity. Indeed, post-hoc analyses indicate that in the concavity x ad-position interaction the ad-position *–ssa* is rated significantly ($p<0.05$) higher than *–lla* at all levels of concavity.

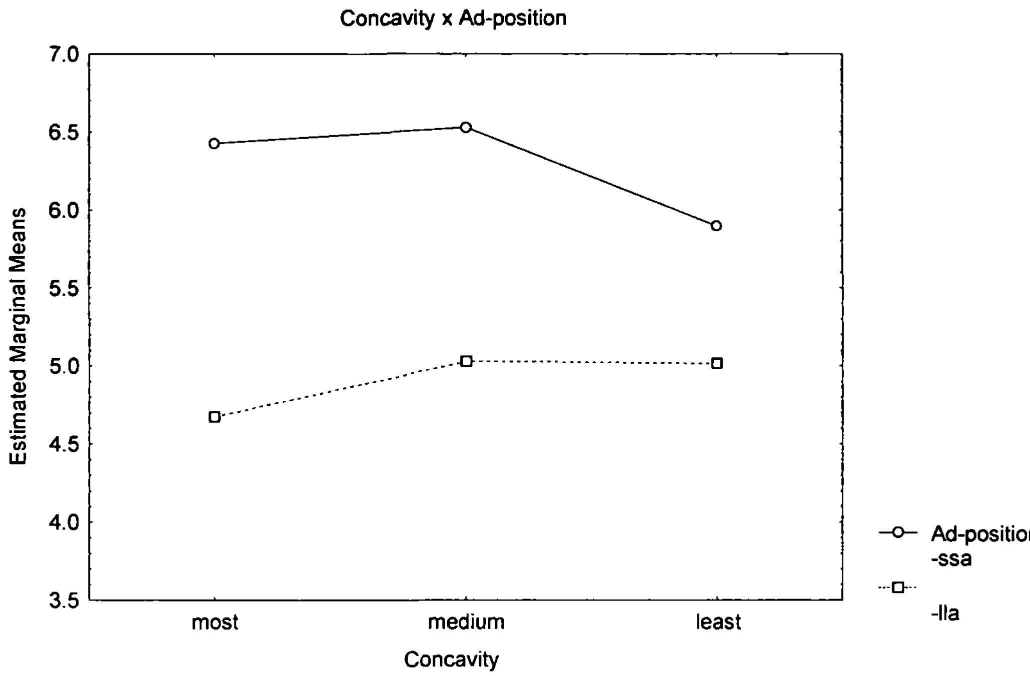


Figure 2.8 The significant Finnish interaction between Concavity x Ad-position, Experiment One.

The interaction between located object animacy and ad-position was not significant, nor were there any other significant interactions found for the Finnish language group.

2.1.2.3. SPANISH

The mean ratings by condition are displayed in Table 2.4.

Table 2.4 *The mean ratings of the Spanish group for each condition in Experiment One(N=17).*

Located Object	**Reference Object**	**Concavity**	**Ad-position** *En*	*Sobre*
Coin	Dish	Least	6.47	3.29
		Medium	6.53	3.24
		Most	5.94	3.76
	Hand	Least	6.35	5.71
		Medium	6.24	5.65
		Most	6.00	6.00
Fly	Dish	Least	6.06	3.94
		Medium	6.35	4.06
		Most	6.12	4.76
	Hand	Least	6.41	5.59
		Medium	6.41	5.59
		Most	6.24	6.12

There was a significant main effect of Reference Object $F(1,16) = 21.35$, $p<0.001$, $MSE = 4.55$, in which the dish ($M = 5.04$) received clearly lower ratings than the hand ($M = 6.02$) in general across all conditions.

As expected a significant effect of Ad-position $F(1,16) = 25.23$, $p<0.001$, $MSE = 7.78$ was also present, with *en* ($M = 6.22$) being rated significantly higher than *sobre* ($M = 4.84$). This was in accordance with the direct translation of *en* being both the English *in* and *on*, whereas *sobre* can be best described as *over* in English.

Additionally, there was a significant two-way interactions between Reference Object x Ad-position $F(1,16) = 15.76$, $p<0.001$, $MSE = 6.66$ (Figure 2.9). In scenes with the hand as reference object both *en* ($M =6.21$) and *sobre* ($M = 5.83$) received very similar ratings, however, when the scenes had a dish *sobre* ($M= 3.84$) had significantly ($p<0.001$) lower ratings than *en* ($M = 6.20$). No support was gained for the hypothesis, as *en* showed no increase in ratings ($p>0.05$) for the scenes involving a dish when compared with scenes depicting a hand.

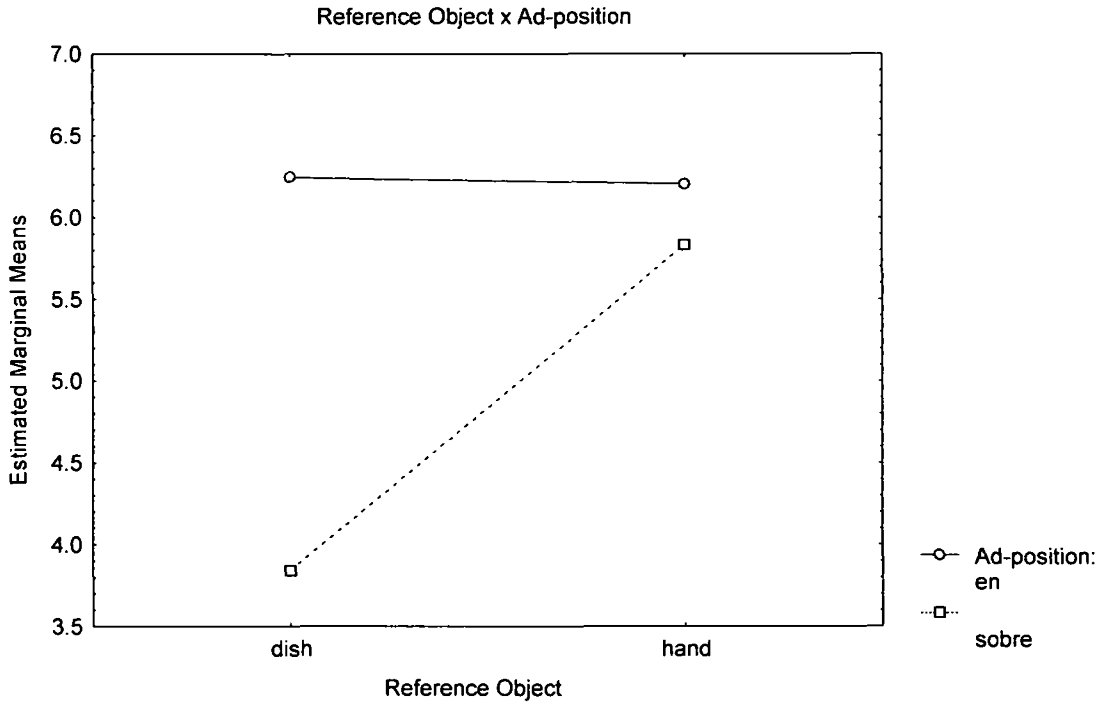


Figure 2.9 The significant Spanish interaction between Reference Object x Ad-position, Experiment One.

There was also a significant interaction between <u>Concavity x Ad-position</u> $F(2,32) = 5.08$, $p<0.01$, $MSE = 1.16$ (Figure 2.10). In general *en* is the significantly ($p<0.05$) preferred ad-position in all levels of concavity (most concave: M = 6.32 ; medium concave: M = 6.28; least concave: M = 6.07) which was expected. In contrast, *sobre* is the less preferred ad-position showing similarly low ratings in all levels of concavity with only some elevation in ratings for the least concave condition (most concave: M = 4.63; medium concave: M = 4.72; least concave: M = 5.16). This suggests that although *sobre* is the less appropriate ad-position generally, it somewhat mirrors the effect pattern of the English ad-position *on* in that as concavity lessened *sobre* became more acceptable as a descriptor. The increments in which the ratings became more favourable for *sobre* were, however, only nearly significant ($p=0.073$) when comparing the most concave conditions with the least concave conditions. Also, as expected the ad-position *en* does not discriminate between levels of concavity.

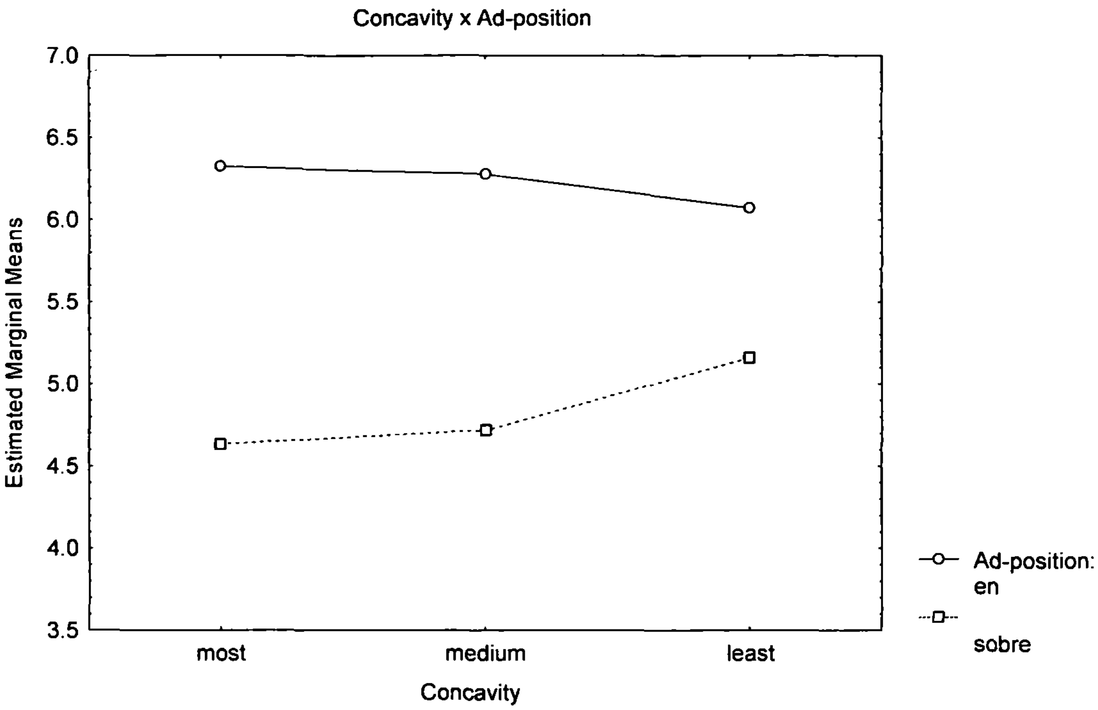


Figure 2.10 The significant Spanish interaction between Concavity x Ad-position, Experiment One.

There was also a marginally significant $F(1,16) = 4.42$, $p = .052$, $MSE = 1.56$ interaction between Located Object x Ad-position, the interaction pattern is displayed in Figure 2.11. It is worth noting that *en* receives very similar high ratings across located object conditions, therefore not showing support for the hypothesis. However, there is an elevation for the ratings of *sobre* when the located object is a fly. This may very well be due to the fact that *sobre* translates to *over* in English hence communicating the potential for an object to progress to a higher location and out of contact with the surface of the reference object.

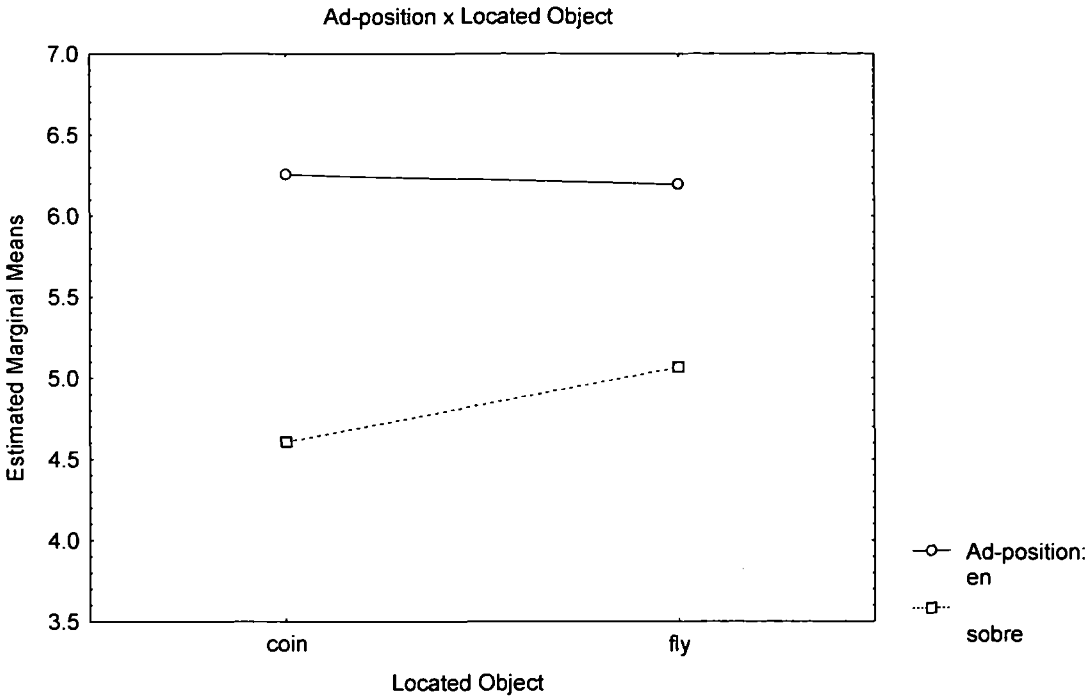


Figure 2.11 The marginally significant Spanish interaction between Figure Object x Ad-position, Experiment One.

2.1.3 Discussion (Experiment One)

A summary of all the main-effects and interactions that were found in Experiment One across all three language groups can be found below in Table 2.5.

***Table 2.5** Significant main effects and interactions across language groups in Experiment One (coin/fly).*

	English	Finnish	Spanish
Main Effects			
Figure Object			
Reference Object		X	X
Concavity			
Ad-position		X	X
2-way interactions			
Fig. Obj. x Ref. Obj.			
Fig. Obj. x Concavity	X		
Fig. Obj. x Ad-position	X		(x) nearly
Ref. Obj. x Concavity			
Ref. Obj. x Ad-position	X	X	X
Concavity x Ad-position	X	X	X
3-way interactions			
Fig. Obj. x Ref. Obj. x Concavity			
Fig. Obj. x Ref. Obj. x Ad-position			
Fig. Obj. x Concavity x Ad-position			
Ref. Obj. x Concavity x Ad-position			
4-way interactions			
Fig. Obj. x Ref. Obj x Concavity x Ad-position			

The experimental hypotheses about the effects of degree of concavity on the appropriateness of ad-position, were generally supported by the results from all three language groups. As expected the ad-position *in* was rated as most appropriate when describing scenes in which the reference object was at its most concave level; the next highest ratings for *in* were found in the medium concave condition; while the lowest ratings for *in* were apparent for the least concave condition. The ad-position *on* illustrated an opposite pattern in which the less concave the reference object was, the higher the appropriateness ratings were for describing the scene. This type of graded effect pattern for concavity was not as visible for the equivalent Finnish ad-positions *(-lla,-ssa*), although the effect was in the predicted direction even though not at quite significant levels. This supports the notion that *in* (*-ssa*) is most appropriate for describing scenes in which the reference object is displayed at a great enough concavity level to be perceived as suitable for containment. Also, the findings are in accord with the proposal that *on* (*-lla*) is most appropriate for describing scenes in which the reference object is displayed at a low concavity level and therefore perceived as ideal for the function of support. The results suggest, however, that while the direction of the effect of concavity was similar for both English and Finnish there was a cross-linguistic difference in lexical sensitivity, as only the English group displayed significant levels of discrimination. Finally, as predicted the Spanish ad-position *en* (*in/on*) displayed equally high appropriateness ratings when describing scenes displaying the reference object at any of the three levels of concavity. Additionally, although *sobre* (*over*) illustrated low rating levels across all conditions of concavity there was slight elevation in rating levels when the scene displayed the reference object at its least concave condition when compared with the most concave condition. Although this discrepancy was only marginally significant, some support was gained for the prediction that since *sobre* could translate to *over* there may be a similar semantic background with the

English lexical item, and it may be interpreted to be appropriate for describing scenes in which the located object is not just higher than the reference object but also in contact with its surface (English example: The tablecloth is over the table).

The hypothesis for the effects of located object animacy on ad-position appropriateness was only supported tentatively by the results from the English group, as the Finnish analysis produced no significant effects for this interaction and the Spanish group had only a nearly significant interaction which did not show a pattern in the direction of predictions. The interaction for the English group was however in the expected direction, as *in* was rated as more appropriate when describing spatial relations between the reference object and the static located object (coin) than when the scene depicted a potentially animate located object (fly). However, this result cannot be considered a replication of Feist's findings for influence of the animacy of the located object, as none of the language groups produced this effect apart from the English group, and even that was not quite at a significant level.

The hypothesis about the effect of reference object animacy on the appropriateness of ad-positions did not receive any support across languages. The prediction was that the ad-position *in*, Finnish *-ssa* or Spanish *en* would be rated higher for the conditions in which the reference object is potentially animate, and therefore able to exert control over the location of the located object than when it is static. In fact the results for the English group displayed an interaction which was quite the opposite as *in* was rated higher when the scene displayed a static reference object (dish) than when it had a potentially animate one (hand). In contrast, *on* was rated higher when the scene depicted a hand than when it showed a dish. These effects were thought to be partially a result of the choice of static reference object and the effects of linguistic routines. Additionally, no support was provided for the reference object animacy hypothesis by the results for the Finnish group, as *–ssa* (*in*) showed hardly any difference in rating levels between either animate or static reference object conditions. In contrast, *-lla* (*on*) displayed a similar effect to that found for the English group illustrating higher ratings for the hand scenes than for the dish scenes. This is likely to be especially due to the effect of language since it is notably more awkward to say something is astia-*lla* (on the dish) than astia-*ssa* (in the dish); whereas regardless of potential animacy of a hand it would be common to hear people say that something is either käde-*ssä* (in the hand) OR käde-*llä* (on the hand). Also, no support for the hypothesis was found in the analysis for the Spanish group since *en* did not display any discrimination between levels of reference object animacy. The fact that we did not even find anything in English as might have been expected in relation to Feist's results, suggests that the result of the animacy of the reference object is somewhat fragile.

It is important to note that no support was found for the reference object animacy hypothesis cross-linguistically, and that the labelling condition used by Feist was eliminated in the present Experiment One. It is possible that because Feist gave the inanimate ambiguous object several different names (i.e. plate, dish, bowl) it caused *in* to be viewed as the less appropriate word for describing the scene when collapsed across labelling conditions. For example, if you were to describe a scene with something that has been labelled something that is inanimate but not an ideal representative of containment (e.g. 'the fly/coin is in the rock') it is possible that describing the figure as *in* the reference object would not feel appropriate. This provides a rational explanation for the preference to describe a fly or coin to be *in* a hand rather than *in* i.e. a plate in the current study; from this it is possible to infer that the choice of materials and labels may have produced the present differences between the experiment reported here and Feist's work.

2.2 Rationale and Design for Experiment Two

The second experiment manipulated location control for support and containment relations in a second way – by manipulating the degree of alternative control of the located object, following the work of Garrod, Ferrier and Campbell (1999). The Garrod et al. experiments were overviewed in Chapter 1, but more details are provided here as the materials were adapted for the present experiment across languages.

Garrod and colleagues have looked at the importance of geometry and location control and how they influence the appropriateness of spatial terms as descriptors. They ran two experiments showing video-clips of static scenes with a glass bowl containing ping-pong balls. A black ball was used as the located object and the reference object was a glass bowl which was always at the same rather deep level of concavity. One of the manipulations was the five different levels at which the located object was displayed (Figure 2.12). This could either be directly touching the bottom of the bowl or half way to the middle of the interior of the bowl, or just under the rim of the bowl, or at two levels above the rim of the bowl. The black located object was a ball which was either supported or contained on and amongst a number of white balls, or it was portrayed at the same geometric locations but without the support of the white balls. The control manipulation was achieved by either showing the located object attached to an outside source of control (thin piece of wire suspended above the bowl) or without. When a source of external control is provided it impinges on the location control exerted over the located object by the reference object.

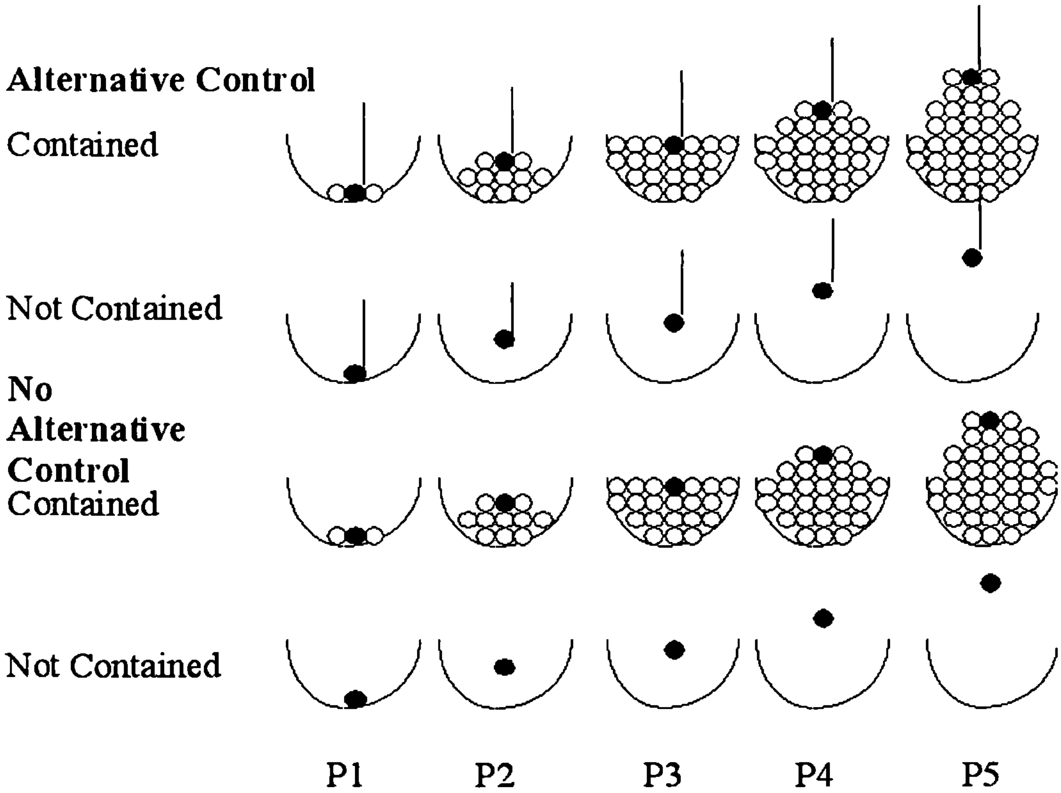


Figure 2.12 Schematic representation of the scenes from the experiment by Garrod, Ferrier and Campbell, 1999.

Participants were divided into two different conditions. One group of participants was shown each scene and simply asked to make a judgement about what would happen to the located object if the bowl was moved from side to side. The second group of participants viewed the same scenes and were then asked to give ratings for a selection of sentences containing spatial prepositions ('The ball is *in/on/over*... the bowl'). The results from the two different groups were correlated to see whether the viewers' confidence in describing the black ping-pong ball as being *in* the bowl was directly related to the degree they judged the container to be exerting location control over the figure object (Figure 2.13). When the figure object was at or above the rim of the bowl external control and containment were found to have strong influences on both the control judgement group and the sentence evaluation group. In general the higher the figure object was located the more the ratings for *in* decreased when the figure object was not contained or attached to an external source of control. However, when the figure was located below the rim of the bowl only the control judgement group seemed to be affected by the influences of external control and containment.

In contrast, the sentence evaluation group gave high appropriateness ratings irrespective of the manipulation of external control or containment conditions. The analyses of the *in* ratings (this was a separate analysis) revealed that the alternative control manipulations were important only for higher positions of the located object. Therefore, the strong correlation that was present suggested that location control is an important factor for understanding containment when the contents are not being completely enclosed by the reference object.

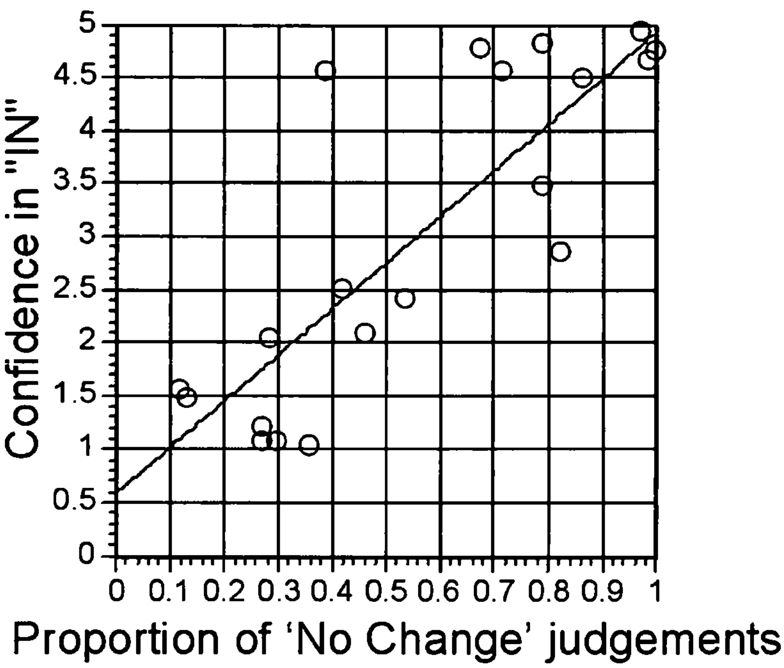


Figure 2.13 Correlation between perceived locational control and 'in' ratings (adapted from Garrod, Ferrier and Campbell, 1999).

The present Experiment Two, although strongly modelled on the work by Garrod et al. (1999) outlined above, made some modifications to the design. The sentence rating task was presented in paper and pencil format with line drawings of scenes of glass bowls and plates containing apples with a pear as located object. By contrasting a plate with a bowl as reference object in line with the Garrod et al. study, the intention was to investigate whether external control would influence the appropriateness ratings of '*on* the plate' in a similar way to '*in* a bowl'. Also, a tilted condition was included to look into another potentially detrimental factor to location control as uncovered by Coventry (1992, 1998) and Ferrier (1996) The intention was to examine how tilting compares with the influences of the external control of a wire suspended from the located object in compromising location control.

The present experiment does not have as many levels in which the figure object is positioned. Only the levels in which the figure object is just below the rim of the container and two levels which are at increasing heights above the rim have been included, due to their previously identified sensitivity to manipulation of location control. Again, the most notable alteration in design is that this experiment has been extended to include not only English, but also the Finnish and Spanish languages.

The most straight forward prediction was that when a plate, which is usually conceptualised as a support object, is in a scene *on/-lla* would be the preferred terms for describing the scene. Additionally, when a scene has a bowl which implies a containment relationship *in/-ssa* would be a more appropriate descriptor. However, the Spanish ad-position *en* was expected to be rated at an equal level regardless of whether a bowl or a plate are displayed in a scene. This again is because *en* can be translated roughly to English as having a combined meaning of both *in* and *on*. The second and third predictions were that the introduction of <u>external control</u> to the scene, or the positioning of the reference object at a <u>tilted angle</u>, would compromise the location control of the reference object. This would result in a decrease of acceptability in the spatial terms *in/on*, and the Finnish *(-lla/-ssa)* and Spanish (*en*) equivalents. Also, the higher the level at which the located object was placed above the rim of the container was hypothesised to influence the ratings for *in* detrimentally and the Finnish *(-ssa)* and Spanish (*en*) equivalents.

Finally, introducing both external control and/or a tilt to the scene was predicted to affect the ratings for *in/on* and their Finnish *(-ssa/-lla)* and Spanish equivalents (*en*) in an increasingly detrimental fashion as the located object height on the pile of fruit increased. This type of result would indicate that participants perceive that the higher the located object was in a bowl or a plate, the more vulnerable it was to the introduction of a disruptive influence on the location control of the reference object. In other words, the located object is thought to be more in danger of moving independently of the reference object when the pear is high on a pile of fruit in i.e. a tilted dish.

2.2.1 Method

The administration of Experiment Two is exactly as in Experiment One. Again the three language groups (English, Spanish and Finnish), consisting of 17 participants each, were given the same scenes to rate. The same groups of participants were used throughout the cross-linguistic test series.

2.2.1.1 Materials

Experiment Two had a total of 24 scenes that were created by using a combination of drawings and clipart (see Figure 2.14). This Experiment was part of a series of eight cross-linguistic experiments that were all administered at once (eighty-five scenes in the full experimental series).

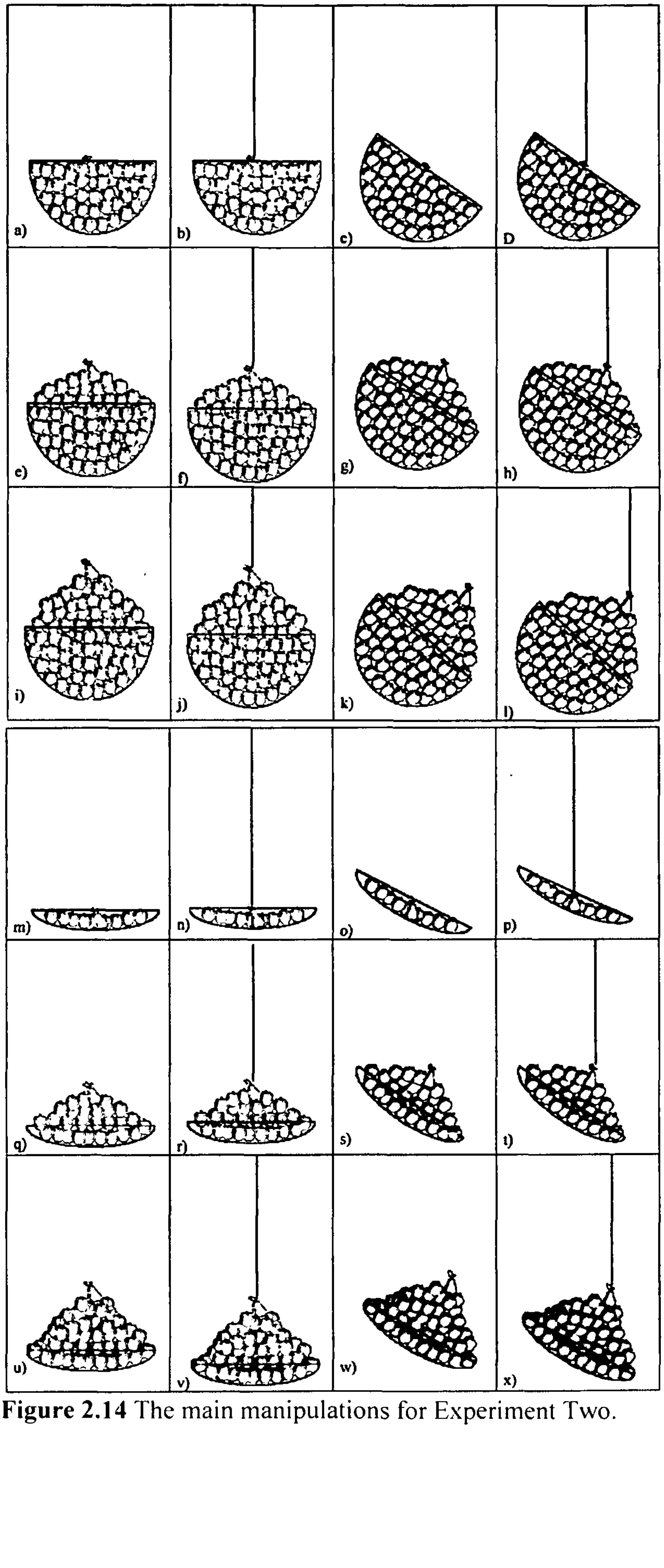


Figure 2.14 The main manipulations for Experiment Two.

2.2.1.2 Procedure

The procedure of administration of Experiment Two was identical to that of Experiment One.

2.2.1.3 Design

The five factor design used in this experiment was the same for all factors across languages apart from differing numbers of levels in the fifth factor. A 2 (reference object) x 3 (height) x 2 (angle) x 2 (control) x 4, or 3 (ad-position) within participants design was used for the investigation (see Table 2.6).

2.2.1.3.1. Main Manipulations

Factor 1: Reference object

Two levels of reference object were used. The reference object filled with apples and a pear was either a transparent bowl, or a plate and also labelled as these objects (see Figure 2.14).

Factor 2: Height of pile

Three levels of height were manipulated in the scenes (see Figure 2.14).

Factor 3: Angle of reference object

Two levels of angle were used (see Figure 2.14). The angle of the reference object was manipulated by displaying the reference object (plate or bowl) either with its rim in a level position (canonical) or at a 45° angle (tilted).

Factor 4: Locational control

The locational control of the bowl was investigated at two levels (see Figure 2.14). In the 'external control' condition the located object was depicted with a string vertically attached to the top, whereas in the 'no control' condition there was no string attached to the located object.

Factor 5: Ad-position of sentence

There were four levels of ad-positions in use for the English group (see Table 2.6). The four English sentences under each scene were of the form: 'The pear is *in* the bowl/plate'. There were also four levels of ad-positions in use for the Finnish group (see Table 2.6). The four Finnish sentences under each scene were of the form: 'Päärynä on kulhon/lautasen *yllä'* when an ad-position was being used; or 'Päärynä on kulho-*lla*/lautase-*lla'* when a case conjugation was used. Finally, there were only three levels of ad-positions in use for the Spanish group (Table 2.6). The three Spanish sentences under each scene were of the form: 'La pera está *en* el cuenco/plato'.

Table 2.6 *The ad-positions used for each language group in Experiment Two*

English	In	On	Above	Over
Finnish	-ssa	-lla	Yllä	Yläpuolella
Spanish	En		Sobre	Encima

2.2.2 Results

In this experiment a repeated measures Analysis of Variance (ANOVA) was carried out separately for each language group. The chosen alpha level is .05 throughout all the statistical analyses in this thesis. The results of each separate five -way ANOVA are reported individually below for each language group in separate sections preceded by tables of Mean ratings. Furthermore, the full ANOVA tables can be found in Appendix One.

2.2.2.1 ENGLISH

The mean ratings by condition are displayed in Table 2.7.

Table 2.7 *The mean ratings of the English group for each condition in Experiment Two (N=17).*

Reference Object	Height	Angle	External Control of Figure	AD-POSITION *above*	*On*	*in*	*Over*
Bowl	High	Canonical	Control	6.00	3.76	3.94	5.18
			no Control	5.53	2.47	4.29	5.29
		Tilted	Control	4.53	2.82	4.06	4.53
			no Control	4.71	2.82	4.29	4.53
	Low	Canonical	Control	2.88	2.71	6.47	2.71
			no Control	2.35	2.76	6.65	1.76
		Tilted	Control	2.53	2.88	6.00	2.82
			no Control	1.41	2.59	6.65	1.94
	Medium	Canonical	Control	5.59	3.59	4.71	5.29
			no Control	5.12	3.12	4.35	5.12
		Tilted	Control	5.00	3.18	4.29	4.59
			no Control	4.71	3.35	4.53	4.65
Plate	High	Canonical	Control	5.82	4.18	3.24	5.35
			no Control	5.00	4.35	3.29	4.94
		Tilted	Control	4.18	4.29	2.82	4.59
			no Control	3.88	3.82	2.82	4.47
	Low	Canonical	Control	2.06	5.12	5.12	2.76
			no Control	1.82	5.47	5.24	2.18
		Tilted	Control	2.24	4.12	5.59	2.18
			no Control	2.29	5.29	5.18	2.47
	Medium	Canonical	Control	5.00	4.06	2.71	5.06
			no Control	4.65	4.24	4.18	4.06
		Tilted	Control	4.00	4.41	3.18	5.18
			no Control	3.82	4.47	3.47	4.12

There was a significant main effect of Height $F(2,32) = 13.14$, $p<0.001$, MSE = 6.90. Higher ratings were given for High (M=4.24) and Medium (M=4.31) conditions than Low (M=3.57) conditions. This slightly surprising effect could result from the fact that this is collapsed across all ad-positions, therefore if the ratings for *over* and *above* are high in the higher level positions then this would explain inflated ratings. Also, there was a significant main effect of Angle $F(1,16) = 5.18$, $p<0.05$, MSE = 7.94, in which the straight (M=4.20) condition was given higher ratings than the tilted (M=3.88) condition and this was in accord with the hypotheses.

There was an interaction between <u>Reference Object x Height</u> $F(2,32) = 3.50$, $p<0.05$, $MSE = 2.90$, in which the high and medium conditions received significantly higher ratings ($p<0.05$) than the low condition regardless of whether the reference object was either a bowl or a plate (see Figure 2.15). However, there seems to be a slight (although not significant, $p>0.05$) preference to rate the bowl more highly than the plate for the high (M=4.30 for bowl, M=4.19 for plate) and medium (M=4.45 for bowl, M=4.16 for plate) conditions, whereas in the low condition the plate (M=3.70) gets higher ratings than the bowl (M=3.45) (again not significant, $p>0.05$). This pattern in the interaction again may be due to collapsing across all levels of ad-position.

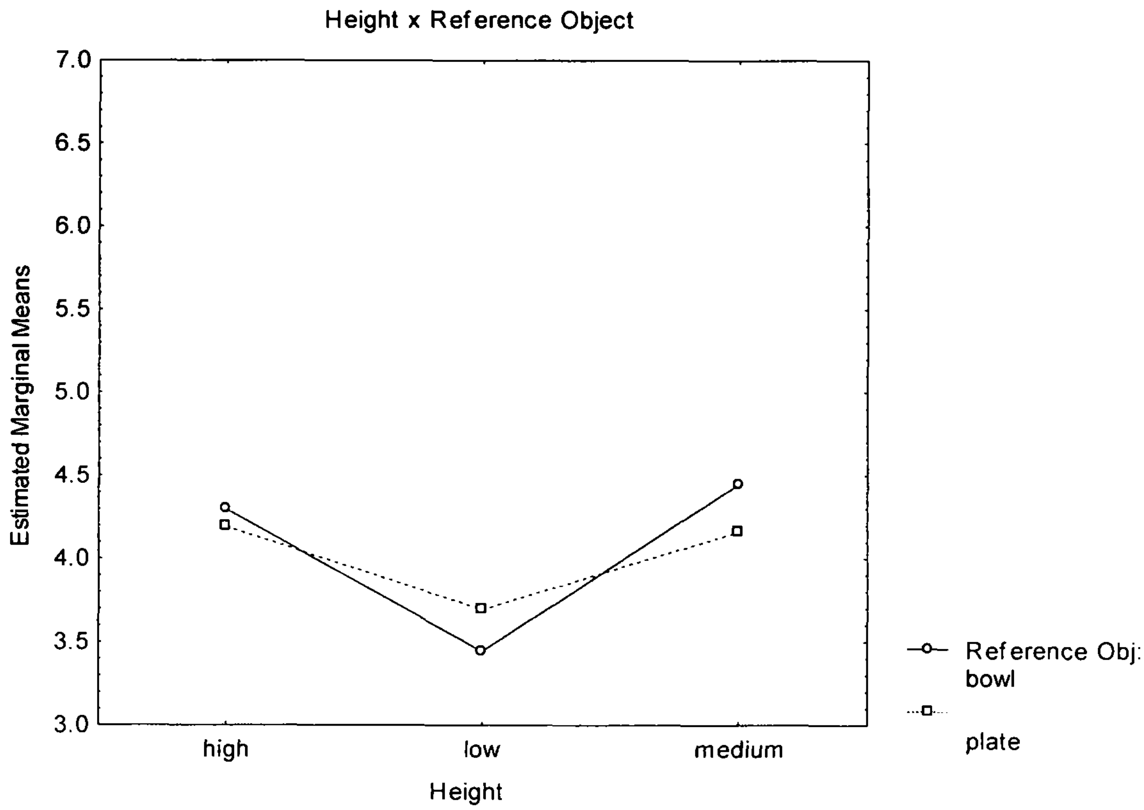


Figure 2.15 *Interaction between Height x Reference Object for the English group in Experiment Two.*

There was also a significant interaction between Reference Object x Ad-position $F(3,48) = 11.39$, $p<0.001$, MSE = 10.92 (see Figure 2.16). There were no significant differences between the ratings in the '*above*' (M=4.20 for bowl, M=3.73 for plate) condition or the '*over*' (M=4.03 for bowl, M=3.95 for plate) condition regardless of which reference object was displayed; although *above* showed some discrepancy in favour of the bowl. For the scenes where '*on*' was being rated the plate (M=4.49) condition had significantly higher ($p<0.001$) ratings than the bowl (M=3.01) condition, and when '*in*' was being rated the bowl (M=5.02) condition had significantly higher ($p<0.05$) ratings than the plate (M=3.90) condition. This was as expected.

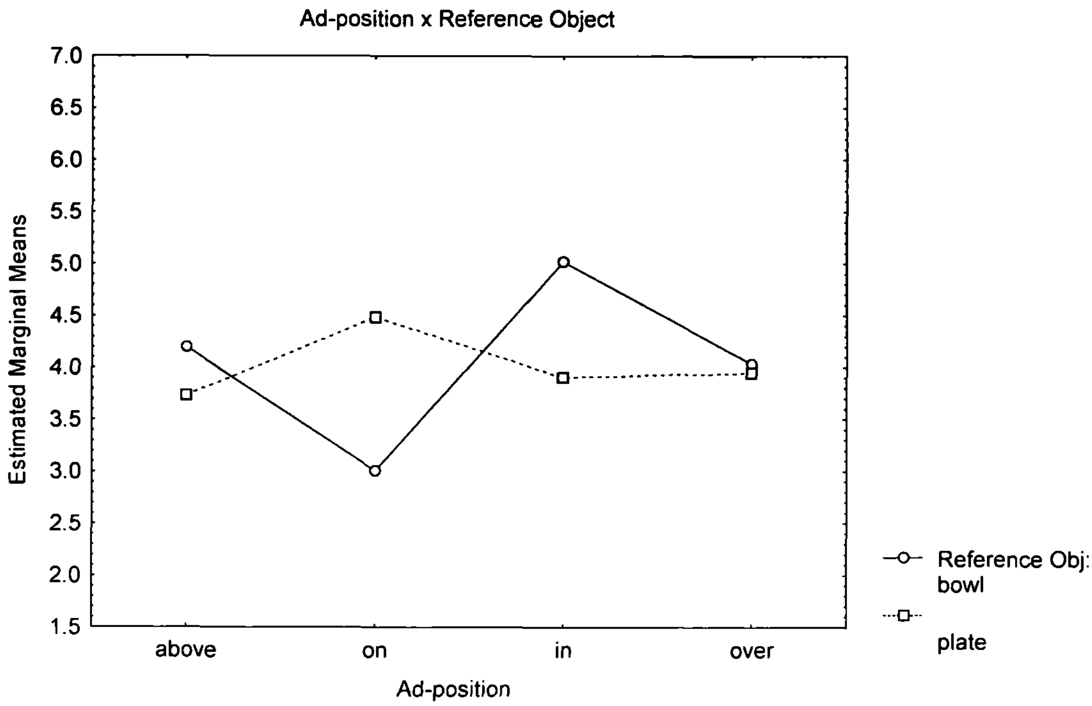


Figure 2.16 *Interaction between Ad-position x Reference Object for the English group in Experiment Two.*

There was a significant interaction between Height x Ad-position $F(6,96) = 27.63$, $p<0.001$, MSE = 8.56, with a pattern in accordance with the hypotheses (see Figure 2.17). *On* ratings were not affected significantly ($p>0.05$) by height, (high M = 3.57, medium M = 3.80, low M = 3.87). However *in* ratings were rated as significantly ($p<0.001$) most appropriate in the low height (M =5.86) condition in comparison to the medium (M = 3.92) and high (M= 3.60) conditions which lends support to the hypothesis. The terms *above* and *over* had elevated ratings when in the higher conditions. The highest condition (*above* M = 4.96, *over* M= 4.86) and medium condition (*above* M = 4.74, *over* M = 4.76) had significantly (p<0.001) higher ratings for these prepositions than the lowest condition (*above* M = 2.20, *over* M = 2.35).

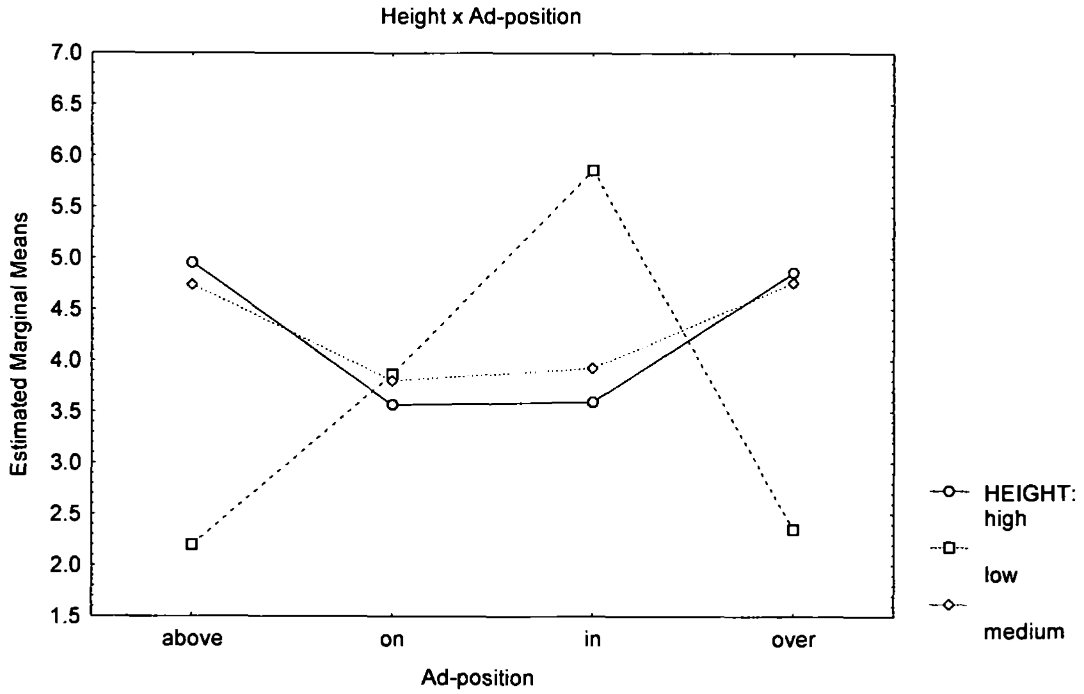


Figure 2.17 *Interaction between Ad-position x Height for the English group in Experiment Two.*

There was also a significant interaction between Angle x Ad-position, F(3,48) = 3.79, p<0.05, MSE = 2.04 (Figure 2.18). *In* (canonical M = 4.52, tilted M=4.41) received significantly (p<0.001) higher rating levels than *on* (canonical M = 3.82, tilted M=3.67) for both levels of angle. Both *in* and *on* displayed minor but non-significant (p>0.05) elevation of ratings for the canonical condition in comparison to the tilted condition. The term *over* (canonical M=4.14, tilted M=3.84) showed some, although a non-significant (p>0.05) level of discrimination between levels of angle. However, *above* (canonical M=4.32, tilted M=3.61) distinguished between conditions of angle at a significant (p<0.001) level with a clear preference for the canonical scenes in comparison to the tilted ones. The higher ratings for '*above*' in the canonical condition suggest that this preposition in particular is quite sensitive to geometrical shifts (this was in line with the findings of Coventry, Prat-Sala and Richards, 2001).

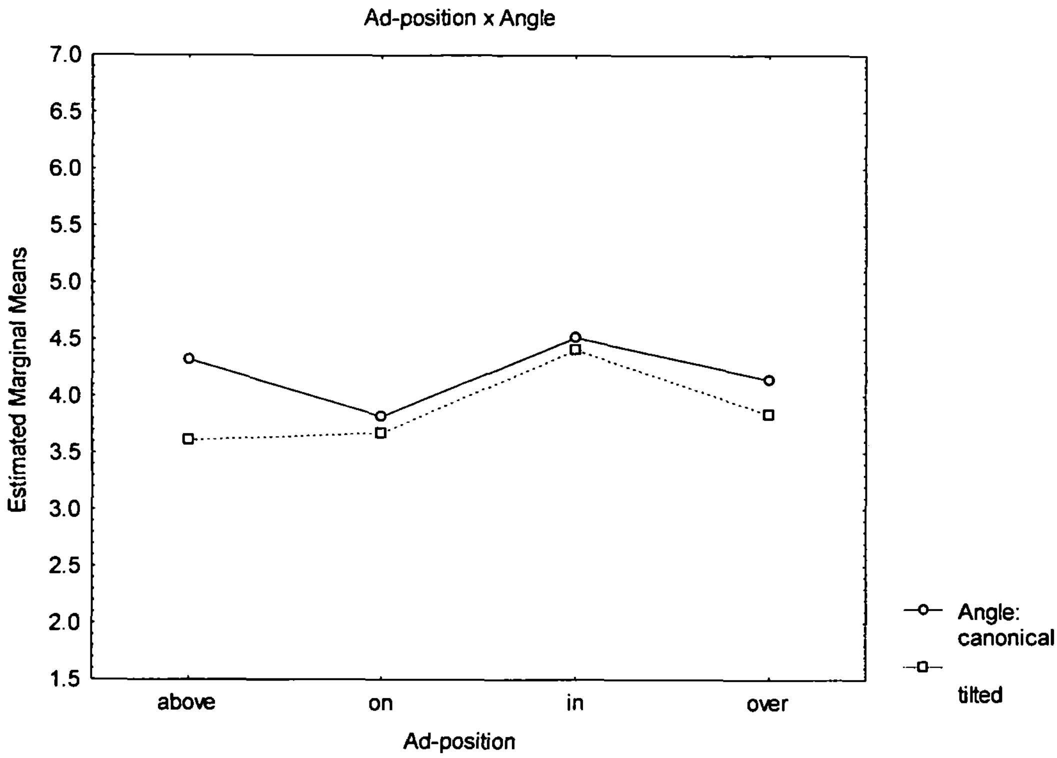


Figure 2.18 *Interaction between Ad-position x Angle for the English group in Experiment Two.*

There was a significant interaction between <u>Control x Ad-position</u> $\underline{F}(3, 48) = 4.88$, $p<0.01$, MSE = 1.90 (Figure 2.19). Generally, '*in*' has highest ratings of all the ad-positions for which the no external control (M=4.58) condition had slightly higher ratings than the control (M=4.34) condition. In contrast, the ad-positions '*above*' (M=3.78 for no control, M=4.15 for control) and '*over*' (M=3.79 for no control, M=4.19 for control) have higher ratings in the control condition than in the no control condition. However, none of these differences was at a significant level ($p>0.05$). The ad-position '*on*' (M=3.73 for no control, M=3.76 for control) receives the lowest ratings overall with no visible difference between ratings across levels of control. Alternative control slightly reduced ratings for *in* and *on* but increased ratings for *over* and *above*, however none of the pair-wise comparisons was significant (p>0.05), therefore clear support for the hypothesis was not gained.

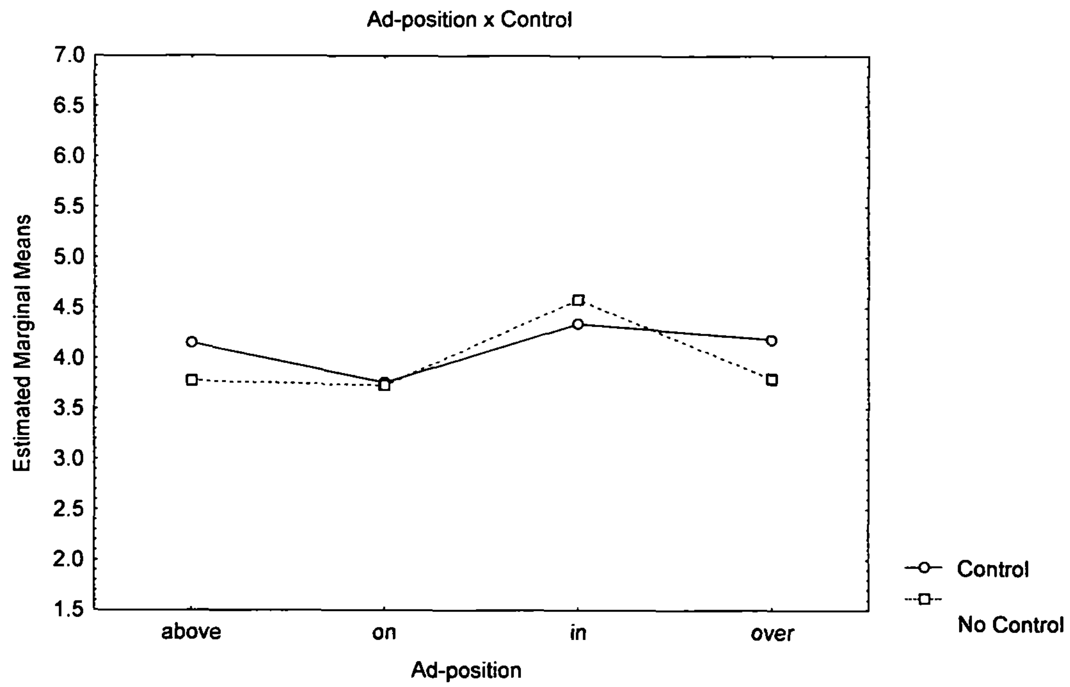


Figure 2.19 *Interaction between Ad-position x Control for the English group in Experiment Two.*

There was also a significant three-way interaction between Height x Angle x Ad-position, displayed in Figure 2.20. F(6, 96) = 2.33, p<0.05, MSE = 1.12. Tilting the reference object affects ratings for ad-positions, but only for some ad-positions in some situations.

At the low height condition *over* (tilted M = 2.35, canonical M = 2.35) and *above* (tilted M = 2.12, canonical M = 2.28) are rated at similarly low levels regardless of level of angle. Furthermore, the ad-position *in* has significantly (p<0.001) highest ratings with no real discrepancy between angles (canonical M = 5.87, tilted M = 5.85). The ad-position *on* receives quite high ratings with a slight elevation (although non-significant, p>0.05) for canonical scenes (M = 4.02) in comparison to the tilted condition (M = 3.72).

In the medium height condition the ratings for *above* and *over* were highest and were the only terms displaying a more marked discrepancy between different angles, the ratings were elevated in the canonical condition (*above* M = 5.01 , *over* M = 4.88) in comparison to the tilted condition (*above* M = 4.38, *over* M = 4.63) with only *above* showing a significant ($p<0.05$) discrimination. The terms *in* and *on* were rated at similar levels in both the canonical (*in* M = 4.00, *on* M = 3.75) and tilted (*in* M = 3.87, *on* M =3.85) conditions with only very minor discrepancy between levels of angle.

For the <u>high condition</u> there is a stronger discrepancy between levels of angle for both *above* (significant difference; $p<0.05$: canonical M = 5.59, tilted M = 4.32) and *over* terms (nearly significant difference 0.066 : canonical M = 5.19, tilted M = 4.53) in favour of the canonical scenes. However, both *in* and *on* receive lower ratings showing only a non-significant ($p>0.05$) discrepancy between tilted (*in* M = 3.50, *on* M = 3.44) and canonical conditions (*in* M = 3.69, *on* M = 3.69) in favour of canonical.

Hence, this interaction does not provide clear support for the hypothesis that tilting the reference object would be perceived as increasingly unfavourable to the location control of the reference object as the located object height increases. This would have lead to significantly detrimental effects on the rating levels of *in* and *on,* which was not the case although the tendency was at times suggested in the pattern of the interaction.

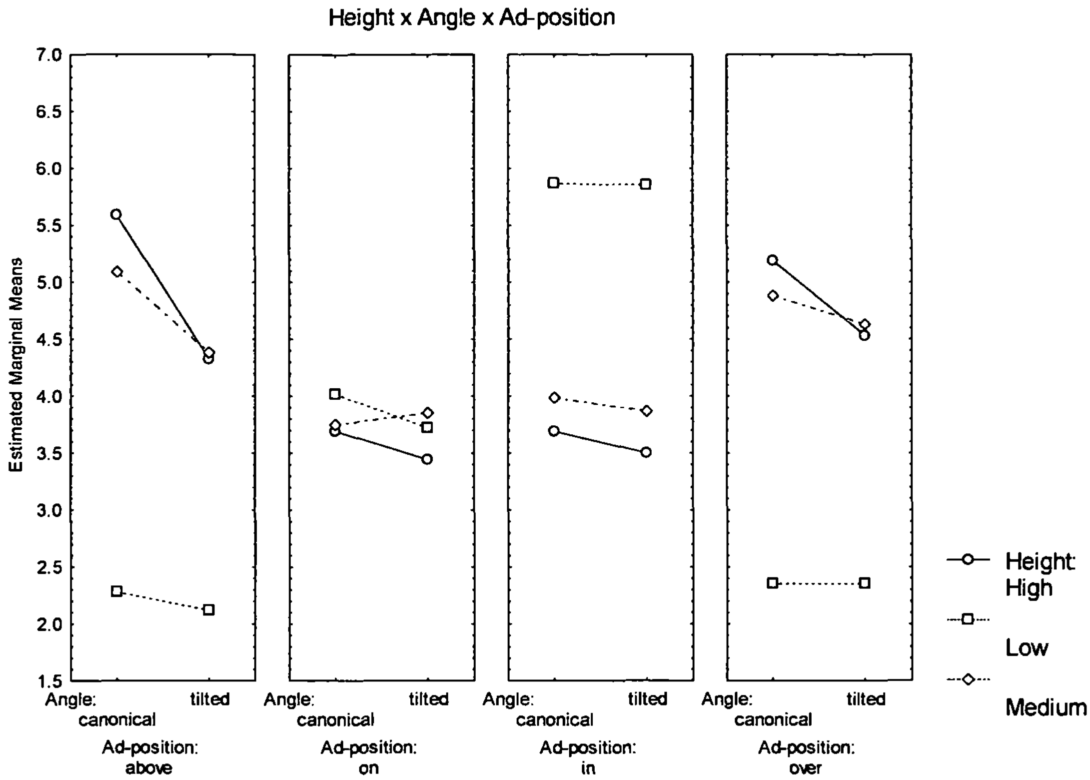


Figure 2.20 *Interaction between Height x Angle x Ad-position for the English group in Experiment Two.*

Finally, there were significant four-way interactions between Reference Object x Height x Angle x Ad-position $\underline{F}(6, 96) = 2.57$, $p<0.05$, $MSE = 1.28$ (see Figure 2.21). This higher level interaction provides support and further breakdown for significant effects found in the above three-way interaction. To clarify which factors were significantly interacting with the reference object, the data was divided into two sets by reference object for which two separate analyses were carried out.

Bowl as Reference Object

The interactions found between different levels of height, angle and ad-position and the reference object when it was a **bowl** are not discussed, as none of these effects resulted in significant discrepancies ($p>0.05$).

Plate as Reference Object

Only one part of this four-way interaction was significant between different levels of height, angle and ad-position and the reference object when it was a **plate.** More specifically when the height of the fruit pile was at the highest level there was a significant difference ($p<0.05$) between the rating levels for the ad-position *above* favouring the canonical condition ($M = 5.41$) over the tilted condition ($M = 4.03$).

In conclusion, there was no real support for the hypothesis that the terms *in* and *on* would be detrimentally effected the higher the located object was placed in the plate/bowl if the container were tilted. Importantly, while the pattern of discrepancy was there in some instances, the interaction was not significant for either *in* or *on*.

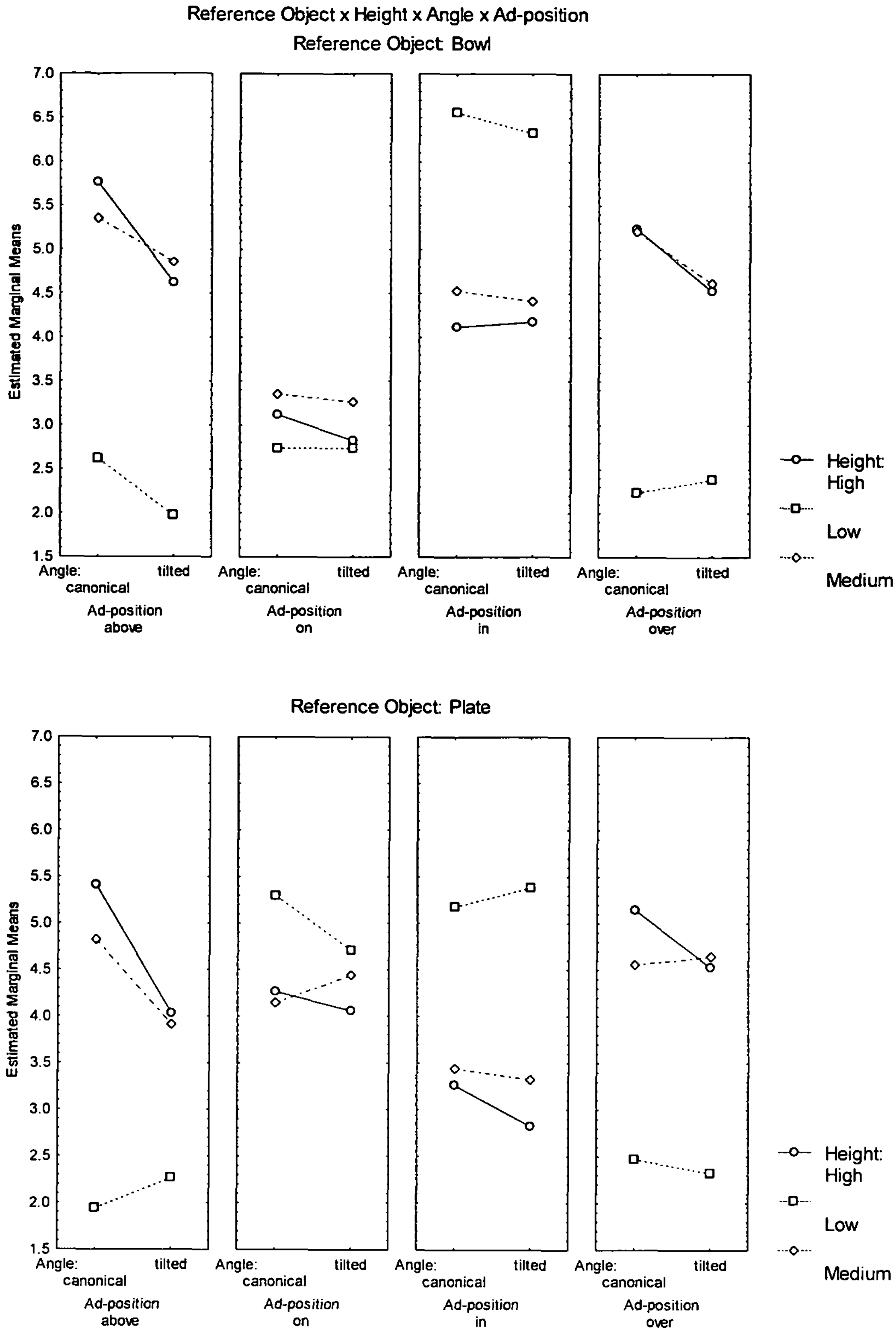


Figure 2.21 *Significant Four-way interaction between Angle x Height x Reference Object x Ad-position for the English group in Experiment Two*

A second four-way interaction was found between Reference Object x Height x Control x Ad-position $F(6, 96) = 2.47$, $p<0.05$, $MSE = 1.70$ (see Figure 2.22). This interaction was also further investigated by splitting the data into two sets by reference object for separate analyses. Surprisingly, neither the analysis involving only the scenes in which the plate was the reference object or the scenes in which the bowl was the reference object produced a significant ($p>0.05$) interaction with all other three factors (height x control x ad-position), therefore a detailed interpretation of the effects pattern is not provided. They were however nearly significant for both data sets: bowl x height x control x ad-position ($p = 0.0715$), plate x height x control x ad-position ($p = 0.0719$). This follow-up analysis leads to the inference that this significant four-way interaction is only significant as a result of the two reference objects interacting with each other in a significant way.

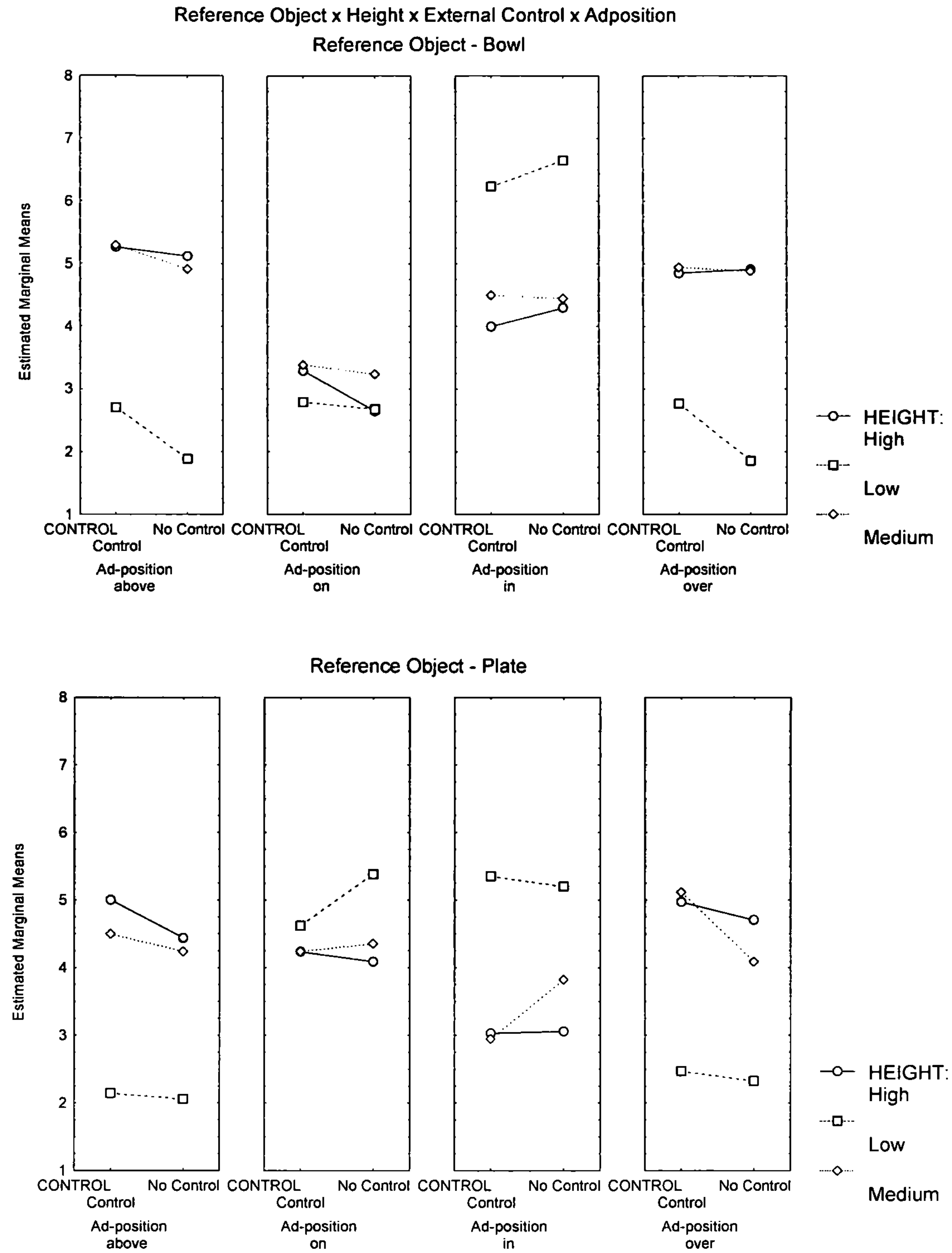


Figure 2.22 *Significant Four-way interaction between Control x Height x Reference Object x Ad-position for the English group in Experiment Two.*

2.2.2.2 FINNISH

The mean ratings by condition are displayed in Table 2.8.

***Table 2.8.** The mean ratings of the Finnish group for each condition in Experiment Two (fruit bowl).*

Ref. Obj.	**Height**	**Angle**	**External Control of Figure**	**AD-POSITION** *yllä*	*ssa*	*lla*	*Yläp.*
Bowl	High	Straight	Control	4.94	4.41	3.47	5.18
			no Control	4.65	5.71	4.00	5.06
		Tilted	Control	4.24	5.41	4.12	5.00
			no Control	3.65	5.29	3.71	3.82
	Low	Straight	Control	1.59	6.71	4.12	1.35
			no Control	1.65	7.00	4.00	1.65
		Tilted	Control	1.53	6.94	4.29	1.94
			no Control	2.24	6.82	3.94	1.82
	Medium	Straight	Control	3.71	5.06	4.00	4.29
			no Control	4.18	6.29	4.47	3.76
		Tilted	Control	4.29	5.24	4.71	4.94
			no Control	3.59	5.24	3.71	4.18
Plate	High	Straight	Control	4.53	3.00	5.47	5.18
			no Control	3.88	3.65	6.53	4.82
		Tilted	Control	3.47	3.35	6.00	4.76
			no Control	3.41	4.06	5.88	4.18
	Low	Straight	Control	1.53	5.24	6.35	1.94
			no Control	1.47	5.24	6.24	2.00
		Tilted	Control	1.94	5.35	6.00	1.47
			no Control	1.47	5.82	6.29	1.76
	Medium	Straight	Control	3.71	4.59	6.35	5.00
			no Control	3.88	4.59	6.47	4.24
		Tilted	Control	3.35	4.12	6.06	3.94
			no Control	3.53	3.94	6.35	3.88

There were significant main effects of Height $F(2,32) = 28.49$, $p<0.001$, MSE = 4.71 and Ad-position $F(3,48) = 15.35$, $p<0.001$, MSE = 27.23. Higher ratings were given to the high (M=4.53) and medium (M=4.55) conditions than the low (M=3.68) condition, mirroring the effect found for the English group. Also, the ad-positions '*-ssa*' (M=5.13 , which is the '*in*' equivalent) and '*-lla*' (M=5.11, which is the '*on*' equivalent) received higher ratings overall than *'yllä'* (M=3.18, which is the *'over'* equivalent) and *'yläpuolella'* (M=3.59, which is the *'above'* equivalent).

There was a significant interaction between Angle x Control $F(1,16) = 5.27$, $p<0.05$, MSE = 1.93. When the scenes displayed the located object under the influence of external control both the straight (M=4.24) and tilted (M=4.27) scenes did not display ratings that showed a marked discrepancy between conditions. In contrast, when there was no external control present and the reference object was positioned at a straight angle (M=4.39) the ratings were significantly higher ($p<0.05$) than they were for scenes in which the reference object was tilted (M=4.11).

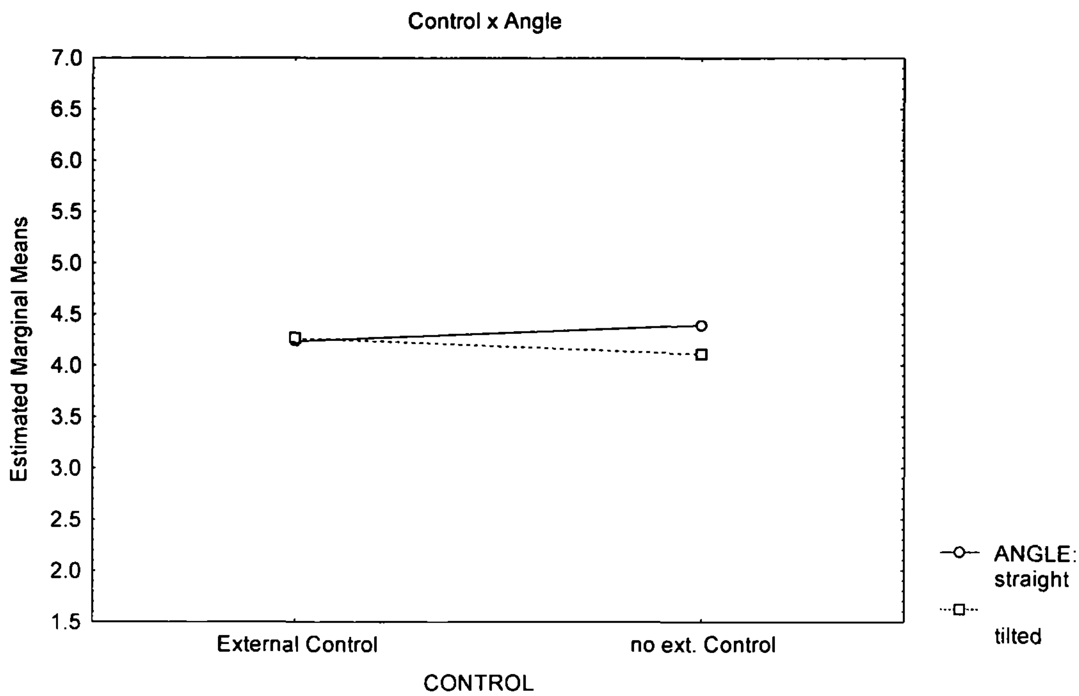


Figure 2.23 *Interaction between Control x Angle for the Finnish group in Experiment Two.*

The interaction between Reference Object x Ad-position $F(3,48) = 12.67$, $p<0.001$, MSE = 17.80 shows low ratings for *'yllä'* (equivalent of *'above'*; M=3.35 for bowl, M=3.02 for plate) and *'yläpuolella'* (equivalent of *'over'*; M=3.58 for bowl, M=3.60 for plate) regardless of reference object condition (Figure 2.24). In contrast, '-*ssa'* (equivalent of '*in*') was significantly ($p<0.05$) more highly rated in scenes with a bowl (M=5.84) than in scenes with a plate (M=4.41), and *'-lla'* (equivalent of *'on'*) had significantly ($p<0.001$) higher ratings when a *plate* (M=6.17) was viewed than a bowl (M=4.04). This pattern clearly mirrors the effects for the English language group and predictions of ad-position reference object compatibility.

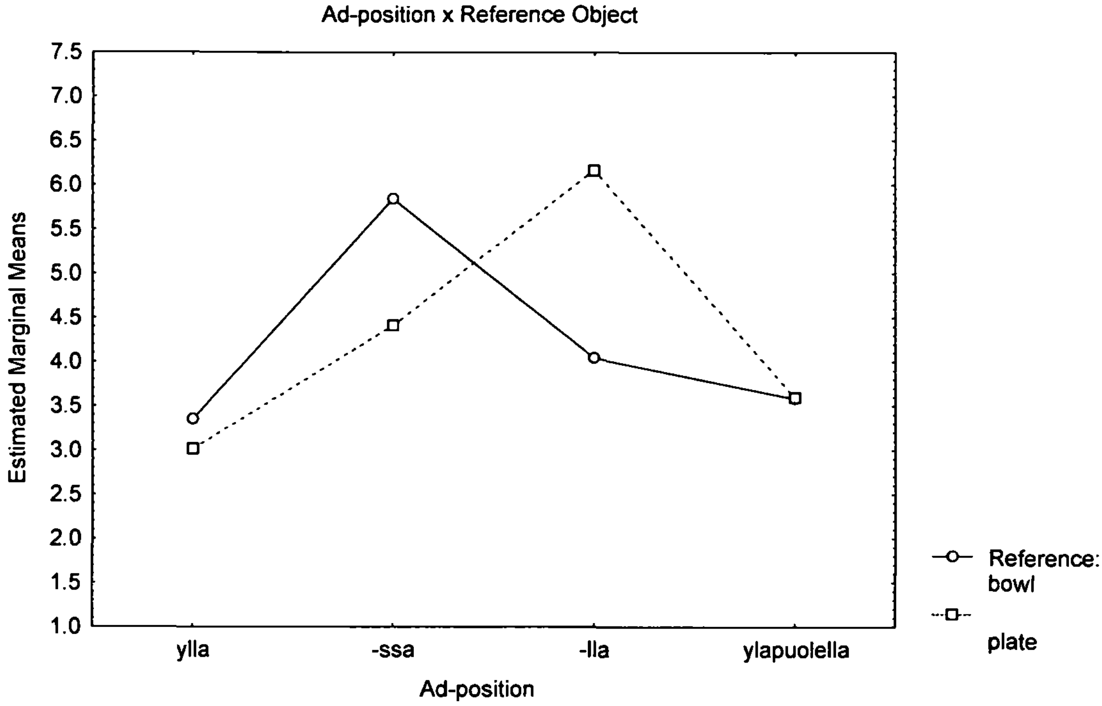


Figure 2.24 *Interaction between Ad-position x Reference Object for the Finnish group in Experiment Two.*

There was also a significant interaction between <u>Height x Ad-position</u> $\underline{F}(6,96) = 21.40$, $p<0.001$, MSE = 8.96 (Figure 2.25). The effects of this interaction were quite similar to those of the English language group. Rather equal rating levels were displayed in which the located object was at the highest level regardless of ad-position (M=4.09 for *'yllä'*, M=4.90 for *'-lla'*, M=4.36 for *'-ssa'*, M=4.75 for *'yläpuolella'*). Also, similar level of ratings was found in the medium height condition (M=3.78 for 'ylla', M=5.27 for *'-lla'*, M=4.88 for *'-ssa'*, M=4.28 for *'yläpuolella'*) with the exception of *–lla* getting significantly ($p<0.05$) higher ratings than *yllä*. However, in the low condition *'yllä'* (*over*) (M=1.68) and *'yläpuolella'* (*above*) (M=1.74) were rated at the significantly ($p<0.05$) lowest levels. The ad-position *'-lla'* (*on*) (M=5.15) gets higher ratings which were, nonetheless, similar to the ratings it received throughout the other heights. The ad-position *'-ssa'* (*in*) (M=6.14), on the other hand gets significantly ($p<0.001$) highest ratings in the low height condition when compared to the other located object height conditions and this is in accord with the experimental prediction. The suggestion appears to be that *'–ssa'* (*in*) is more sensitive than *'–lla'* (*on*) to geometric manipulation, and this effect mirrors the pattern found for the English group. This makes sense since for an object to be contained (in the bowl/plate) by a reference object it has to be surrounded by the reference object surface.

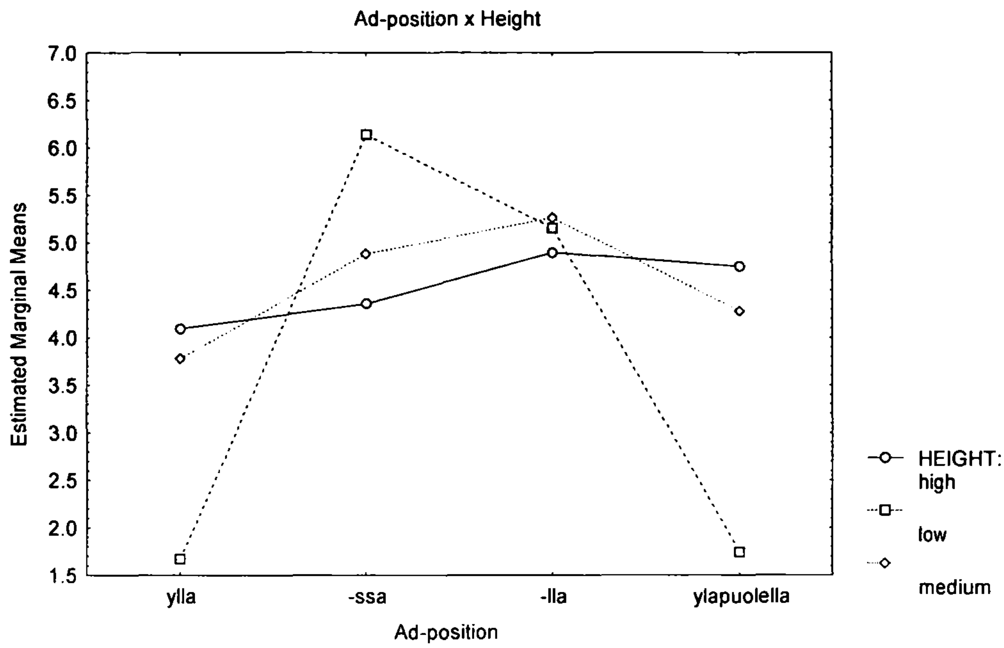


Figure 2.25 *Interaction between Ad-position x Height for the Finnish group in Experiment Two.*

Additionally, there was a significant interaction between <u>Height x Angle x Ad-position</u> $F(6,96) = 2.41$, $p<0.05$, MSE = 2.10 (Figure 2.26). The pattern basically replicates the findings for the English group. Again *yllä* (*over*) shows significantly ($p<0.001$) higher ratings for the tilted high (M = 3.69) and medium height (M =3.69) conditions in comparison to the low condition (M =1.79). This pattern for *yllä* is similar although more graded in the canonical condition for high (M = 4.50) and medium height

(M =3.87), which in comparison to the low condition (M =1.56) were both rated significantly higher (p<0.001).

Also, *yläpuolella* (above) shows the same significantly (p<0.001) elevated rating pattern for the tilted high (M =4.44) and medium (M =4.24) conditions in comparison to the low condition (M =1.75). Again, the more graded pattern for *yläpuolella* basically repeats itself in the canonical condition for the high (M =5.06) and medium (M =4.32) conditions, which were rated significantly (p<0.001) higher in comparison to the low condition (M =1.74).

The ad-position *–lla* (on) showed similar levels of ratings (no significant differences; p > 0.05) throughout height conditions for the tilted condition (high M =4.93, medium M =5.21, low M =5.13) and also the canonical condition (high M =4.87, medium M =5.32, low M =5.18).

In contrast, the ratings increased the lower the height was (high M =4.19, medium M =5.13, low M =6.04) for *-ssa* (in) in the canonical condition although this increase was only at a significant level (p<0.001) between low and high location positions not the medium condition (p>0.05). However, in the tilted scenes *–ssa* (in) both the high (M =4.53) and medium (M =4.63) conditions received similarly low ratings when compared to the low (M =6.24) condition which was rated at a significantly (p<0.001) higher level. The effect for *–ssa* supports the hypothesis that when an object is tilted it would be affected more detrimentally by height. It should however be noticed that this decrease in *–ssa* rating levels in relation to height was also present for the canonical condition, but it was much more pronounced even at the medium height level when the reference object was tilted than when it was canonical.

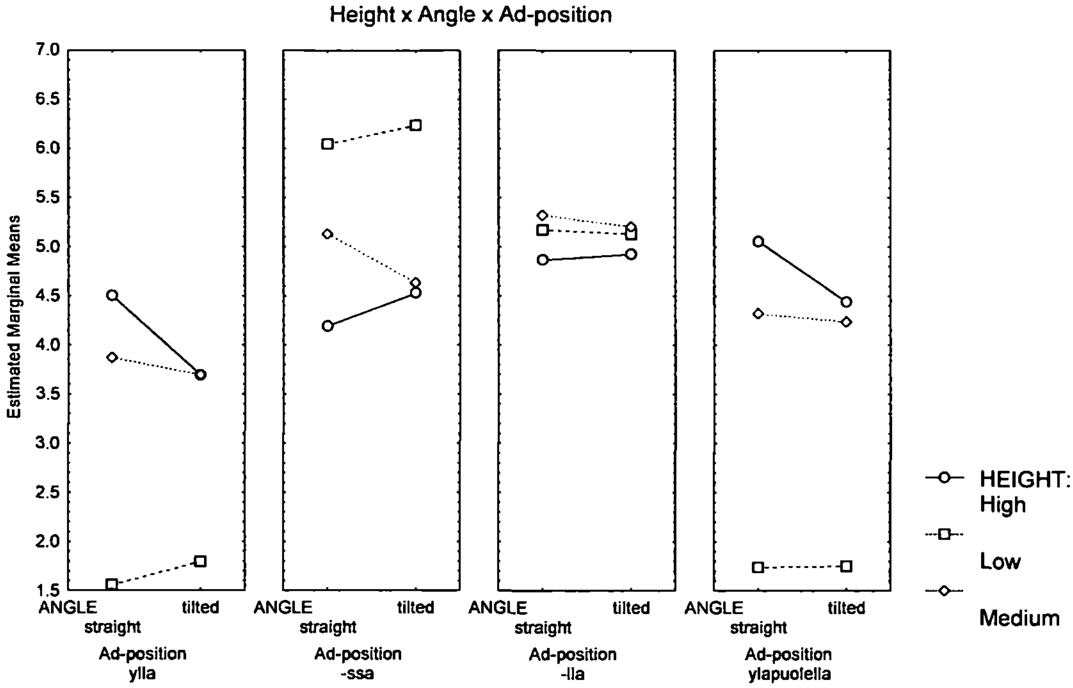


Figure 2.26 *Significant three-way interaction between Height x Angle x Ad-position for the Finnish group in Experiment Two.*

The interaction between <u>External Control x Ad-position</u> $\underline{F}(3,48) = 4.28$, $p<0.01$, MSE = 1.90 is significant (Figure 2.27). The ad-position *'-ssa'* (equivalent for *'in'*) shows a similar effect to that of the English group in that slightly higher ratings were given for the no control (M=5.30) condition than the external control (M=4.95) condition (although not significantly; p>0.05). In contrast, the ad-positions *'yllä'* (*'above'*; M=3.13 for no control, M=3.24 for control) and *'yläpuolella'* (*'over'*; M=3.43 for no control, M=3.75 for control) have generally low ratings with hardly any discrepancies between levels of control. The ad-position *'-lla'* (*'on'*; M=5.13 for no control, M=5.08 for control) received much higher ratings here than for the English group with hardly any visible difference between ratings across levels of Control. This elevation in rating level in comparison to that found for the English group is possibly an effect of the Finnish language since the case conjugation *-lla* can also indicate ownership as well as a support relationship. Hence, even in situations in which it is difficult to perceive a support relationship it might still be possible to consider that the bowl or plate 'has' a pear. This interaction does not provide support for the hypothesis about the interfering effects of the introduction of external control.

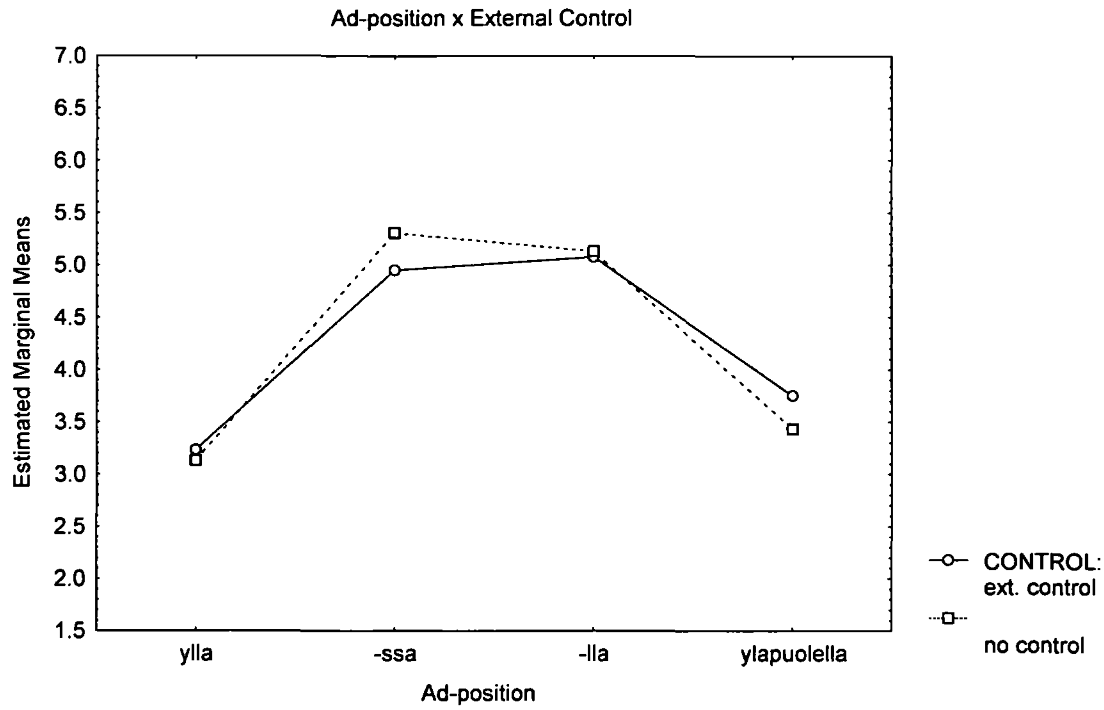


Figure 2.27 *Interaction between Ad-position x External Control for the Finnish group in Experiment Two.*

Finally, there was a marginally significant interaction between Height x External Control x Ad-position $F(6,96)=2.19$; $p<.0504$, MSE = 1.52 (Figure 2.28). Again *yllä* (*over*) shows higher ratings for the no external control high (M = 3.90) and medium height (M =3.79) conditions in comparison to the low condition (M =1.71). This pattern for *yllä* is similar although more graded in the external control condition for high (M = 4.29) and medium height (M =3.77), which in comparison to the low condition (M =1.65) were both rated higher. Also, *yläpuolella* (above) shows the same significantly elevated rating pattern for the no external control scenes high (M =4.47) and medium (M =4.02) conditions in comparison to the low condition (M =1.81). Again, the more graded pattern for *yläpuolella* basically repeats itself in the external control scenes for the high (M =4.47) and medium (M =4.02) conditions, which were rated higher in comparison to the low condition (M =1.81).The ad-positon *–lla* (on) showed similar levels of ratings throughout height conditions for the no external control condition (high M = 5.25, medium M = 5.03, low M = 5.12) and also in the condition in which external control was present (high M = 5.28, medium M = 4.77, low M =5.19). For the external control condition, the ratings for the ad-position *-ssa* (*in*) increased the lower the height was (high M = 4.04, medium M = 4.75, low M = 6.06). Furthermore, in the no external control scenes the ad-position *–ssa* (in), for both the high (M =5.02) and medium (M = 4.68) conditions, received increasingly low ratings when compared to the low height (M = 6.22) condition which was rated at a higher level. This would seem to suggest that –*ssa* was more sensitive to height manipulations regardless of whether there was or was not external control present in the scene, whereas *-lla* did not show very much discrimination at all. In addition to not being quite at a significant level, this three-way interaction did not provide any clear evidence for the prediction that height combined with location control would effect the ad-positions *–lla/-ssa.*

None of the other effects or interactions were significant.

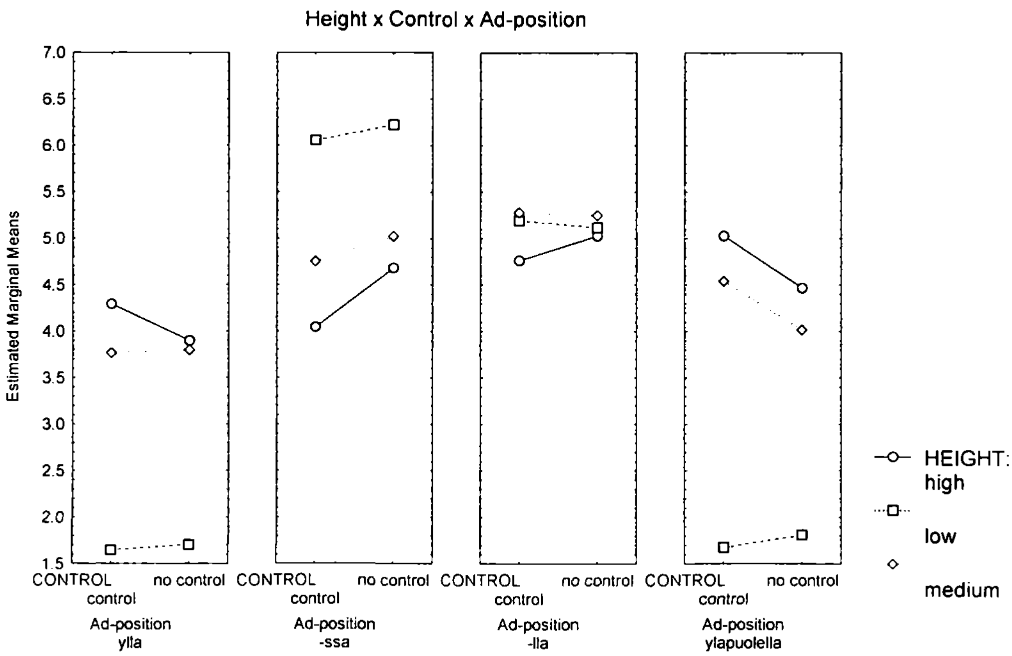


Figure 2.28 *Marginally significant three-way interaction between Height x External Control x Ad-position for the Finnish group in Experiment Two.*

2.2.2.3 SPANISH

The mean ratings by condition are displayed in Table 2.9.

Table 2.9. *The mean ratings of the Spanish group for each condition in Experiment Two (fruit bowl).*

Reference Object	Height	Angle	External Control Of Figure	AD-POSITION *Sobre*	*en*	*encima*
Bowl	High	Straight	Control	3.62	5.46	4.15
			no Control	2.85	5.54	2.77
		Tilted	Control	2.92	4.77	2.69
			no Control	3.00	5.69	2.77
	Low	Straight	Control	3.00	5.08	3.31
			no Control	2.54	5.92	2.00
		Tilted	Control	2.77	6.23	3.00
			no Control	2.08	6.00	2.08
	Medium	Straight	Control	3.46	5.23	3.85
			no Control	2.92	6.00	2.85
		Tilted	Control	3.31	5.08	3.54
			no Control	2.77	5.69	2.69
Plate	High	Straight	Control	3.69	4.69	3.92
			no Control	2.77	6.15	2.92
		Tilted	Control	2.31	4.23	3.23
			no Control	2.85	5.46	2.54
	Low	Straight	Control	3.38	5.77	2.77
			no Control	2.85	5.85	1.92
		Tilted	Control	3.38	5.85	2.92
			no Control	3.46	6.08	2.62
	Medium	Straight	Control	3.31	4.85	3.69
			no Control	2.85	5.77	3.31
		Tilted	Control	3.46	5.08	3.54
			no Control	3.38	5.69	2.23

There was a significant main effect of Ad-position $F(2,32) = 19.31$, $p<0.001$, MSE = 38.57, for which '*sobre*' (M=2.98, '*above*' equivalent) and '*encima*' (M=3.31, '*over*' equivalent) received the lowest ratings, whereas, '*en*' (M=5.47, 'on/in' equivalent) is given the highest ratings.

There was an interaction between Height x Angle $F(2,32) = 9.30$, $p<0.001$, MSE = 1.13 (Figure 2.29). Only slightly higher ratings are shown for the tilted (M=3.94) condition than for the straight (M=3.78) condition in the low height scenes (although not significantly; p>0.05). However, the medium height condition (M=4.11 for straight, M=3.97 for tilted) shows an opposite pattern in which the straight scenes have slightly higher ratings than the tilted scenes (not significant; p>0.05). Finally, the high condition (M=4.10 for straight, M=3.61 for tilted) shows the strongest and only significant (p<0.001) distinction in favour of the straight scenes over the tilted ones. This indicates that the higher the located object is placed on the fruit bowl the more an added threat to location control (i.e. tilt) will detrimentally effect the appropriateness ratings for any of the Spanish ad-positions.

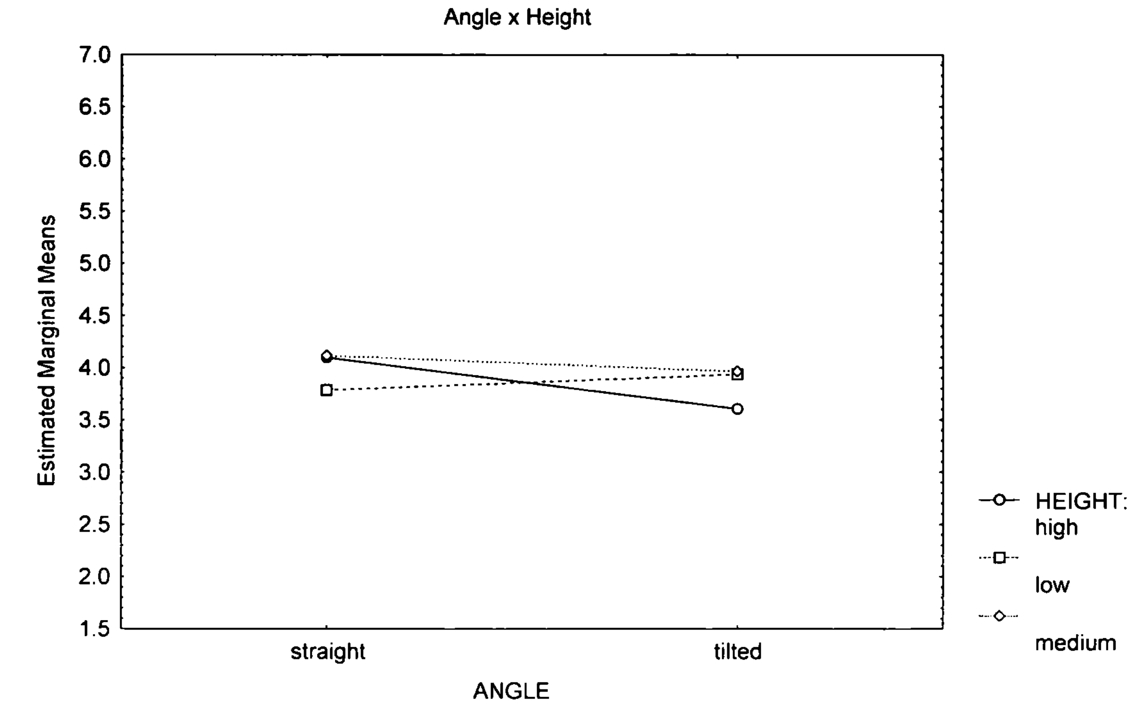


Figure 2.29 *Interaction between Angle x Height for the Spanish group in Experiment Two.*

An interaction between <u>Height x Ad-position</u> <u>F</u>(4,64) = 5.25, p<0.01, MSE = 6.46 is also present (Figure 2.30). The ad-position '*en*' *(on/in)* (M=5.08 for high, M=5.27 for medium, M=6.04 for low) receives the highest ratings throughout all levels of height. Nonetheless, there is an elevation (although not quite significant, p = 0.06) of ratings in the low condition of '*en*' which mirrors the effects found for *in* and *-ssa* in

English and Finnish providing tentative support for the experimental prediction. However, ad-positions *'sobre' (above)* (M=2.97 for high, M=2.77 for low, M=3.18 for medium) and *'encima' (over)* (M=3.51 for high, M=2.77 for low, M=3.66 for medium) have low ratings regardless of the level of Height. There is a slight increase (again not significant, p>0.05) in ratings of *'encima'* for high and medium conditions indicating possibly that it is being perceived as somewhat appropriate for describing higher piles of fruit as was the case for the English and Finnish equivalents *'over'* and *'ylla'* respectively. The difference with English and Finnish is that the effects displayed by *'over'* and *'ylla'* were more marked and the same pattern was also visible for *above* and *ylapuolella,* whereas the Spanish term *sobre* displayed very little (p>0.05) discrepancy between levels of height.

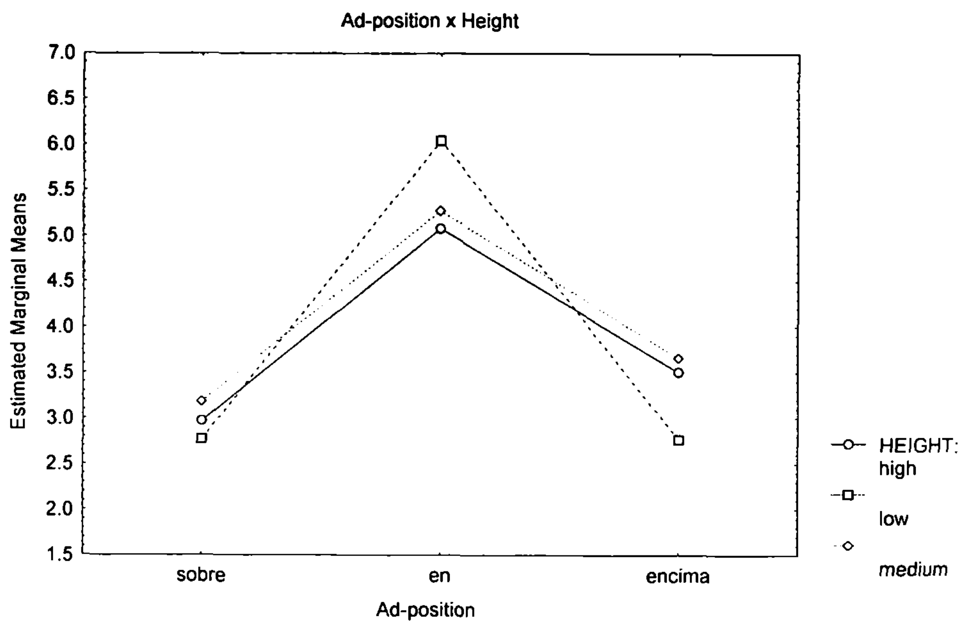


Figure 2.30 *Interaction between Ad-position x Height for the Spanish group in Experiment Two.*

Finally, a nearly significant interaction between <u>Control x Ad-position</u> F(2,32)=3.22; p<.0534, MSE = 10.08 mirrors the pattern found for the English and Finnish analyses (Figure 2.31). The ad-position *'en' (on/in)* (M= 5.19 for external control, M= 5.75 for no external control) receives the highest ratings throughout all levels of Control with some preference for the scenes in which there was no external control present. However, ad-positions '*sobre' (above)* (M= 3.09 for external control, M= 2.86 for no external control) and '*encima' (over)* (M= 3.58 for external control, M= 3.04 for no external control) have low ratings regardless of the level of External Control. This lends no real support for the experimental prediction as neither the interaction nor the post-hoc analyses are at quite significant levels.

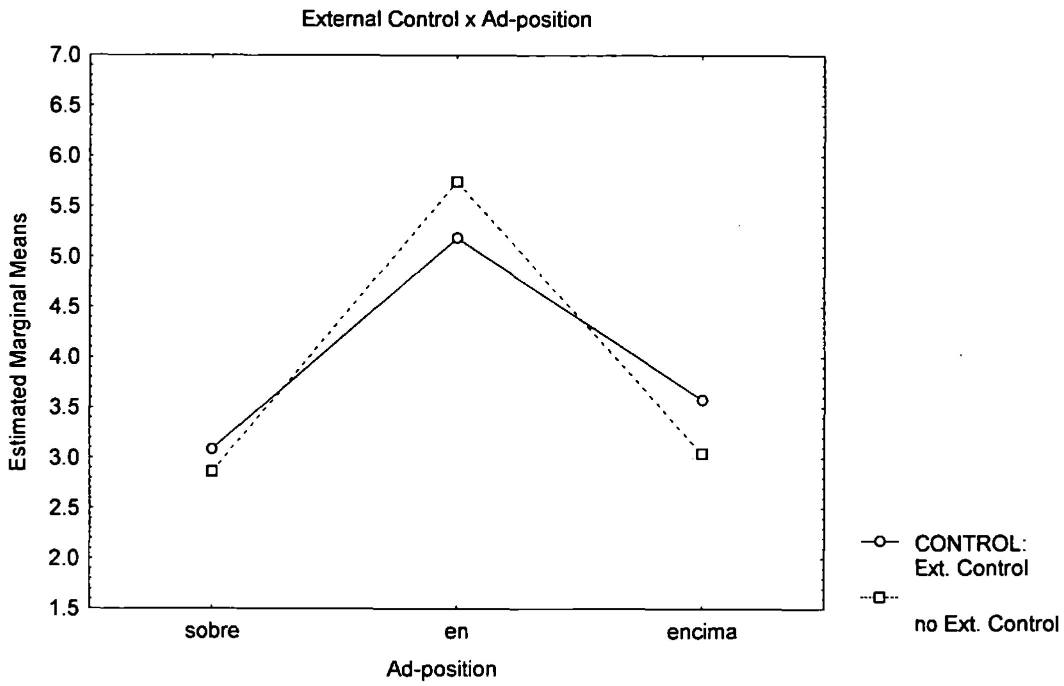


Figure 2.31 *A Marginally Significant two-way interaction between Control x Ad-position for the Spanish group in Experiment Two.*

2.2.3 Discussion (Experiment Two)

A summary of all the main-effect and interactions that were found in Experiment Two across all three language groups can be found below in Table 2.10.

***Table 2.10** Significant main effects and interactions across language groups in Experiment Two (fruit bowl), all borderline non-significant effects are in brackets.*

Main Effects	**English**	**Finnish**	**Spanish**
Reference Object			
Height	X	X	
Angle	X		
Control (external)			
Ad-position		X	X
2-way interactions			
Ref. Obj. x Height	X		
Ref. Obj. x Angle			
Ref. Obj. x Control			
Ref. Obj. x Ad-position	X	X	
Height x Angle			X
Height x Control			
Height x Ad-position	X	X	X
Angle x Control		X	
Angle x Ad-position	X		
Control x Ad-position	X	X	(X)
3-way interactions			
Ref. Obj. x Height x Angle			
Ref. Obj. x Height x Control			
Ref. Obj. x Height x Ad-position			
Ref. Obj. x Angle x Control		(X)	
Ref. Obj. x Angle x Adposition			
Ref. Obj. x Control x Ad-position			
Height x Angle x Ad-position	X	X	
Height x Angle Control			
Height x Control x Ad-position		(X)	
Angle x Control x Ad-position			
4-way interactions			
Ref. Obj. x Height x Angle x Control			
Ref. Obj. x Height x Angle x Ad-position	X		
Ref. Obj. x Height x Control x Ad-position	X		
Ref. Obj. x Angle x Control x Ad-position			
Height x Angle x Control x Ad-position			
5-way interaction			
Ref. Obj. x height x Angle x Control x Ad-position			

One of the main predictions that certain ad-positions would be more appropriate for describing certain objects was found for the Finnish and English groups. As expected the ad-positions *on* and the Finnish equivalent *–lla* were rated clearly as most appropriate for describing a relationship of support in the plate scenes. In contrast, *in* and *–ssa* were given noticeably higher ratings when used as descriptors for scenes depicting a bowl which portrays containment. Furthermore, as predicted there was no significant interaction between reference object and ad-position for the Spanish group resulting from the fact that that the ad-position *en* is the only lexical item available to Spanish participants, which roughly translates to the joint meaning of the English *in* and *on.* Therefore, it had been predicted that *en* would be appropriate when describing both support and containment relationships.

Another cross-linguistic effect for Finnish and English was found for height influences on appropriateness ratings of ad-position, whereas although similar patterns were often visible for Spanish equivalent terms they were not quite at significant levels. The lower the figure was located the higher the ratings for *in,* and *–ssa* became, whereas height did not make much difference to the ratings of *on* or *–lla.* Hence, in the English and Finnish sections when the located object was either in the high, low or medium height condition *–lla* and *on* received ratings at a similar level. In contrast, *-ssa* and *in* were rated at an increasingly high appropriateness level the lower the figure was located on the pile of fruit. Additionally, *above* and *over* and there respective Finnish counterparts *yllä* and *yläpuolella* displayed elevated ratings for scenes in which the located object was placed at either the medium or highest heights on the fruit bowl.

The prediction that the introduction of an *external control* to the scene would cause a decrease in the appropriateness ratings of *in/on*, *–ssa/-lla*, and *en* was not supported in any of the languages. Although the predicted pattern was visible for the ad-positions *in, -ssa,* and *en*, none of the discrepancies were at a significant level.

Furthermore, the hypothesis that *tilting* the reference object would reduce the appropriateness ratings for *in/on, –ssa/-lla,* and *en* was not really supported in any of the language analyses. Even though English did produce a significant interaction between Angle x Ad-position, the discrimination between levels of angle and *in/on* were not significant.

The hypothesis that introducing a tilt to the reference object would decrease the ratings for *in/on*, the Finnish *–ssa/-lla* and Spanish *en*, as the height of the figure object on the pile of apples increased was not fully supported. For the English study the discovery was that when the reference object was a bowl and the located object was at the highest level, *in* had some discrepancy in favour of the canonical scenes when compared to the tilted scenes, *on* did not mirror this pattern. Also, when the reference object was a plate *in* seemed to be effected more detrimentally when the container was tilted, while *on* did not display a very visible discrimination. Importantly, while the pattern of discrepancy was there in some instances, the interaction was not significant for either *in* or *on*. However, *–ssa* (*in*) in the Finnish study (collapsing across levels of reference object) was found to be most detrimentally effected at a <u>significant level</u> in the tilted scenes at both the medium and high positions in contrast to the low position. It should be noted, however, that this effect on ratings for *–ssa* was also present to a lesser degree for the canonical scenes as well as the tilted scenes. Furthermore, the sentences with the Finnish *–lla* (*on*) did not really produce any discriminating pattern of effect between height and angle, nor was there any such interaction for the Spanish *en* either. Generally it appears that only the Finnish *–ssa* was clearly sensitive to the manipulation of the reference object angle when the located object was positioned high on a pile of fruit, as this was the only significant effect, as even though the English *in* displayed the predicted pattern the discrimination was not at a significant level. Furthermore, *on* and its Finnish equivalent *–lla* did not show sensitivity to manipulation of height and angle as had been predicted nor did the Spanish *en*.

Finally, the hypothesis that adding an external source of control to the scenes would produce a decrease in rating levels for the ad-positions *in* and *on*, Finnish *–ssa* and *–lla*, and Spanish *en* to an increasing degree the higher the located object was positioned, received no real support. Interestingly for the English analyses there was a higher level interaction in which ad-position interacted with not only height and external control factors, but also with levels of reference object. However, when the data was divided by reference object for follow-up analyses neither of these interactions came up as significant. This indicates that even though the predicted pattern was visible when the bowl was the reference object for the ad-position *in*, the significant part of the original analysis must have been between levels of reference object. Furthermore, a nearly significant interaction suggests that the Finnish ad-position *–ssa* was more sensitive to the combined manipulation of height and external control than *–lla*. This does not, however, lend clear support for the hypothesis as it was only a marginally significant interaction. Additionally, the Spanish language study showed absolutely no support for the hypothesis whatsoever.

2.2.4 Summary for Experiments One and Two

In conclusion, both Experiments One and Two produced results which suggested that the type of object that was being described affected the language choice used for describing the spatial relationship in both English and Finnish. The terms *on* and its Finnish counterpart *–lla* were favoured as descriptors if the object was more appropriate for support, whether purely due to the concavity levels (i.e. less concave) of an object that was named a dish (super-ordinate of plate and bowl), or whether it did indeed look like a plate and was also labelled as one. In contrast, if the object was more appropriate for containment because it was very concave regardless of being named a dish (super-ordinate of plate and bowl), or if it did indeed look like a bowl and was also labelled as one, then the terms *in* and its Finnish counterpart *–ssa* were favoured as descriptors. However, it is clear from the results that there is a cross-linguistic difference in lexical sensitivity when the manipulated factor was purely concavity without alterations in reference object labelling, as although the effect patterns were similar, only the English results produced clearly significant effects.

Also, the height at which a located object was situated above the rim of a dish affected what language was used to describe it. When the dish was considered to be fulfilling the function of containment to some degree (i.e. located object partly enclosed by the rim of the dish) then the word *in, -ssa* (Finnish *in* equivalent), and *en* (Spanish *in/on* equivalent) were chosen as descriptors rather than *on,* or *-lla* (Finnish on equivalent). It should, however, be noted that although the pattern for the Spanish *en* was similar, follow-up analyses indicate that the effect was not quite significant.

There were indications that dynamic-kinematic routine, i.e. location control of the located object by the reference object, was not quite as an important factor influencing the type of spatial language used to describe a relationship between objects as had been predicted based on past research. Location control was manipulated in several different ways across the two experiments. In one of the studies an alternative source of external control was added to the scenes to compete with the location control the reference object had over the located object. The results showed the predicted pattern in which the ad-positions *in, -ssa* (Finnish *in*) and *en* (Spanish *in/on*) all decreased in appropriateness when external control was depicted in the scenes, whereas *on* and *–lla* were not as sensitive. However, none of the discrepancies were at significant levels. Furthermore, the expected detrimental effect on ratings for *in, -ssa*

(Finnish *in*) and *en* (Spanish *in/on*) was not found for scenes in which the reference object was tilted. Finally, the prediction that reference object location control would be compromised over the located object when it was potentially mobile (i.e. fly), received no real support. However, the expected pattern of interaction was only found for the English *in* term, although not at a significant level. Furthermore, the potential animacy of the reference object itself did not have the expected beneficial effect on location control for any of the language groups.

This chapter has examined extra-geometric factors affecting the way we use language to describe object relationships. We have looked at the interplay between object knowledge and dynamic-kinematic routine across the English, Spanish and Finnish languages focussing on topological terms for support and containment. The next chapter will examine the interplay between geometric and extra-geometric factors influencing the production and comprehension of vertical axis projective terms across languages.

Chapter Three

3.0 Examining Projective Vertical Terms

This chapter examines the relationship between geometric and extra-geometric factors in relation to the production and comprehension of vertical axis projective terms cross-linguistically. The intention is to map similarities and/or differences that may exist between the selected languages in the way vertical axis spatial relationships are spoken about. Indeed, the core question: 1) '*To what extent are the different factors influencing spatial language, the same cross-linguistically?*' is addressed in relation to the terms *over/under* and *above/below* and their Finnish and Spanish counterparts. In this chapter three experiments endeavour to examine the effects of not only geometry, but also functional relationships between the reference object and located object. Experiment Three manipulates functional relationship by pairing two objects together which are normally associated with one another (i.e. toothbrush – toothpaste) or not (toothbrush - paint). Alternatively, Experiments Four and Five display objects such as an umbrella or wine glass fulfilling (or not fulfilling) their function, by successfully protecting a person from rain or containing wine respectively. As in the Topological Chapter (Chapter Two), the same three languages (English, Finnish and Spanish) were included in the paradigm as before to represent different language families and/or different branches within those families.

3.1 Rationale and Design for Experiment Three

In the opening chapter of the thesis, we considered relevant literature examining the influences of conceptual knowledge on the understanding and production of vertical axis projective terms. Here more detail is provided about the work carried out by Carlson-Radvansky et al. (1999) investigating the interaction of geometric factors and knowledge of object function, as it provided the basis for the next experiment. .

Carlson-Radvansky and colleagues set out to investigate the influences of 'what' an object is on how we describe 'where' it is. They used a range of objects which had a functional part to one side (i.e. toothbrush, can opener, finger etc.) when pictured from a side view, or with the functional part aligned with the centre of mass when displayed from a frontal view (see Figure 3.1). These pictures were then presented to participants who were asked to place either a related (toothpaste, tin can, nail varnish) or unrelated object (paint tube, mascara, slinky) *above* or *below* the reference object. The dependent measure was the amount of deviation the placement of the located object displayed from a line extended directly through the reference object centre-of-mass. The results show that when the reference object's centre of mass was aligned with the functional end (displayed from the front) there were only minor deviations to either side of the centre-of-mass-line. However, when the reference object was shown in its side view, where the functional part was misaligned with the centre-of-mass, there was a clear bias to deviate away from the centre-of-mass line towards the functional part of the reference object. This tendency to place the located object towards the functional part of the reference object was significantly more marked when the two objects were functionally related than when they were not.

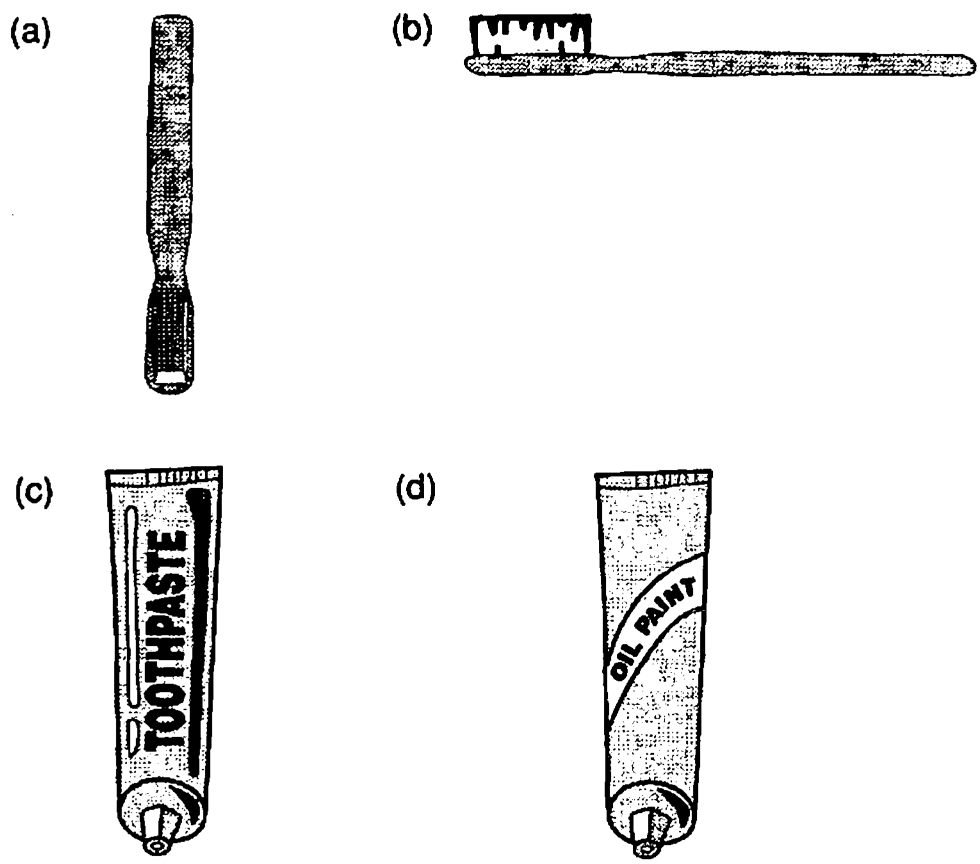


Figure 3.1 Stimuli used in Carlson-Radvansky et al. (1999).

Experiment Three includes some alterations to the design conducted by Carlson-Radvansky et. al. (1999), to allow adaptation to the needs of this present series of cross-linguistic experiments. Only one set of stimuli was selected out of the range of materials used in the original study; they were the toothbrush paired either with the tube of toothpaste or the tube of paint. Also, instead of asking participants to place the located object *above* or *below* the reference object, participants were shown a series of scenes with the located object placed in five differing locations in the area higher than the reference object (see Figure 3.2). They were then asked to rate (1 = totally inappropriate; 7 = totally appropriate) a sentence of the form 'The tube of toothpaste/paint is *ad-position* the toothbrush' or 'The toothbrush is *ad-position* the tube of toothpaste/paint'. The selection of ad-positions provided for English was *above, over, under* and *below*; the Spanish and Finnish sections naturally used native semantic equivalents. The intention was to allow any factors differentiating the available prepositions to become apparent through this comparison. Also, the frontal view toothbrush was eliminated because when the functional end of the toothbrush was aligned with the centre-of-mass in the previous study there were hardly any deviations of preferred placement, and therefore providing such a scene with just one locational relationship to rate seemed pointless.

One of the predictions for Experiment Three was that if the functional effect of the reference object is strong, there would be a general increase in rating levels when any object is placed directly over the bristles of the toothbrush (viewed from side) than when it is aligned according to centre-of-mass. More specifically, this effect was expected to be more emphasised for the functional object association (toothpaste-toothbrush) relationship than for the non-functional object association (tube of paint – toothbrush) relationship. Additionally, following Coventry, Prat-Sala and Richards (2001) it was hypothesised that there would be an effect of ad-position in that functional object association influences would be stronger on the ad-positions *over* and *under* (Finnish *yllä* and *alla,* Spanish *sobre* and *bajo)* than for *above* and *below (*Finnish *yläpuolella* and *alapuolella,* Spanish *encima* and *debajo).* However, *above* and *below* (Finnish *yläpuolella* and *alapuolella,* Spanish *encima* and *debajo)* were expected to show more geometric sensitivity than *over* and *under (*Finnish *yllä* and *alla,* Spanish *sobre* and *bajo)* with ratings decreasing more markedly especially once the located object is positioned outside the reference object boundaries. This would provide support for previous work (Coventry et. al., 2001; Coventry & Mather, 2002; Coventry & Prat-Sala, 1998) which has shown these discrepancies between geometric and functional influences on appropriateness of spatial language. Additionally, it would be interesting to see if such effects would be mirrored by the Finnish and Spanish terms which were thought to be the closest possible semantic translations of the English terms. Indeed, Coventry and Guijarro-Fuentes (2004) found that *sobre* seemed to be more effected by functionality than *encima*. However there appeared to be no such discrimination between *debajo* and *bajo,* as they seemed to both be generally more affected by function than geometry.

3.1.1 Method

The administration of Experiment Three is exactly like for Experiment One and Two of the Topological chapter. Again the three language groups (English, Spanish and Finnish), consisting of 17 participants each, were given the same scenes to rate. The same groups of participants were used throughout the cross-linguistic test series.

3.1.1.1 Materials

Experiment Three had a total of ten scenes that were created by using a combination of drawings and clipart (see figure 3.2). This Experiment was part of a series of eight cross-linguistic experiments that were all administered at once (eighty-five scenes in the full experimental series). All materials were presented as in Experiments One and Two.

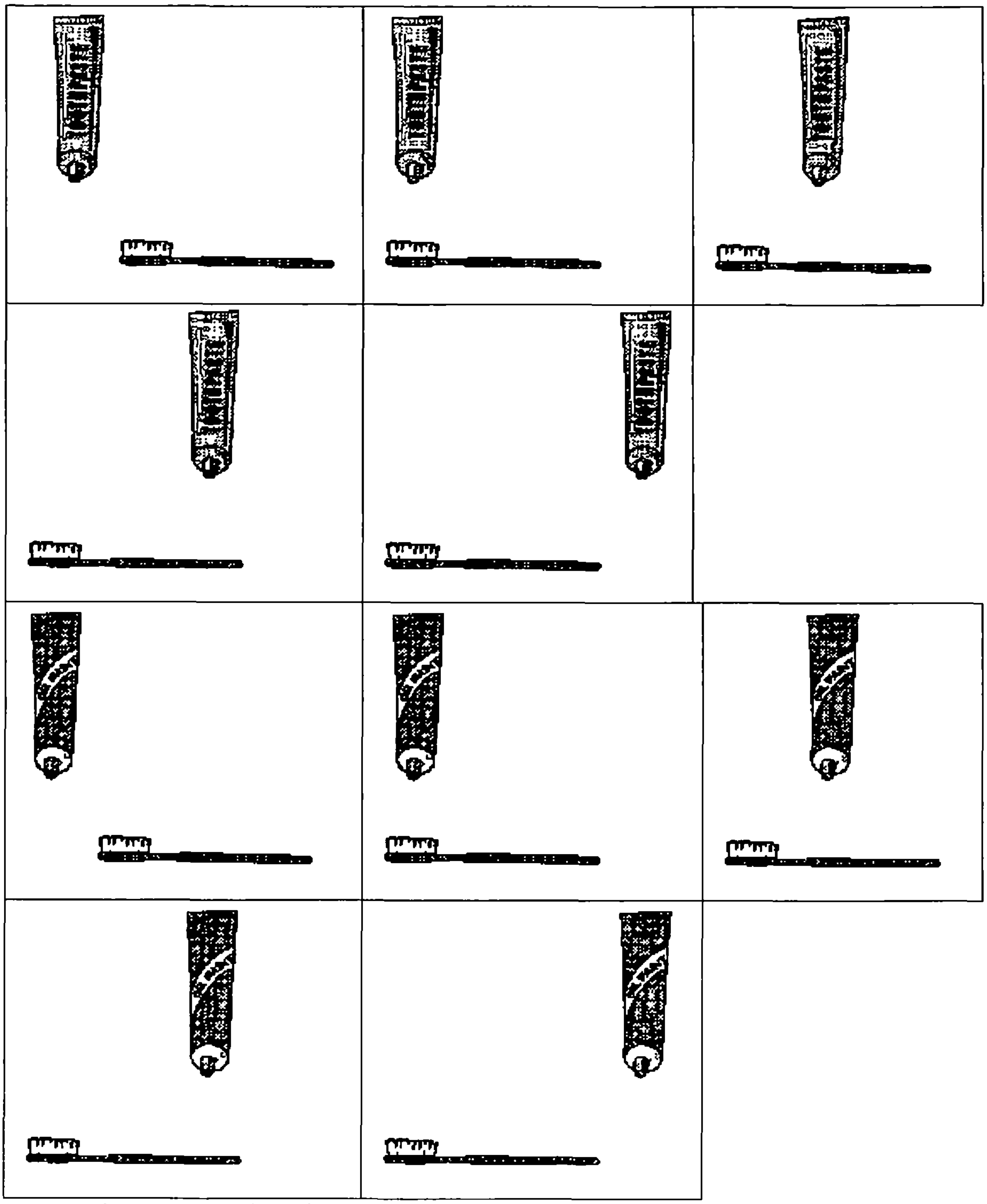


Figure 3.2 Manipulations for Experiment Three.

3.1.1.2 Procedure

The procedure of administration of Experiment Three is identical to that of Experiment One and Two. Each participant received an individual test packet containing all eight randomised experiments in their native languages.

3.1.1.3 Design

The three factor design used in this experiment was the same for all factors across languages. A 2 (figure object) x 5 (location) x 4 (ad-positions) within-participants design was used for the investigation.

3.1.1.3.1 Main Manipulations

Factor 1: Object Association

Two levels of located object were used (see Figure 3.2). The located object was either a tube of toothpaste (functional) or a tube of paint (non-functional) paired with a toothbrush.

Factor 2: Location

Five levels of location were manipulated (see Figure 3.2). The located object (toothpaste/paint) was illustrated in a canonical position in five different locations higher than the horizontally positioned toothbrush. The figure is always positioned 1.7 cm higher than the bristles of the toothbrush, and the toothbrush is 6.6 cm long. The first location displays the edge of the figure about 0.6 cm to the left of the bristle end of the toothbrush. The second position of the figure is about 1.0 cm to the right of the first location, centred directly above the bristles of the toothbrush. The third figure location is again about 1.0 cm to the right of the second location, which is directly at centre-of-mass above the middle of the toothbrush handle. The fourth figure location is again about 1.0 cm to the right of the third location bringing the figure above the handle tip of the toothbrush. The final location is again 1.0 cm to the right of the fourth location bringing the figure about 0.6 cm over the tip of the handle end of the toothbrush.

Factor 3: Ad-position of sentence

There were four levels of ad-positions in use in which each of the three language groups (English, Finnish, and Spanish) viewed sentences in their native languages. The four English sentences under each scene were of the form: 'The tube of toothpaste/paint is *above* the toothbrush'; or 'The toothbrush is *under* the tube of toothpaste/paint'. The four Finnish sentences under each scene were of the form: 'Hammastahna/maali on hammasharjan *yllä*; or 'Hammasharja on hammastahnan/maalin *alla.*' Finally, the four Spanish sentences under each scene were of the form: 'El tubo de dentifrico/pintura está *sobre* el cepillo de dientes'; or 'El cepillo de dientes está *debajo* del tubo de dentifrico/pintura.' The specific ad-positions that were rated by the language groups are reported in Table 3.1.

Table 3.1 *The four ad-positions used for each language group in Experiment Three*

English	Above	Over	Under	Below
Finnish	Yläpuolella	Yllä	Alla	Alapuolella
Spanish	Encima	Sobre	Bajo	Debajo

3.1.2 Results

In this experiment a repeated measures analysis of variance was carried out separately for each language group. The chosen alpha level is .05 throughout all the statistical analyses in this thesis. Throughout the cross-linguistic section of this thesis, Tukey (HSD) was the follow-up analysis of choice when further investigation was required. The results of each separate three-way ANOVA are reported individually below for each language group in separate sections which include tables of mean ratings. Furthermore, the full ANOVA tables can be found in Appendix Two.

3.1.2.1 ENGLISH

The mean ratings by condition are displayed in Table 3.2.

Table 3.2. *The mean ratings of the English group for each condition in Experiment Three (N=17).*

Manipulated Object	**Location**	*above*	**Ad-position** *Over*	*under*	*Below*
Paint	Left	4.47	1.76	2.76	3.12
	Brush end	6.12	6.12	5.94	6.00
	Centre	5.82	5.94	5.94	5.94
	End tip	5.94	5.71	5.76	5.82
	Right	4.65	1.76	3.24	3.59
Toothpaste	Left	4.35	2.00	3.00	4.12
	Brush end	6.35	6.24	6.47	6.18
	Centre	6.29	5.76	6.12	6.12
	End tip	6.29	5.47	5.76	6.18
	Right	3.59	1.94	2.06	3.76

Unsurprisingly, there was a significant main effect of Location $F(4,64) = 51.09$, $p<0.001$, MSE = 6.64 present. The highest rating levels were given over the body of the reference object, the brush end (M = 6.18) with highest ratings, the next highest ratings were for the centre of mass location (M = 5.99), followed by the tip end of the toothbrush (M = 5.87) Unfortunately none of these differences were significant (p>0.05), therefore no support was provided for the experimental prediction of functional effect. The visibly lowest rating levels were apparent for the locations that were outside of the reference object boundaries (left side M = 3.20; right side M = 3.07). There was also an apparent main effect of Ad-position $F(3,48) = 9.49$, $p<0.001$, MSE = 4.18. *Above* (M = 5.39) received higher ratings than *over* (M = 4.27), whereas *below* (M = 5.08) was rated higher than *under* (M = 4.71).

Furthermore, there was a significant two-way interaction between Location x Ad-position $F(12,192) = 4.25$, $p<0.001$, MSE = 2.21 (See Figure 3.3). As might be expected all spatial terms have the lowest rating levels when the located object is situated outside the reference object boundaries (left: *above* M = 4.41, *over* M = 1.88, *under* M = 2.88, *below* M = 3.62; right: *above* M = 4.12, *over* M = 1.85, *under* M = 2.65, *below* M = 3.68). These lower ratings did however discriminate between ad-positions in that both *under* and *over* were less appropriate descriptors than *above* and *below* when the located object was positioned outside the boundaries of the reference object, which seems to be against the prediction for geometric sensitivity. However, only the superior relationship terms (*above* and *over*) showed a significant discrepancy between one another ($p <0.0001$), whilst the inferior relationship terms (*under* and *below*) did not (p>0.05). Furthermore, there are slight indications that *over* (brush M = 6.18, centre M = 5.85, end tip M = 5.59) and *under* (brush M = 6.21, centre M =6.03, end tip M = 5.76) deteriorate more than *above* (brush M = 6.24, centre M = 6.06, end tip M = 6.12) and *below* (brush M = 6.09, centre M = 6.03, end tip M = 6.00) the further the located object is positioned from the functional end of the toothbrush. However, these differences were not at a significant level (p>0.05), therefore it is only possible to say that this pattern suggests a subtle trend.

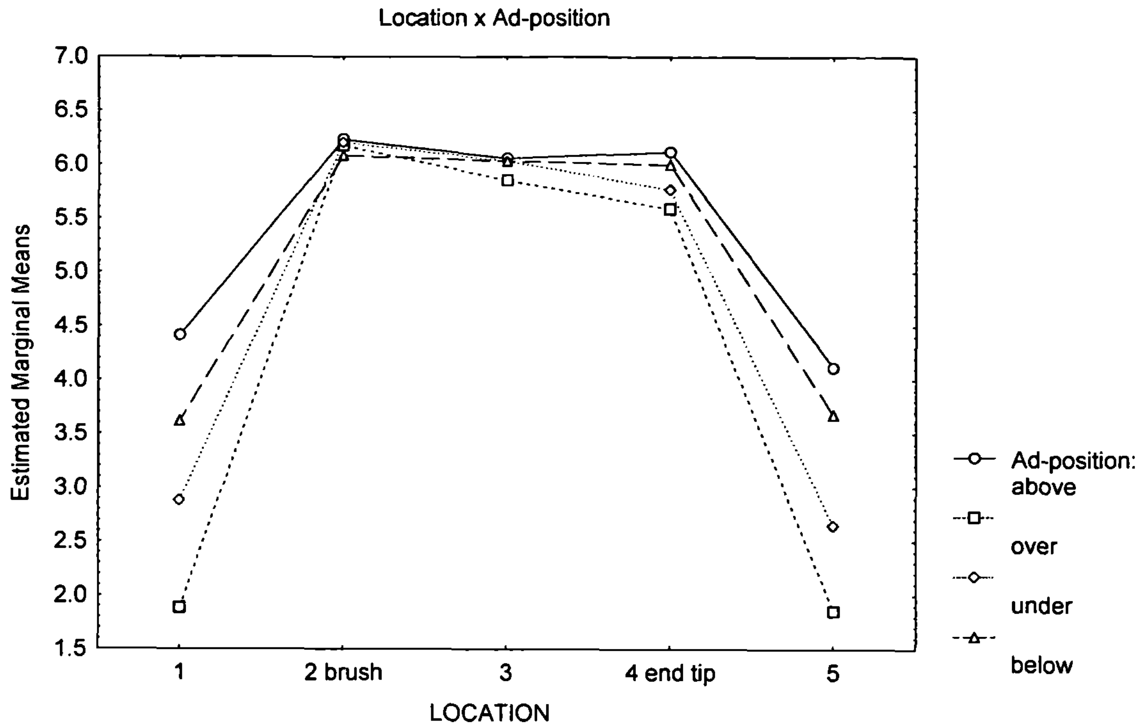


Figure 3.3 *Significant two-way interaction for the English group in ExperimentThree.*

Finally, there was a significant three-way interaction between Object Association x Location x Ad-position $F(12,192) = 2.05$, $p<0.05$, MSE = 0.80 (see Figure 3.4). On inspecting the interaction where the located object was placed within the reference object boundaries there was indication that when the functional object relationship was present (toothbrush/toothpaste) *under* (brush M = 6.47; centre M = 6.12; end tip M = 5.77) and *over* (brush M =6.24; centre M = 5.77; end tip M = 5.47) show a decrease (not significantly p>0.05) in ratings the further the located object was situated from the functional part of the reference object. However, the rating levels for *above* (brush M =6.35; centre M = 6.29; end tip M = 6.29) and *below* (brush M =6.18; centre M = 6.12; end tip M = 6.18) in the functional condition seem to be quite level when the located object was within the reference object boundaries. Furthermore, when the located object (toothpaste) was placed either to the right (*above* M = 3.59, *over* M = 1.94, *under* M = 2.06, *below* M = 3.77) or left (*above* M = 4.35, *over* M = 2.00, *under*

M = 3.00, *below* M = 4.12) of either end of the reference object the ratings were generally very low across ad-positions indeed with *under* and *over* being more detrimentally affected (mostly at a significant level $p<0.05$) than the ratings for *above* and *below* which is the opposite pattern of geometric sensitivity expected by the hypothesis.

In contrast, when scrutinising the rating levels for the scenes in which the located object was placed within the reference object boundaries and the non-functional object relationship (paint-tube/toothbrush) was presented there was no such discrimination in the mean rating levels across spatial terms regardless of whether the figure object was located directly higher than the functional end of the reference object (*above* M = 6.12, *over* M = 6.12, *under* M = 5.94, *below* M = 6.00) or directly over the middle (*above* M = 5.82, *over* M = 5.94, *under* M = 5.94, *below* M = 5.94) or further towards the other end (*above* M = 5.94, *over* M = 5.71, *under* M = 5.77, *below* M = 5.82). However, once again when the located object (paint-tube) was situated outside the reference object boundaries ratings for all ad-positions dropped significantly ($p<0.05$) with *under* and *over* once again displaying the most sensitivity to geometric manipulations whether on the left (*above* M = 4.47, *over* M = 1.77, *under* M = 2.77, *below* M = 3.12) or right (*above* M = 4.65, *over* M = 1.77, *under* M = 3.24, *below* M = 3.59) of the reference object.

Hence, this interaction pattern seems to provide very little support for the predictions that *above* and *below* would be more sensitive to geometric manipulations than *over* and *under*, as the pattern seems to suggest the opposite. Nor is there any real support for the prediction that *over* and *under* would be more sensitive to functional manipulation than *above* and *below*. Although there is some tentative (not significant) support that *over* and *under* are more sensitive to geometric manipulation over the body of the reference object, but only when there is a functional object association present.

Furthermore, rating levels drop visibly across all ad-positions when the figure object is situated outside the reference object boundaries regardless of whether there is a functional relation present or not, although there is some evidence that ratings for *below* but especially *above* ($p<0.05$) are always reduced the least despite this greater geometric compromise. This would seem to contradict the prediction that *above* and *below* are more geometrically sensitive than *over* and *under*. However, *above* and *below* are also clearly the most popular ad-positions in terms of perceived appropriateness across all the experimental conditions (refer to main-effect of ad-position).

None of the other main effects or interactions were significant in this experiment.

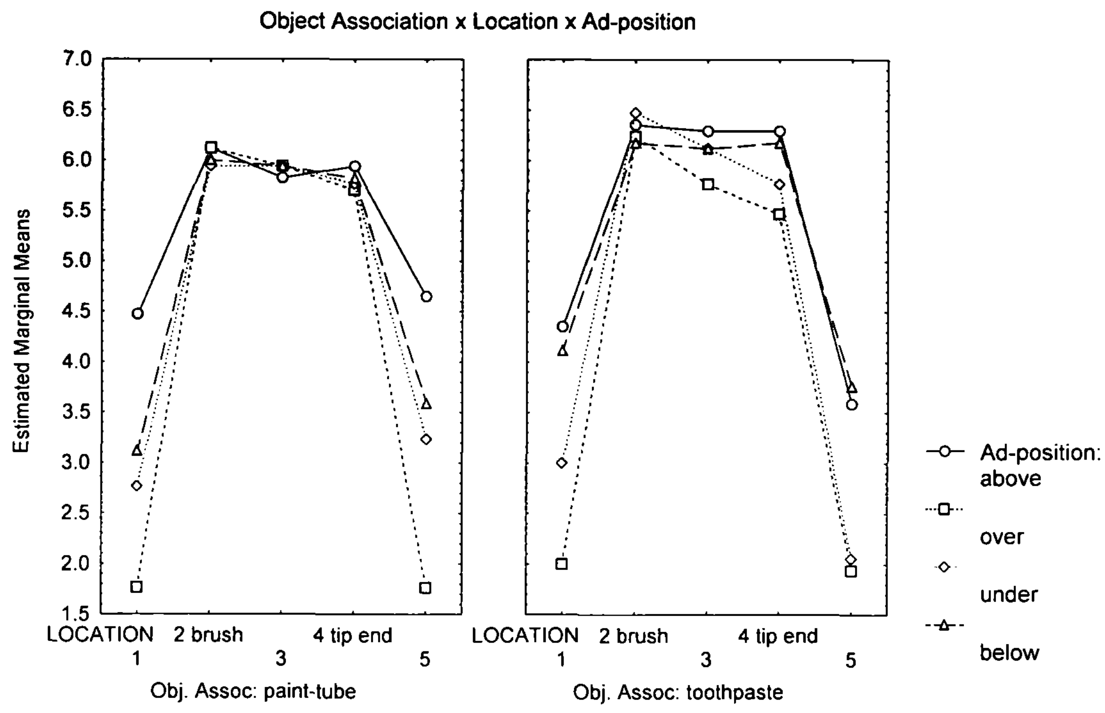


Figure 3.4 *Significant three-way interaction for the English group in Experiment Three.*

3.1.2.2 FINNISH

The mean ratings by condition are displayed in Table 3.3.

Table 3.3 *The mean ratings of the Finnish group for each condition in Experiment Three (N=17).*

Manipulated Object	Location	*yllä*	Ad-position *Yläpuolella*	*alla*	*Alapuolella*
Paint	1	3.18	5.18	3.00	5.82
	2	5.71	6.71	6.12	6.76
	3	5.76	6.88	5.94	6.82
	4	4.82	6.53	5.12	6.35
	5	2.82	5.47	2.94	5.41
Toothpaste	1	3.12	6.12	3.29	6.24
	2	6.12	6.94	6.18	6.82
	3	5.76	6.88	5.76	6.65
	4	4.53	6.53	5.41	6.12
	5	2.24	5.88	2.76	6.06

A significant main effect of Location $F(4,64) = 17.36$, $p<0.001$, $MSE = 8.24$ was present in which as expected locations outside of the reference object boundaries had the lowest ratings (left M = 4.49; right M = 4.20), and the locations over the main body of the reference object had highest ratings showing a decrease in ratings the further the located object was placed from the functional part of the reference object (brush M = 6.42; centre M = 6.31; end tip M = 5.68). Although the predicted pattern is visible, the discrepancies over the body of the reference object were not at a significant level. Thus, no real support has been gained for the hypothesis.

There was also a main effect of Ad-position $F(3,48) = 17.93$, $p<0.001$, $MSE = 10.10$; with the ad-positions *yläpuolella* (*above* M = 6.31) and *alapuolella* (*below* M = 6.31) getting noticeably higher ratings than *alla* (*under* M = 4.65) and *yllä* (*over* M = 4.41). This result mirrors the pattern found for the English language.

Furthermore, there was a two-way interaction between Location x Ad-position $F(12,192) = 8.35$, $p<0.001$, $MSE = 1.47$ (see Figure 3.5). The ad-positions *yläpuolella* (*above* left M = 5.65; brush M = 6.82; centre M = 6.88; end tip M = 6.53; right M =

5.68) and *alapuolella* (*below* left M = 6.03; brush M = 6.79; centre M = 6.74; end tip M = 6.24; right M = 5.74) show reasonably high rating levels throughout locations. The only significant ($p<0.05$) dip in ratings is for the ad-position *yläpuolella* when the located object is positioned outside the reference object boundaries. In contrast, *alla* (*under* brush M = 6.15; centre M = 5.85; end tip M = 5.26) and *yllä* (*over* brush M = 5.91; centre M = 5.76; end tip M = 4.68) show rating levels which are quite high over the reference object body, but are significantly compromised (in each case $p <0.0001$) when the located object is situated outside the reference object boundaries (*alla*: left M = 3.15, right M = 2.85; *yllä*: left M = 3.15, right M = 2.53). There is even a visible rating dip for *alla* and *yllä* when the located object is positioned over the body of the reference object but furthest away from the functional end, although this effect is only significant ($p<0.05$) for *yllä*. This leads us to draw the conclusion that *yläpuolella* and *alapuolella* are less compromised by geometric constraints than *yllä* and *alla,* which seems to go against the experimental hypothesis.

None of the other main effects or interactions were significant in this experiment.

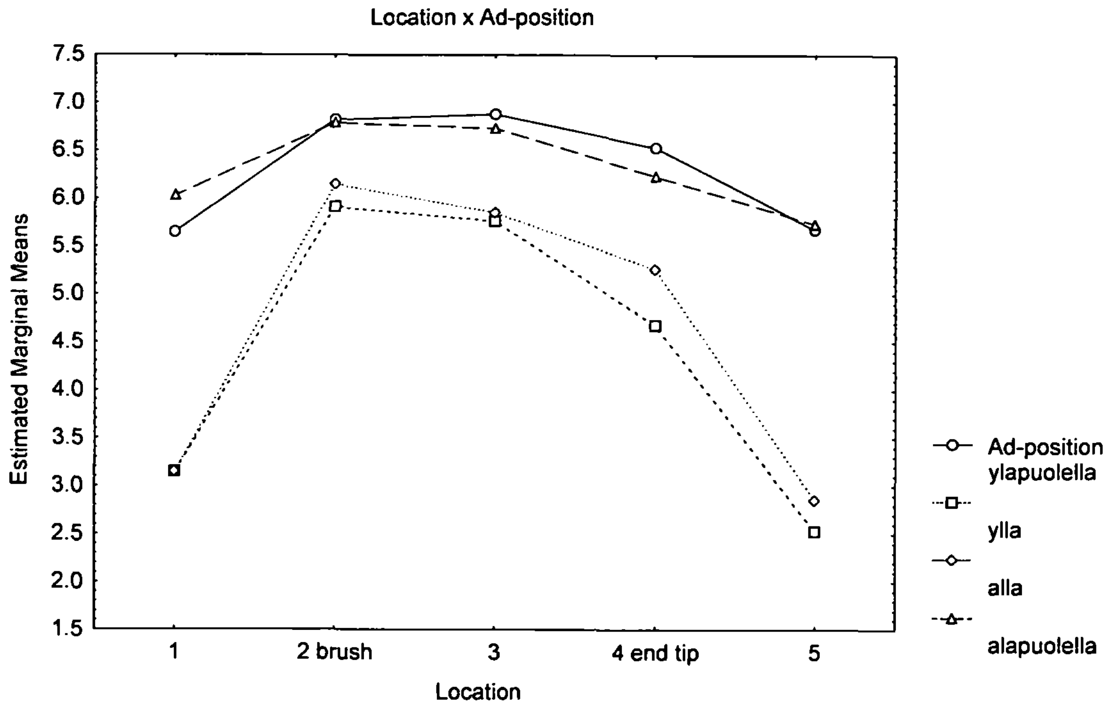


Figure 3.5 *Significant two-way interaction for the Finnish group in Experiment Three.*

3.1.2.3 SPANISH

The mean ratings by condition are displayed in Table 3.4.

Table 3.4. *The mean ratings of the Spanish group for each condition in Experiment Three (N=17).*

Manipulated Object	Location	Ad-position *Sobre*	*Encima*	*debajo*	*bajo*
Paint	1	2.41	3.06	2.76	3.06
	2	3.65	4.76	5.12	4.59
	3	2.76	4.82	5.24	4.06
	4	3.35	5.00	4.82	4.41
	5	2.00	2.59	2.65	2.41
Toothpaste	1	2.53	2.65	3.00	2.76
	2	3.18	5.35	5.47	4.24
	3	3.47	4.88	5.18	4.35
	4	2.88	4.76	4.53	3.65
	5	1.59	2.53	2.65	2.29

A significant main effect of Location $F(4,64) = 12.91$, $p<0.001$, $MSE = 10.64$ was found with a similar pattern of effect as for the English and Finnish groups.

The rating means were the highest when the located object was within the reference object boundaries and significantly ($p<0.001$) lowest when outside of them (left M = 2.78; brush M = 4.54; centre M = 4.35; end tip M = 4.18; right M = 2.34). There was also a pattern of decrease in acceptability ratings when the located object was positioned further away from the functional end of the reference object along the body of the toothbrush, however, this again was not significant. Thus, no real support has been gained for the hypothesis.

Additionally a main effect of <u>Ad-position</u> $F(3,48) = 5.65$, $p<0.01$, MSE = 11.54 was found with *encima* (*above* M = 4.04) and *debajo* (*below* M = 4.14) demonstrating highest rating levels and also *bajo* (*under* M = 3.58) is rated quite highly, whereas *sobre* (over M = 2.78) has the lowest ratings of all. This pattern deviates from what has been found across English and Finnish suggesting that there is not as much discrimination between the two Spanish inferior terms (*bajo* and *debajo*) although the familiar pattern for favouring *encima* (the *above* term) to *sobre* (the *over* term) is apparent.

A significant two-way interaction between <u>Location x Ad-position</u> $F(12,192) = 2.03$, $p<0.05$, MSE = 1.90 repeats the effect patterns for Spanish reported above (Figure 3.6). *Debajo* (left M =2.88, brush M = 5.29, centre M = 5.21, end tip M = 4.68, right M = 2.65) and *encima* (left M = 2.85, brush M = 5.06, centre M = 4.85, end tip M = 4.88, right M = 2.56) show the highest rating levels with no significant ($p>0.05$) distinction in ratings when located within the boundaries of the reference object, however decreasing to a significantly ($p<0.0001$) lower level when outside the boundaries. Also, *bajo* (left M = 2.91, brush M = 4.41, centre M = 4.21, end tip M = 4.03, right M = 2.35) displays relatively high rating levels when positioned over the reference object body with significantly ($p<0.0001$) lower ratings outside the boundaries. However, *sobre* (left M = 2.47, brush M = 3.41, centre M = 3.12, end tip M = 3.12, right M = 1.79) shows the lowest rating levels throughout even when the located object is positioned within the object boundaries, but significantly (p<0.0001) lower rating levels are found outside the reference object boundaries. This higher level interaction supports the findings of the main effects for the Spanish language group but is not really in accordance with the predictions for a more discriminatory geometrical sensitivity for the ad-positions *encima* and *debajo*.

None of the other main effects or interactions were significant in this experiment.

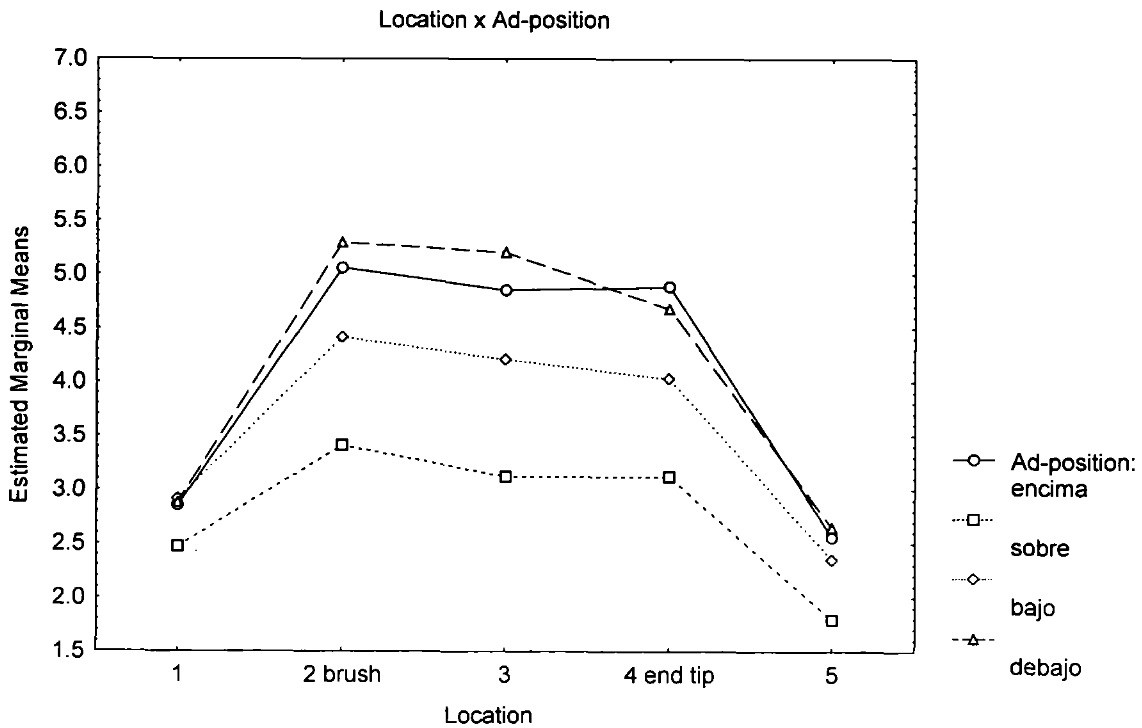


Figure 3.6 *Significant two-way interaction for the Spanish group in Experiment Three.*

3.1.3 Experiment Three Discussion (Toothbrush)

A summary of all the main-effects and interactions that were found in Experiment Three throughout all three language groups can be found below in Table 3.5.

***Table 3.5** Significant main effects and interactions across language groups in Experiment Three (Toothbrush).*

	English	Finnish	Spanish
Main Effects			
Object Association			
Location	X	X	X
Ad-position	X	X	X
2-way interactions			
Obj. Assoc. x Location			
Obj. Assoc.xAd-position			
Location x Ad-position	X	X	X
3-way interactions			
Obj. Assoc. x Location x Ad-position	X		

The general prediction that all ad-positions would be rated highest the nearer the located object was positioned to the reference object's functional end was not supported by the results of any of the language groups (English, Finnish, Spanish). Even though the pattern was often there the discrepancy was never significant. Furthermore, the hypothesis that the location effect would be emphasised when there was also a functional object association between the located and reference objects, did not receive any support from the results of the Finnish and Spanish sections. There was, however, a higher level interaction for the English study where such an effect pattern was present, but again not at a significant level. The English ad-positions *over* and *under* were affected more detrimentally by positioning the toothpaste further away from the functional bristle end of the brush, however this was not a significant interaction.

Also, the simple prediction that the presence of a functional object association would have a differentiating affect on certain ad-positions (*over* and *under* and Finnish and Spanish equivalents) in all three language groups did not receive any support. This leads to the suspicion that perhaps the two objects that were chosen to represent a functionally relevant (toothpaste) and non-relevant object (paint tube) association with the reference object (toothbrush) might not have been salient enough for the appearance of a significant effect across different language groups. This lack of a clear result may have differed from the original findings of the Carlson-Radvansky et al. (1999) investigation because the present design did not include any other object association pairs that were present in the original piece of research. Therefore, it is possible that the expected effect did not emerge because the object choice happened to be one of the less influential sets of material contributing to the functional object association effect that they found.

Finally, the hypothesis that the ad-positions *above* and *below*, *yläpuolella* and *alapuolella*, and *encima* and *debajo* would display a discriminating geometric sensitivity, when compared with the other ad-positions, was not supported. In fact what seemed to be found was that *under* and *over* (Finnish *yllä* and *alla*, Spanish *sobre* and *bajo*) showed increasingly compromised rating levels the more the geometry was compromised.

This would seem to contradict the prediction that *above* and *below* and Finnish and Spanish counterparts are more geometrically sensitive than *over* and *under*. However, *above* and *below* (and counterparts) are also clearly the most popular ad-positions in terms of perceived appropriateness collapsed across all the experimental conditions (refer to main-effects of ad-position across languages). Additionally, it is possible that a geometric effect could be found if the sample sizes were larger. Greater numbers of participants might also help bring out functional influences cross-linguistically.

3.2 Rationale and Design for Experiments Four and Five

The first chapter of this thesis outlined research that has explored the effects of factors such as functional and dynamic-kinematic manipulations in combination with geometry on the comprehension and production of English inferior/superior projective terms. This section endeavours to provide a more comprehensive overview of the work conducted by Coventry and colleagues (Coventry et. al., 2001). The focus will be on Experiment One of their research which has been a model for the work carried out in Experiment Four and Five in the present doctoral thesis.

The study set out to inspect the differential influences of function and geometry on the ad-positions *above/over/below/under*. The experiment involved two different types of stimuli; one set involved using a located object which provided protection from falling objects (i.e. umbrella), the second set included using a reference object with the function of containment (i.e. wineglass). For the first type of stimuli the located object was rotated, whereas for the second set of stimuli the reference object was rotated. The rotation was conducted so that the object was displayed in a canonical orientation, 45° angle, or a 90° angle (see figure 3.7). For each level of orientation the located object in material set one or reference object in material set two were shown either fulfilling their function of protection or containment, or not fulfilling their function, or other objects were missing from the scene that would make the functional relation relevant (control condition).

Geometric effects were present in which the further the manipulated object was tilted away from the gravitational plane the less appropriate the projective terms *above* and *below* (umbrella scenes) were for describing the scene, whereas *over* and *under* were not geometrically as sensitive. There was also a significant functional effect in which *over* and *under* were viewed as less appropriate descriptors for non-functional scenes than *above* and *below*.

Experiments Four and Five have been very closely modelled on the work outlined above with only a few alterations to the design. Firstly, the range of materials was reduced to only two; one representing each type of functional stimuli (protective object: umbrella; containment object: wineglass). These experiments were extended to Spanish and Finnish language groups in addition to English and due to this cross-linguistic perspective although Coventry et, al. analysed the data by bunching two types of prepositions together for their analyses (e.g. *above/below, over/under*), the present study has treated each lexical item individually. This was done to allow for any possible subtle differences in meaning to emerge across languages that were not necessarily apparent through simple translation. Also, in Experiment Six the 90° angle condition for the wineglass was eliminated to allow stronger focus on potential significant differences between canonical and 45° orientations that may be otherwise overshadowed by very low rating levels for the most inappropriate 90° angle.

The hypotheses for Experiment Four and Five were in accord with the Coventry et. al. (2001) findings reported above. Hence, for the English group the predictions were that *over* and *under* (Finnish: *yllä, alla*; Spanish: *sobre*, *bajo* respectively) would be most affected by function, whereas *above* and *below* (Finnish: *yläpuolella*, *alapuolella*; Spanish: *encima*, *debajo* respectively) would be most sensitive to geometric manipulations. The predictions were similar for the Finnish language which has superior and inferior projective terms that roughly translate to the English lexical items. However, Coventry and Guijarro-Fuentes (in 2004) have run a similar experimental paradigm to that used by Coventry et. al. (2001), but in addition to having an English group they had a Spanish one as well, and found no effect of geometry for the Spanish group. In fact, in Spanish a differential effect was found for superior relations alone in that *sobre* was affected more by function than *encima*. Therefore, the present experiment was expected to produce a functional effect that was more pronounced for the Spanish superior term *sobre* than for the other superior term *encima* or either of the inferior ones *(bajo, debajo)*.

Experiment Four

3.2.1 Method

The administration of Experiment Four is identical to that used for all above reported experiments. Again the three language groups (English, Spanish and Finnish), consisting of 17 participants each, were given the same scenes to rate. The same groups of participants were used throughout the cross-linguistic test series.

3.2.1.1 Materials

Experiment Four had a total of 9 scenes that were borrowed from the earlier study by Coventry et. al. (2001; see figure 3.7). This Experiment was part of a series of eight cross-linguistic experiments that were all administered at once (eighty-five scenes in the full experimental series). All materials were presented as in Experiments One, Two, and Three.

3.2.1.2 Procedure

The procedure of administration of Experiment Four is identical to that of Experiment One, Two and Three. Each participant received an individual test packet containing all eight randomised experiments in their native languages.

Figure 3.7 The main manipulations for Experiment Four.

3.2.1.3 Design

The three factor design used in this experiment was the same for all factors across languages. A 3 (function) x 3 (angle) x 4 (ad-positions) within-participants design was used for the investigation (see Table 3.5).

3.2.1.3.1 Main Manipulations

Factor 1: Function

Three levels of function were manipulated (see Figure 3.7). In the 'functional' condition the umbrella was illustrated fulfilling its purpose in that it was protecting the man from rain. In the 'non-functional' condition the rain was falling onto the man passed the umbrella. In contrast, in the control condition no rain present in the scene.

Factor 2: Angle

Three levels of angle were used (see Figure 3.7). A man was depicted holding an umbrella in his hand in either a canonical position, or tilted at a 45° angle, or positioned horizontally in front of him at a 90° angle.

Factor 3: Ad-position of sentence

There were four levels of ad-positions in use in which each of the three language groups (English, Finnish, and Spanish) viewed sentences in only their native languages. The four English sentences under each scene were of the form: 'The umbrella is *above* the man'; or 'The man is *under* the umbrella'. The four Finnish sentences under each scene were of the form: 'Sateenvarjo on miehen *ylla'*; or 'Mies on sateenvarjon *alla'*. Finally, the four Spanish sentences under each scene were of the form: 'El paragüas está *sobre* el hombre'; or 'El hombre está *debajo* del paragüas.' The specific ad-positions that were rated by the language groups are reported in Table 3.5.

Table 3.6 *The four ad-positions used for each language group in Experiment Four*

English	Above	over	Below	under
Finnish	Yläpuolella	yllä	Alapuolella	alla
Spanish	Encima	sobre	Debajo	bajo

3.2.2 Results

In this experiment a repeated measures analysis of variance was carried out separately for each language group. The chosen alpha level is .05 throughout all the statistical analyses in this thesis. Throughout the cross-linguistic section of this thesis, Tukey (HSD) was the follow-up analysis of choice when further investigation was required. The results of each separate three-way ANOVA are reported individually below for each language group in separate sections which include tables of Mean ratings. Furthermore, the full ANOVA tables can be found in the Appendix Two.

3.2.2.1 ENGLISH

The mean ratings by condition are displayed in Table 3.6.

Table 3.7 *The mean ratings of the English group for each Condition in Experiment Four (N=17).*

Function	Angle	Ad-position			
		above	*over*	*below*	*under*
no rain	0°	4.76	1.35	4.76	1.88
	45°	3.65	2.71	3.88	2.82
	90°	1.53	1.47	1.53	1.59
Protected	0°	4.82	2.71	5.29	2.94
	45°	3.82	2.82	3.82	3.41
	90°	2.12	2.71	2.88	3.35
Rain	0°	4.00	1.53	3.71	1.35
	45°	3.29	1.59	3.47	1.76
	90°	2.18	2.06	2.88	2.53

There was a significant main effect of Function $F(2,32) = 6.51$, $p<0.01$, $MSE = 6.76$ in which the functional scene has highest ratings ($M = 3.39$) and both the control ($M = 2.66$) and non-functional ($M = 2.53$) conditions have low rating levels. There was also a main effect of Angle $F(2,32) = 8.06$, $p<0.01$, $MSE = 7.62$ ($p < 0.01$) present unsurprisingly indicating high ratings for the canonical ($M = 3.26$) and 45° ($M = 3.09$) degree angles, whereas the least accepting ratings are illustrated in the 90° ($M = 2.24$) orientation. There was also a significant main effect of Ad-position $F(3,48) = 13.72$, $p<0.001$, $MSE = 5.73$ which demonstrated that *above* ($M = 3.35$) and *below* ($M = 3.58$) were generally viewed as more acceptable terms than *over* ($M = 2.10$) and *under* ($M = 2.41$).

Additionally, there was a significant two-way interaction between Function x Angle $F(4,64) = 3.47$, $p<0.05$, $MSE = 4.16$ (Figure 3.8). In the non-functional condition it made hardly any difference to the appropriateness ratings at what angle the umbrella was positioned (canonical $M = 2.65$, 45° = 2.53, 90° $M = 2.41$) as they were all rated at a similarly low level. In contrast, for the functional scenes the ratings were significantly highest for the canonical scenes ($M =3.94$) then for the scenes in which the umbrella was at a 45° ($M = 3.47$) angle and lowest when it was positioned at a 90° angle ($M = 2.77$); the difference between the canonical and 90° conditions was significant ($p<0.05$). Finally, for the control condition it made no real difference whether the umbrella was positioned at a 45° ($M = 3.27$) or canonically ($M = 3.19$) as it was rated at a similar reasonable high level, whereas the 90° angle scenes ($M = 1.53$) were rated as significantly ($p<0.0001$) least appropriate. It is worth noting, however, that this interaction collapses across ad-positions.

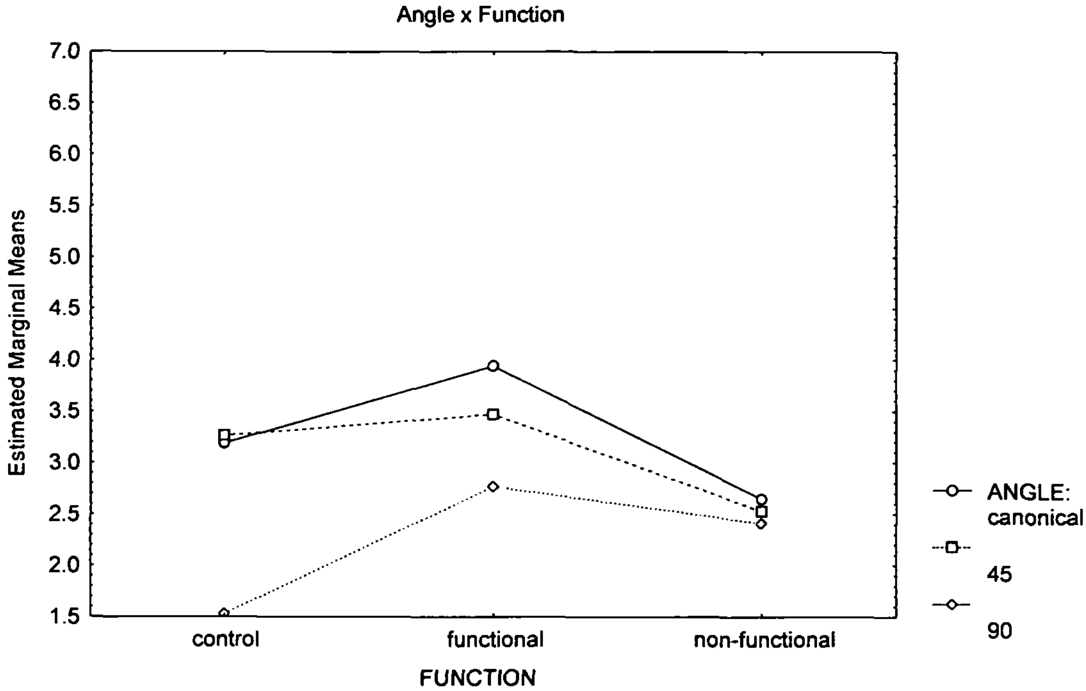


Figure 3.8 *Significant two-way interaction between Angle x Function for the English group in Experiment Four.*

A significant interaction between Function x Ad-position $F(6,96) = 2.70$, $p<0.05$, MSE = 0.98 was present (Figure 3.9). No real discrimination between ratings was found for different levels of function for the ad-positions *above* (control M = 3.31, functional M = 3.59, non-functional M = 3.16) or *below* (control M = 3.39, functional M = 4.00, non-functional M = 3.35). In contrast, *over* (control M = 1.84, functional M = 2.75, non-functional M = 1.73) and *under* (control M = 2.10, functional M = 3.24, non-functional M = 1.88) were rated significantly ($p<0.001$) higher in the functional condition than in the control or non-functional conditions. This is clearly supportive of the predictions made for the English group.

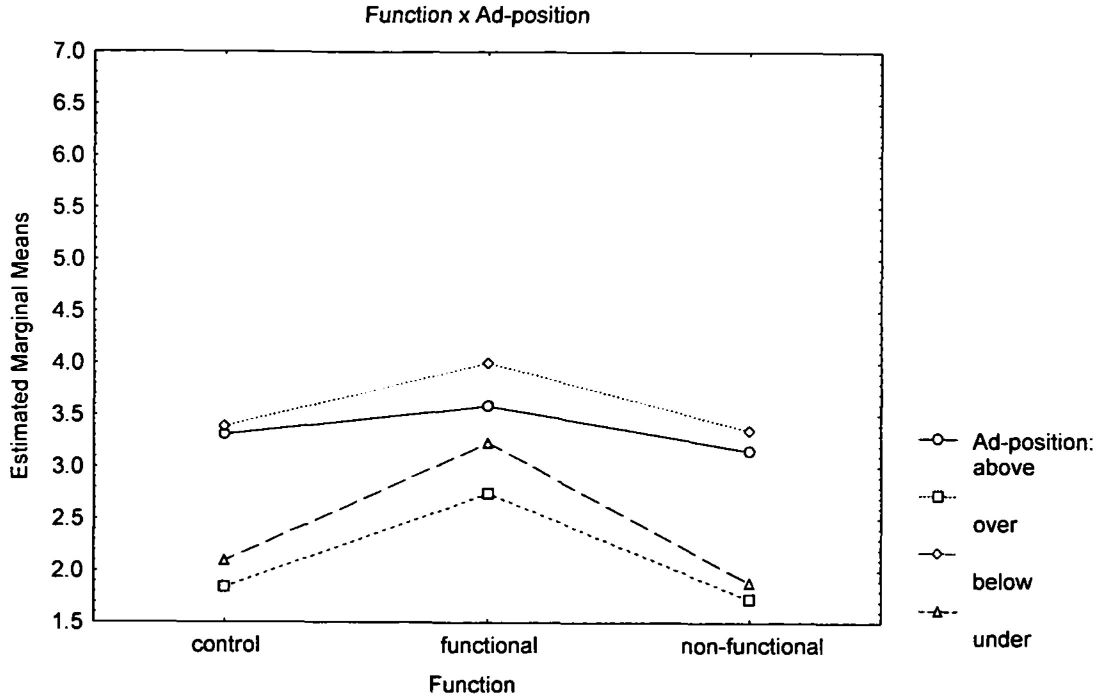


Figure 3.9 *Significant two-way interaction between Function x Ad-position for the English group in Experiment Four.*

Finally there was also a significant interaction between Angle x Ad-position $F(6,96) = 11.45$, $p<0.001$, MSE = 2.75 (Figure 3.10). The term *above* (canonical M = 4.53, 45° M= 3.59, 90° M = 1.94) and *below* (canonical M = 4.59, 45° M= 3.73, 90° M = 2.43) have reduced rating levels the more the orientation of the located object deviates from the canonical (although only significantly $p<0.05$ lower in the 90° condition) . In contrast, *over* (canonical M = 1.86, 45° M= 2.37, 90° M = 2.08) and *under* (canonical M = 2.06, 45° M= 2.67, 90° M = 2.49) seem to have a relatively even but low rating level throughout conditions of orientation showing no significant ($p>0.05$) differences. This interaction pattern provides support for the predictions made for differentiating geometric effects on the English projective terms *above* and *below*.

None of the other main effects or interactions were significant in this experiment.

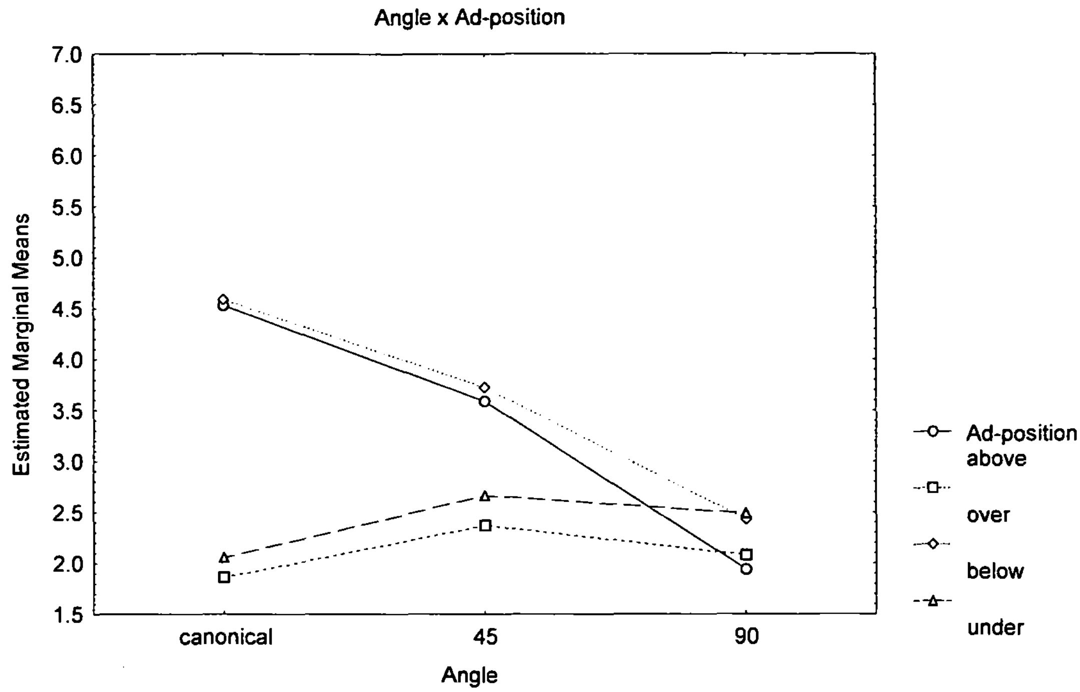


Figure 3.10 *Significant two-way interaction between Angle x Ad-position for the English group in Experiment Four.*

3.2.2.2 FINNISH

The mean ratings by condition are displayed in Table 3.7.

Table 3.8 *The mean ratings of the Finnish group for each Condition in Experiment Four (N=17).*

Function	Angle	Ad-position			
		yllä	*yläpuolella*	*alla*	*alapuolella*
no rain	0°	2.12	5.35	2.47	4.35
	45°	2.29	4.29	3.12	3.71
	90°	1.76	2.82	2.35	3.24
Protected	0°	2.41	5.35	2.82	4.59
	45°	2.88	3.82	3.35	3.47
	90°	1.29	2.59	1.94	2.94
Rain	0°	1.71	4.35	2.24	5.24
	45°	2.35	3.82	2.53	3.35
	90°	1.29	2.29	1.65	2.53

A significant main effect of Angle $F(2,32) = 8.58$, $p<0.01$, $MSE = 11.91$ was found in which the highest ratings were displayed in the canonical ($M = 3.58$) and 45°

(M = 3.25) degree conditions, whereas the 90° (M = 2.23) condition was rated lowest. This effect pattern is very similar to that found for the English group.

There was also a main effect of Ad-position $F(3,48) = 12.21$, $p<0.001$, MSE = 10.30 present in which *yläpuolella* (*above* M = 3.86) and *alapuolella* (*below* M = 3.71) were viewed as more appropriate that *yllä* (*over* M = 2.01) and *alla* (*under* M = 2.50) throughout the experiment which again mirrors the effects in the English analysis.

Additionally, there was a significant two-way interaction between Angle x Ad-position $F(6,96) = 4.05$, $p<0.01$, MSE = 3.85 (Figure 3.11). The terms *yllä* (*over*: canonical M = 2.08, 45° M = 2.51, 90° M = 1.45) and *alla* (under: canonical M = 2.51, 45° M = 3.00, 90° M = 1.98) received rather evenly (no significant differences) low rating levels throughout the Angle conditions. Whislt the ratings of *yläpuolella* (*above*: canonical M = 5.02, 45° M = 3.98, 90° M = 2.57) and *alapuolella* (*below*: canonical M = 4.73, 45° M = 3.51, 90° M = 2.90) decreased as the deviation from the canonical orientation increased, showing a significant ($p<0.01$) difference between the canonical and 90° conditions. Hence, *yläpuolella* and *alapuolella* seem to behave in a similar way to their English counterparts (*above/below*) supporting the experimental prediction.

None of the other main effects or interactions were significant in this experiment.

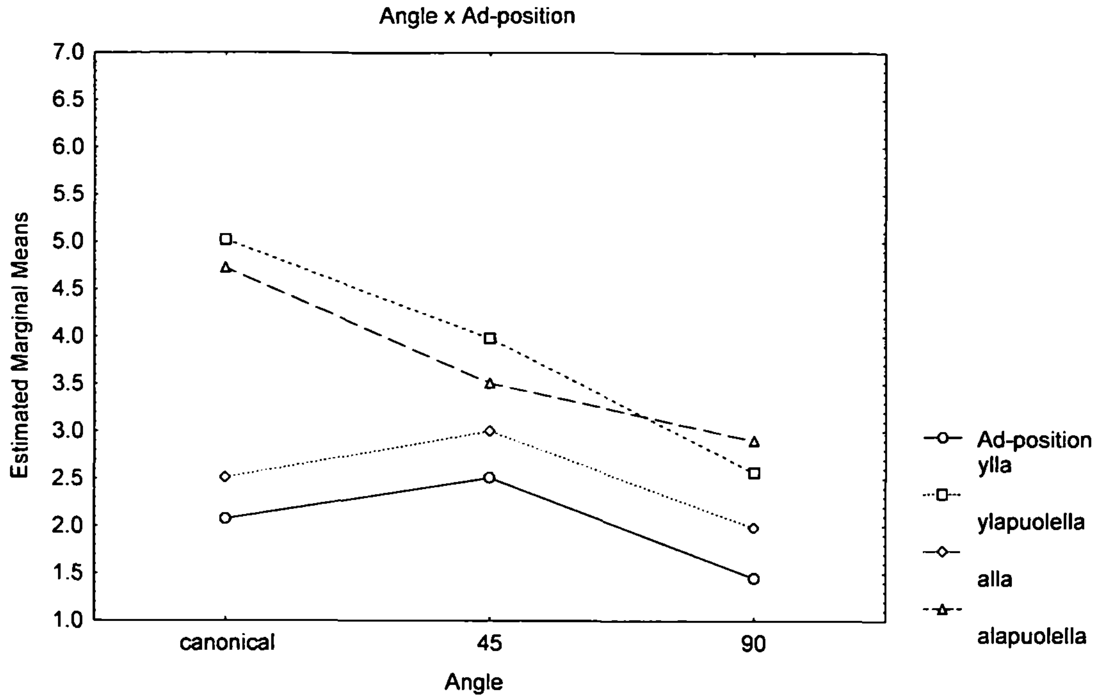


Figure 3.11 *Significant two-way interaction between Angle x Ad-position for the Finnish group in Experiment Four.*

3.2.2.3 SPANISH

No significant main effects or interactions were found for the Spanish language group. The mean ratings by condition are displayed in Table 3.9.

Table 3.9 *The mean ratings of the Spanish group for each Condition in Experiment Six (N=17).*

Function	Angle	Ad-position			
		Sobre	*encima*	*Debajo*	*bajo*
no rain	0°	2.06	1.94	2.53	2.76
	45°	2.35	1.88	1.94	2.59
	90°	1.82	1.71	1.71	1.76
Protected	0°	1.82	1.82	1.88	2.24
	45°	1.94	2.12	2.47	2.53
	90°	1.65	1.76	2.76	2.53
Rain	0°	2.12	2.18	1.82	2.47
	45°	2.06	1.88	2.00	2.12
	90°	1.71	1.35	1.76	1.71

3.2.3 Discussion of Experiment Four

A summary of all the main-effects and interactions that were found in Experiment Four throughout all three language groups can be found below in Table 3.10.

***Table 3.10** Significant main effects and interactions across language groups in Experiment Four (Umbrella).*

	English	Finnish	Spanish
Main Effects			
Function	X		
Angle	X	X	
Ad-position	X	X	
2-way interactions			
Function x Angle	X		
Function x Ad-position	X		
Angle x Ad-position	X	X	
3-way interactions			
Function x Angle x Ad-position			

Significant interactions between Angle and Ad-position were found for the English and Finnish but not for the Spanish group. Hence the predictions that the ad-positions *above* and *below* for English, and *ylapuolella* and *alapuolella* for Finnish would display discrimination at different levels of geometry, were supported. The indications were that the more geometrically compromised the object relations were the less acceptable the terms in question were for describing them. Furthermore, the Spanish lexical terms were not expected to show a differentiating sensitivity to geometric factors in accord with the previous research by Coventry and Guijarro-Fuentes (2004).

A significant interaction between Function and Ad-position was only discovered for the English group as neither the Finnish nor the Spanish interactions were even close to significant levels. Hence, the hypothesis that the terms *over* and *under* were especially sensitive to functional manipulations was supported for the English group but not for the other two language equivalents. It may be that neither the Finnish nor Spanish language groups consider the function of protection from rain salient enough to allow such differentiation of functional influences amongst spatial terms. Alternatively, the sample size of seventeen may not have been adequate to produce functional effects which may be more subtle in these two languages in comparison to English.

Experiment Five

3.2.4 Method

The administration of Experiment Five is identical to that used for all above reported experiments. Again the three language groups (English, Spanish and Finnish), consisting of 17 participants each, were given the same scenes to rate. The same groups of participants were used throughout the cross-linguistic test series.

3.2.4.1 Materials

Experiment Five had a total of 6 scenes that were borrowed from the earlier study by Coventry et. al. (2001; see figure 3.12). This Experiment was part of a series of eight cross-linguistic experiments that were all administered at once (eighty-five scenes in the full experimental series). All materials were presented as in above reported previous experiments.

3.2.4.2 Procedure

The procedure of administration of Experiment Five is identical to that of Experiment One, Two and Three. Each participant received an individual test packet containing all eight randomised experiments in their native languages.

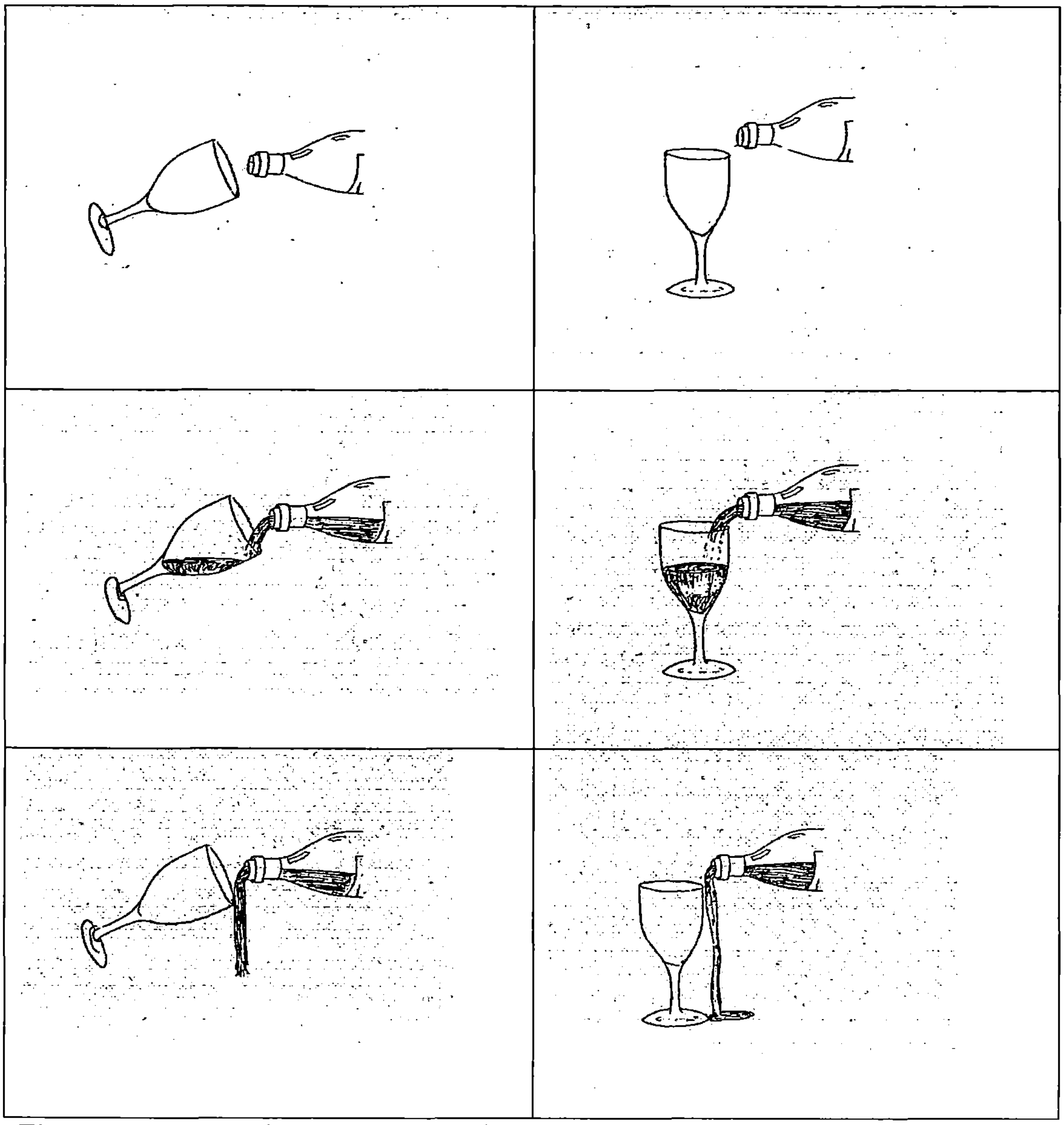


Figure 3.12 The main manipulations for Experiment Five.

3.2.4.3 Design

The three factor design used in this experiment was the same for all factors across languages. A 3 (function) x 2 (angle) x 4 (ad-positions) within-participants design was used for the investigation (see Table 3.11).

3.2.4.3.1 Main Manipulations

Factor 1: Function

Three levels of function were manipulated (see Figure 3.12). In the 'functional' condition the wine-glass was illustrated fulfilling its purpose of containment in that the wine was being poured into it. In the 'non-functional' condition the wine was being poured passed the wine-glass. In contrast, in the 'control' condition no wine was being poured out of the bottle.

Factor 2: Angle

Two levels of angle were used (see Figure 3.12). A wine-glass was depicted in a canonical position, or tilted at a 45° angle.

Factor 3: Ad-position of sentence

There were four levels of ad-positions in use in which each of the three language groups (English, Finnish, and Spanish) viewed sentences in only their native languages. The four English sentences under each scene were of the form: 'The wine-bottle is *above* the glass'; or 'The glass is *under* the wine-bottle'. The four Finnish sentences under each scene were of the form: 'Pullo on lasin *yläpuolella*'; or 'Lasi on pullon *alla*'. Finally, the four Spanish sentences under each scene were of the form: 'La botella está *sobre* el vaso'; or 'El vaso está *debajo* de la botella'. The specific ad-positions that were rated by the language groups are reported in Table 3.11.

Table 3.11 *The four ad-positions used for each language group in Experiment Five*

English	Above	over	below	under
Finnish	Yläpuolella	yllä	alapuolella	alla
Spanish	Encima	sobre	debajo	bajo

3.2.5 Results

In this experiment a repeated measures analysis of variance was carried out separately for each language group. The chosen alpha level is .05 throughout all the statistical analyses in this thesis. Throughout the cross-linguistic section of this thesis, Tukey (HSD) was the follow-up analysis of choice when further investigation was required. The results of each separate three-way ANOVA are reported individually below for each language group in separate sections which include tables of Mean ratings. Furthermore, the full ANOVA tables can be found in the Appendix Three.

3.2.5.1 ENGLISH

The mean ratings by condition are displayed in Table 3.12.

Table 3.12 *The mean ratings of the English group for each Condition in Experiment Five (N=17).*

Function	Angle	Ad-position			
		Above	*over*	*below*	*under*
no wine	Straight	5.00	2.12	5.18	2.24
	Tilted	2.94	3.41	3.35	2.65
spilt wine	Straight	4.59	1.18	4.06	1.53
	Tilted	2.53	1.29	2.35	1.41
Wine	Straight	5.47	3.65	5.65	3.00
	Tilted	3.53	3.71	4.24	3.35

There was a significant main effect of Function $F(2,32) = 16.33$, $p<0.001$, MSE = 6.11 in which the functional condition (M = 4.07) was rated higher than the control (M = 3.36) or non-functional conditions (M = 2.37). However, the control condition and functional conditions had surprising little difference in rating levels suggesting that the non-functional condition emphasised the inappropriateness of the spatial description.

There was also a main effect of Angle $F(1,16) = 6.75$, $p<0.05$, MSE = 8.28 present in which canonical scenes (M = 3.64) were clearly seen as more appropriate than the 45° degree (M = 2.90) orientation scenes.

Furthermore, there was a significant main effect of Ad-position $F(3,48) = 22.93$, $p<0.001$, $MSE = 3.90$ in which *above* ($M = 4.01$) and *below* ($M = 4.14$) were again rated more highly than *over* ($M = 2.56$) and *under* ($M = 2.36$).

There was also a significant two-way interaction between Angle x Ad-position $F(3,48) = 12.66$, $p<0.001$, $MSE = 3.28$ (Figure 3.13). The terms *above* (canonical $M = 5.02$, 45° $M = 3.00$) and *below* (canonical $M = 4.96$, 45° $M = 3.31$) receive significantly ($p<0.001$) higher ratings in the canonical condition than in the 45 degree orientation in support of the experimental hypothesis of geometric sensitivity. Whereas, *over* (canonical $M = 2.31$, 45° $M = 2.80$) and *under* (canonical $M = 2.25$, 45° $M = 2.47$) do not show such discrimination in rating levels regardless of orientation. This result supported the hypothesis.

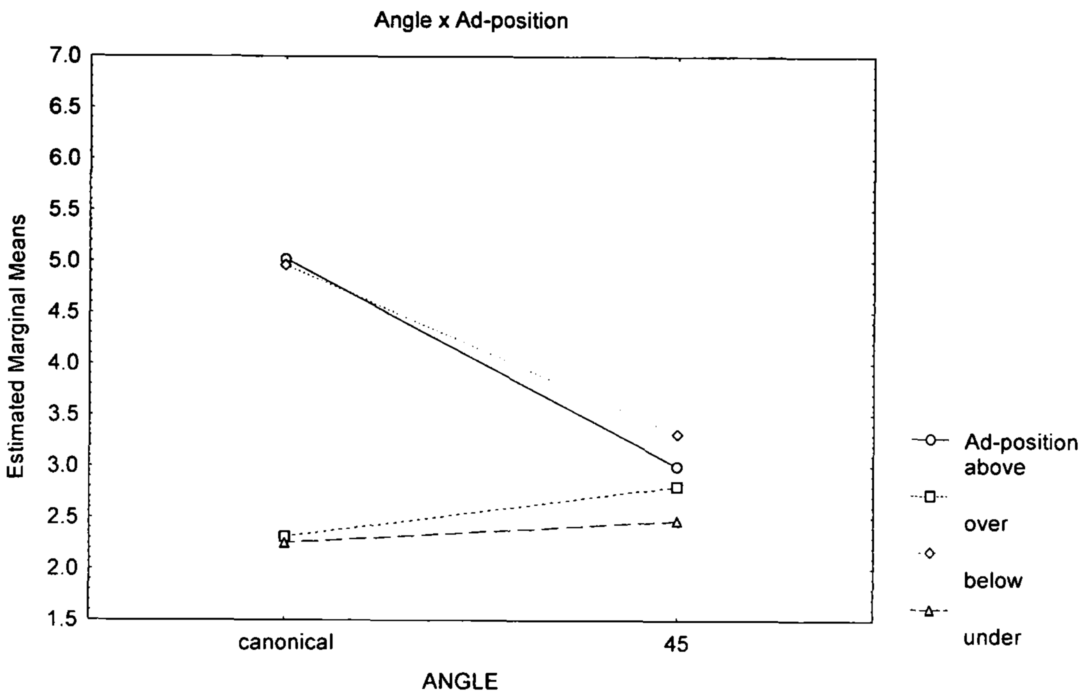


Figure 3.13 *Significant two-way interaction between Angle x Ad-position for the English group in Experiment Five.*

Although the interaction between Function x Ad-position was not quite significant $F(6,96)=2.01$; $p<.0712$ (Figure 3.14), the effect pattern coincides closely with the predictions that *over* (control M = 2.76, functional M = 3.68, non-functional M = 1.24) and *under* (control M = 2.44, functional M = 3.18, non-functional M = 1.47) show more functional sensitivity than *above* (control M = 3.97, functional M = 4.5, non-functional M = 3.56) and *below* (control M = 4.27, functional M = 4.94, non-functional M = 3.21), although this affect is not very pronounced since it is not quite significant. None of the other main effects or interactions were significant in this experiment.

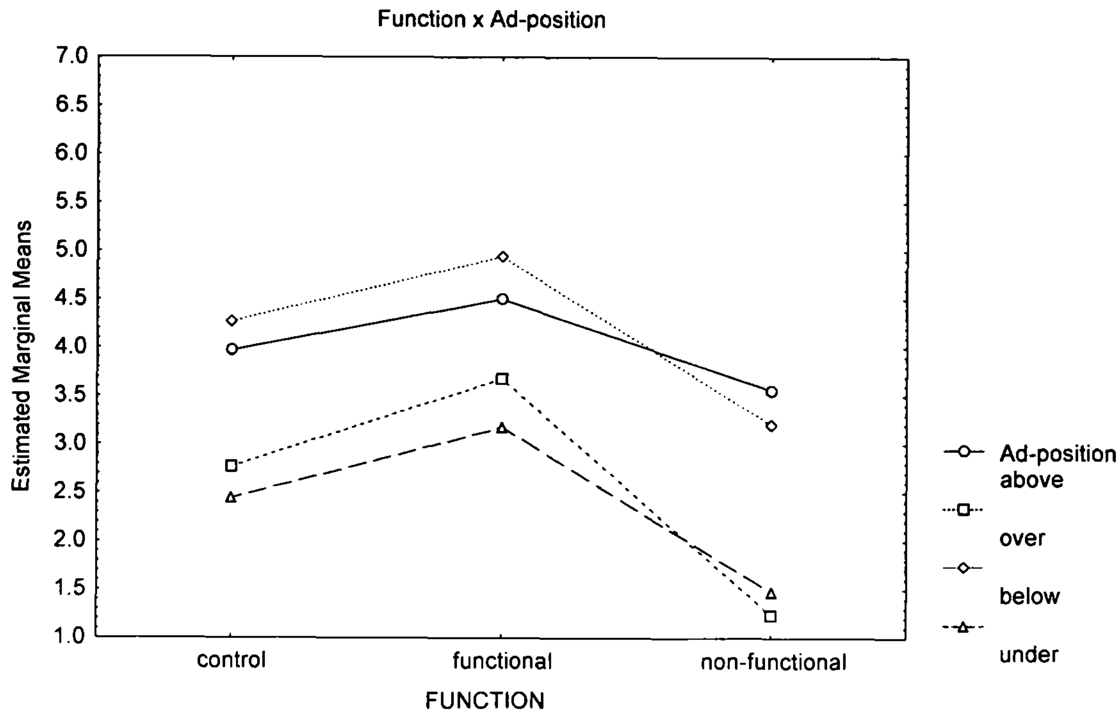


Figure 3.14 Nearly *significant two-way interaction between Function x Ad-position for English group in Experiment Five.*

3.2.5.2 FINNISH

The mean ratings by condition are displayed in Table 3.13.

Table 3.13 *The mean ratings of the Finnish group for each Condition in Experiment Five (N=17).*

Function	Angle	Ad-position			
		yläpuolella	*yllä*	*alla*	*alapuolella*
no wine	straight	5.24	2.53	2.94	5.12
	tilted	2.29	1.88	2.41	3.29
spilt wine	straight	4.53	1.88	1.59	4.65
	tilted	3.41	1.94	1.94	3.65
Wine	straight	5.76	3.65	3.76	5.29
	tilted	4.35	3.24	3.94	4.35

A significant main effect of Function $F(2,32) = 13.46$, $p<0.001$, MSE = 5.13 was found in which the ratings for functional scenes (M = 4.29) were much higher than for non-functional (M = 2.95) or control scenes (M = 3.21).

Also an effect of Angle $F(1,16) = 7.56$, $p<0.05$, MSE = 9.82 was present where higher ratings were given for the canonical scenes (M = 3.91) than for the 45° degree (M = 3.06) orientation.

Also, a main effect of Ad-position $F(3,48) = 12.56$, $p<0.001$, MSE = 7.80 was found in which *yläpuolella* (M = 4.26) and *alapuolella* (M = 4.39) were rated as more appropriate than *yllä* (M = 2,52) and *alla* (M = 2.76).

There was also a significant two-way interactions between Function x Angle $F(2,32) = 4.38$, $p<0.05$, MSE = 2.42 (Figure 3.15). The canonical condition was rated quite highly for both the functional (M = 4.62) and control conditions (M = 3.96) in comparison to the non-functional condition (M = 3.16) which was significantly lower. Whereas, the 45 degree orientation scenes were rated highly only in the functional condition (M = 3.97), while the non-functional (M = 2.74) and control conditions (M =

2.47) both had significantly lower rating levels (p<0.01). Again it should be noted that this interaction collapses across ad-positions.

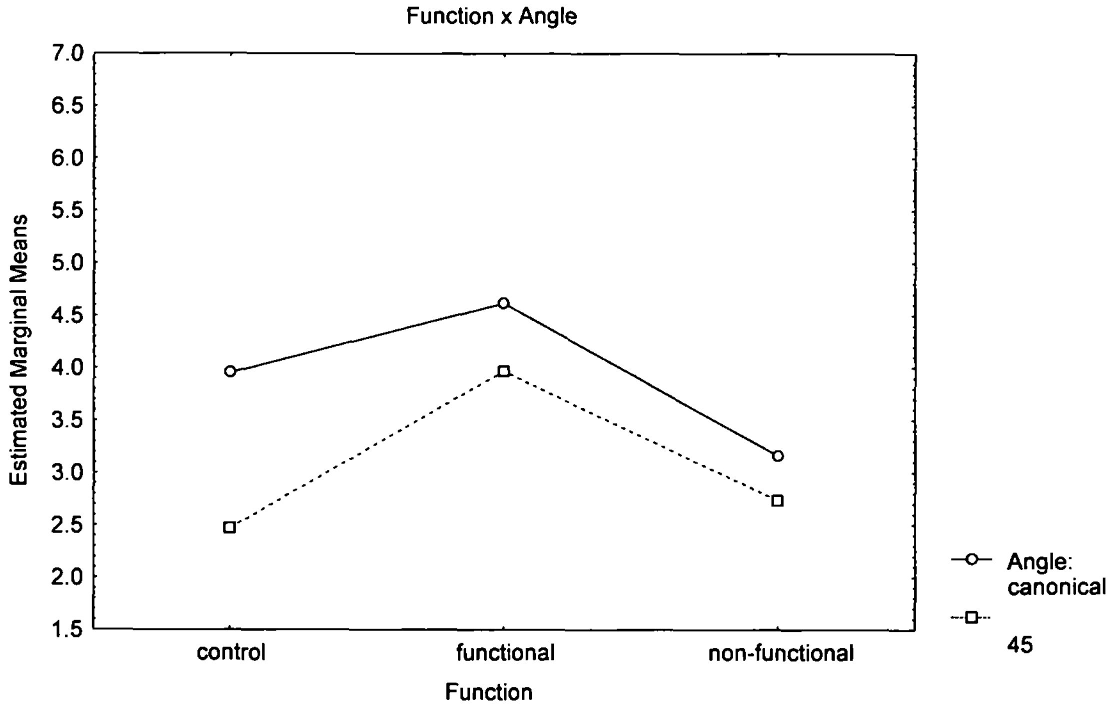


Figure 3.15 *Significant two-way interaction between Function x Angle for the Finnish group in Experiment Five.*

A significant interaction between Angle x Ad-position F(3,48) = 5.50, p<0.01, MSE = 3.25 provides support for the experimental predictions that *yläpuolella* and *alapuolella* would show a discrepancy to geometric manipulation (Figure 3.16). The terms *yllä* and *alla* show evenly low rating levels regardless of whether they are viewed in the canonical (*yllä* M = 2.69, *alla* M = 2.76) or 45° degree orientation (*yllä* M = 2.35, *alla* M = 2.76). Whilst *yläpuolella* and *alapuolella* show significantly (p<0.05) higher appropriateness ratings in the canonical condition (*yläpuolella* M = 5.18, *alapuolella* M = 5.02) than in the 45° degree condition (*yläpuolella* M = 3.35, *alapuoella* M = 3.76).

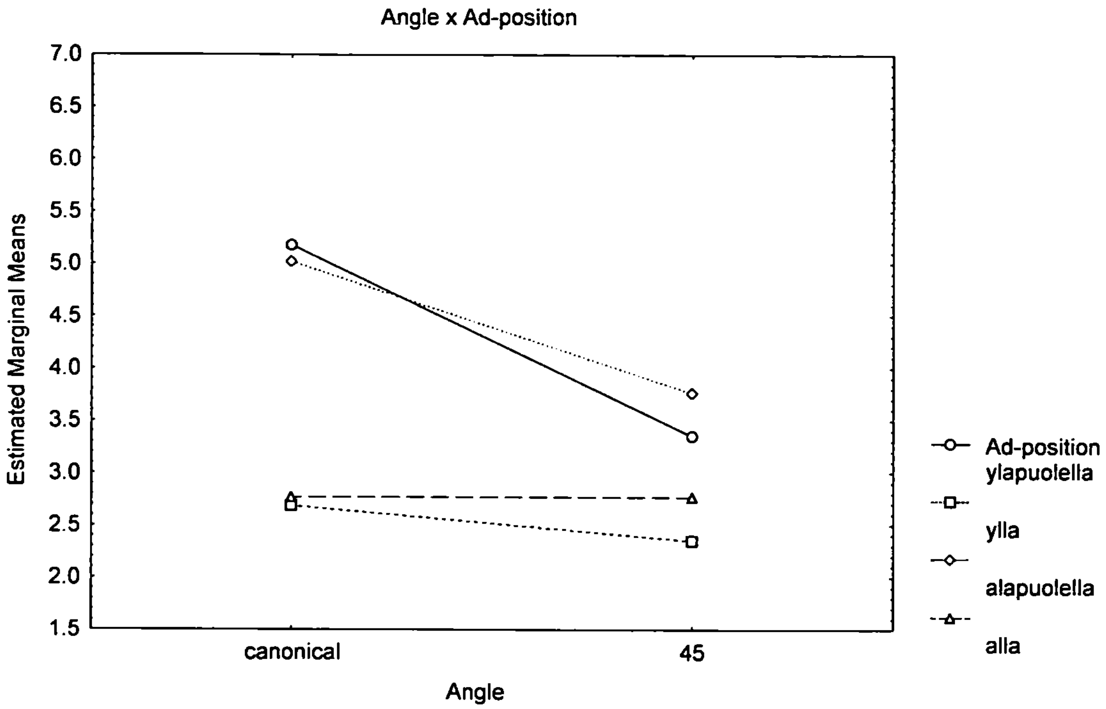


Figure 3.16 *Significant two-way interaction between Angle x Ad-position for the Finnish group in Experiment Five.*

There is also a nearly significant $F(6,96)=1.98$; $p<.0753$, $MSE = 1.98$ interaction between function x ad-position (Figure 3.17) in which the pattern again provides some support for the functional predictions in which *yllä* and *alla* were expected to be functionally more sensitive than *yläpuolella* (control M = 3.77, functional M = 5.06, non-functional M = 3.97) and *alapuolella* (control M = 4.21, functional M = 4.82, non-functional M = 4.15). The ad-positions *yllä* (control M = 2.21, functional M = 3.44, non-functional M = 1.91) and *alla* (control M = 2.68, functional M = 3.85, non-functional M = 1.77) did indeed show more discrimination in favour of the functional condition in comparison to the control and especially non-functional conditions.

None of the other main effects or interactions were significant in this experiment.

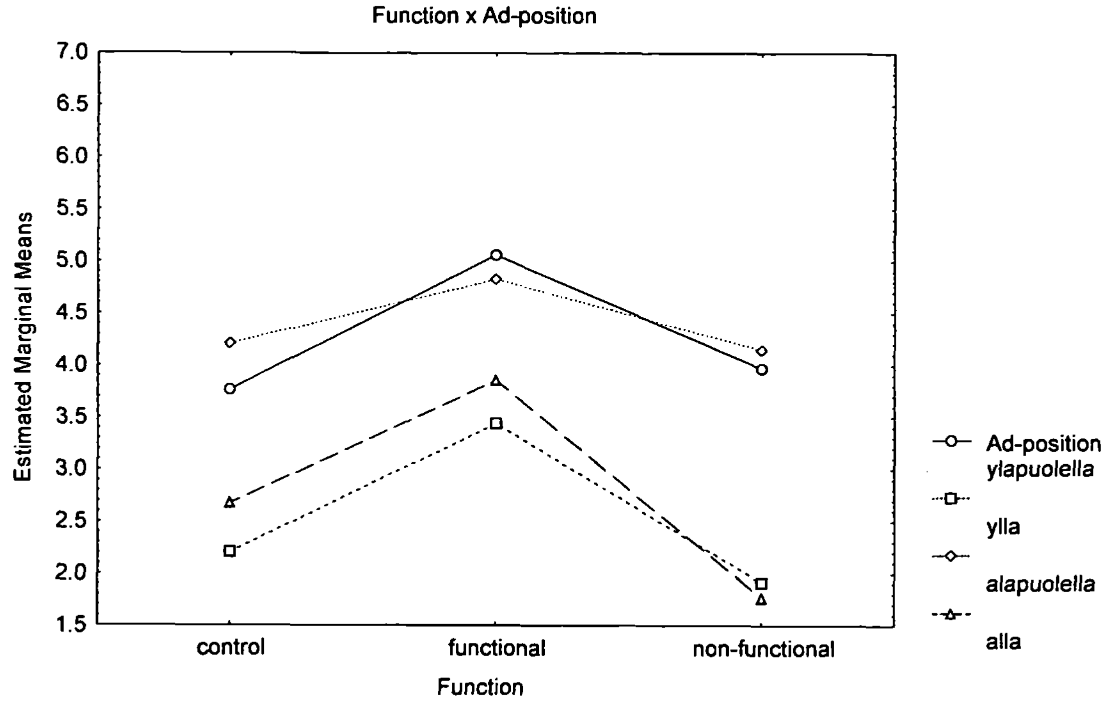


Figure 3.17 *Nearly significant two-way interaction between function x ad-position for Finnish group in Experiment Five*

3.2.5.3 SPANISH

The mean ratings by condition are displayed in Table 3.14.

Table 3.14 *The mean ratings of the Spanish group for each Condition in Experiment Five (N=17).*

Function	Angle	Ad-position			
		sobre	*encima*	*debajo*	*bajo*
no wine	Straight	2.35	2.53	2.88	3.06
	Tilted	2.41	2.41	3.29	2.24
spilt wine	Straight	2.00	1.88	2.06	2.18
	Tilted	1.65	2.00	2.12	1.88
Wine	Straight	3.06	3.00	3.76	3.18
	Tilted	2.41	2.59	3.53	3.12

Only one nearly significant effect was found and that was the main effect of Function $F(2,24)=2.85$; $p<.0774$, MSE = 9.15. The ratings for functional scenes (M = 3.11) were higher than for non-functional (M = 2.12) or control scenes (M = 2.74). None of the other main effects or interactions were significant in this experiment.

3.2.6 Discussion of Experiment Five

A summary of all the main-effects and interactions that were found in Experiment Five throughout all three language groups can be found below in Table 3.15.

Table 3.15. *Significant main effects and interactions across language groups in Experiment Seven (Wine), borderline effects are in brackets.*

	English	Finnish	Spanish
Main Effects			
Function	X	X	(X)
Angle	X	X	
Ad-position	X	X	
2-way interactions			
Function x Angle		X	
Function x Ad-position	(X)	(X)	
Angle x Ad-position	X	X	
3-way interactions			
Function x Angle x Ad-position			

Significant interactions between Angle and Ad-position were again only present for the English and Finnish language groups. Hence, evidence is provided for the predictions that the projective terms *above* and *below*, and *yläpuolella* and *alapuolella* would be more sensitive to changes in geometric relations. Furthermore, according to expectations there was no discrimination of geometric conditions amongst the Spanish terms. Additionally, both the Finnish and English languages produced nearly significant interactions between Function and Ad-position. The effect patterns were in accordance with the predictions that *over* and *under*, and *yllä* and *alla* would display differentiating functional sensitivity. It is worth noting that the functional effect on spatial terms was not visible at all for the Finnish language in Experiment Four, which may suggest that containment (wine in wine glass) as a functional property is more salient in Finnish than the function of protection (umbrella sheltering from rain). Once again the Spanish analyses produced no significant effect of either Function or Geometry.

3.2.7 Summary for Experiments Three, Four and Five

In conclusion, all three experiments revealed effects of geometry, however this effect was only in line with the experimental hypothesis for Experiments Four and Five. Both of these experiments revealed that *above/below* and *yläpuolella/alapuolella* were more sensitive to geometric manipulation than *over/under* and *yllä/alla*. In contrast, Experiment Three produced results that were in conflict with the geometry hypothesis in that it was revealed that both English and Finnish displayed interaction patterns which suggest that *over/ under* and *yllä/alla* were instead more affected by manipulation of located object position than the predicted terms *above/below* and *yläpuolella/alapuolella.* However, as expected Spanish did not reveal discrimination amongst ad-position and geometric manipulation for any of the three experiments in this chapter.

Finally, the hypotheses that specific terms would show more sensitivity to the manipulation of function received only tentative support in some circumstances. Experiment Four showed clearly that *over/under* were more sensitive to functional manipulations than *above/below* as predicted, however there was no such evidence for the Finnish equivalent term *yllä/alla* or the Spanish term for *over: sobre* in this experiment. Furthermore, although the predicted pattern of functional sensitivity for the *over/under* and *yllä/alla* terms was present for both English and Finnish in Experiment Five, the results were not quite significant nor was there any effect for the Spanish term *sobre*. The English, Spanish and Finnish sections of Experiment Three did not support the hypotheses for functional discrepancy between ad-positions.

This chapter has examined the interplay between extra-geometric and geometric factors that influence the way we use language to describe object relationships. Specifically, functional relationships in combination to geometric relations have been manipulated and their effects on vertical axis projective terms across English, Spanish and Finnish have been carefully examined. The next chapter moves onto investigating the interplay between geometric and extra-geometric factors that might influence the production and comprehension of horizontal axis projective terms across languages.

Chapter Four

4.0 Horizontal Projective Term Investigation

Experiments Six and Seven were developed from the materials used by Carlson-Radvansky et al. and Richards (2000). Therefore, this section of the thesis endeavors to give a more detailed account of their work.

4.1 Rationale and Designs for Experiment Six and Seven

In both the production experiment and comprehension experiment by Carlson-Radvansky and Radvansky (1996) the same set of stimuli were used in which object pairs were presented that either had a functional or a non-functional relationship. The functional relationship was depicted by showing the reference object and located object positioned in a manner in which they are able to interact with one another (Figure 4.1 A), whereas the non-functional condition was achieved by positioning the objects in a way in which typical interaction would not be enabled (Figure 4.1 B). The comprehension task involved presenting each scene with sentences of the form "The located object is *to the left of/in front* of the reference object". Participants rated the sentences for acceptability on a scale numbered 1-5. Furthermore, the production task used a modified version of the sentences from the comprehension task in which the spatial terms were replaced with a blank line. Participants were required to fill in the blank with one of the provided spatial terms. Both the production and comprehension tasks produced results which suggested that people are more willing to adopt the object-centered (intrinsic) frame of reference when speaking about the relationship between two objects if a functional relation between them is enabled. In contrast, when no functional relationship was present there is a preference for a relative/absolute frame of reference.

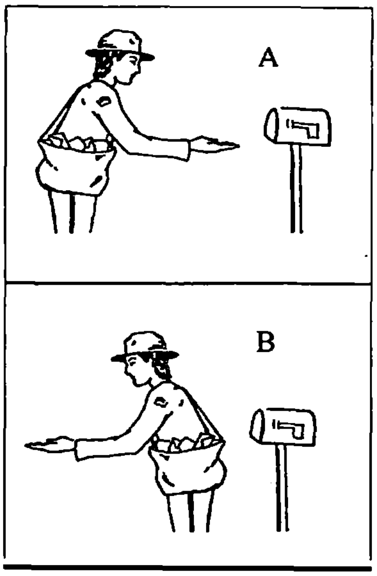


Figure 4.1 Example of scenes from Carlson-Radvansky & Radvansky (1996).

Richards (2000) has expanded on this line of work with not only adults but also children by using a free response paradigm. In addition to manipulating the functional relationship between the two objects by enabling or disabling interaction by using two different levels of orientation, blocking and contextual object relations were also manipulated. Blocking functional relations was accomplished by positioning a screen between the two objects in the blocking of interaction condition. Object association was also manipulated; the two objects either had a functional relationship with one another or not (e.g. artist/easel versus artist/stove). The most important finding of this experiment was that adults were more likely to use the intrinsic frame of reference when the objects were oriented towards one another especially in the absence of blocking, whereas the child participants did not produce such a distinction in their descriptions. Richards (2000) also conducted a further study which used all the previous manipulations however blocking was replaced by proximity as the third factor. Although the proximity factor may be viewed as a geometric manipulation, it can also be considered a functional one, as the further away two objects are located from one another the more difficult a functional interaction is. The result patterns were very similar to Richard's first study in that adults once again used the intrinsic frame of reference more often when the located object was oriented towards the reference object than when it was not. Also, there was a significant effect of proximity present which indicated that the nearer an object is to the reference object the more appropriate the use of the intrinsic frame of reference is.

Experiment Six used a sub-group of the scenes deployed by Richards (2000) in order to investigate similar issues cross-linguistically while not adding too many scenes to the test series. The artist scenario was chosen using both a functionally related context (artist/easel) and a non-functionally related one (artist/stove). Also, the orientation and blocking factors were maintained to allow for a thorough investigation of functional influences on reference frame selection across three language groups (English, Finnish and Spanish). Experiment Seven also utilized a sub-group of scenes from one of Richard's experiments in which the functionally related (postman/post-box) and unrelated contexts (postman/bookshelf) were manipulated in the postman scenario. Here the orientation and proximity factors were manipulated as well. Both Experiments Six and Seven reverted back to fixed response paradigms as used in Carlson-Radvansky and Radvansky (1996) instead of the open one used by Richards (2000). This was mainly to ensure that the terms of investigation would be of a spatial nature; open-ended instructions in the Richards (2000) studies sometimes produced utterances without spatial language (e.g. The artist is painting the easel). Given anticipated issues regarding participant numbers, we were keen to avoid participant attrition, so comprehension tasks were preferred.

Generally speaking, it was expected that any manipulations that would compromise the functional interaction between the reference and located object would make it more likely for the participant to adopt the relative frame of reference (*to the left of* or equivalent). To be more precise the predictions for these two experiments were that all language groups would be more likely to use an intrinsic frame of reference (*in* *front of* or equivalent) when a functional relationship is enabled by appropriate orientation of objects, and a relative frame of reference *(to the left of* or equivalent) if the functional relations is thus inhibited. Furthermore, it was expected that when function is disabled by obstruction with a screen then the use of the intrinsic frame of reference would be lower than the relative frame of reference, whereas for unblocked scenes people would be more likely to adopt the intrinsic frame of reference. More specifically, the tendency for adopting the intrinsic frame of reference was expected to be emphasized when objects were oriented towards one another AND additionally not obstructed (as was found by Richards, 2000). Additionally, when objects were at a far proximity from each other it was predicted that the use of an intrinsic frame of reference would be lower and the relative frame of reference higher. In contrast, objects located nearer to one another would instantiate the intrinsic frame of reference more readily. Finally, the appropriateness of the *in front of* terms was expected to be higher when the objects themselves were functionally relevant to one another (artist/easel) than when they were not (artist/stove). The hypothesis was that these effects would be apparent across all three language groups, however it was of interest to notice any potential discrimination between the two Finnish *in front of* (*edessä* and *edellä*) terms as the term *edellä* has previously displayed higher ratings when describing a scene in which the object fronts are pointing in the same direction rather than facing one another (Coventry and Frias-Lindqvist, 2005).

Experiment Six

4.1.1 Method

The administration of Experiment Six is identical to that used for all earlier experiments in both the Topological terms and Vertical axis projective terms chapters. Again the three language groups (English, Spanish and Finnish), consisting of 17 participants each, were given the same scenes to rate. The same groups of participants were used throughout the cross-linguistic test series.

4.1.1.1 Materials

Experiment Three had a total of eight scenes that consisted of images previously used by **Richards** (see figure 4.2). This Experiment was part of a series of eight cross-linguistic experiments that were all administered at once (eighty-five scenes in the full experimental series). All materials were presented in the same way throughout the cross-linguistic section.

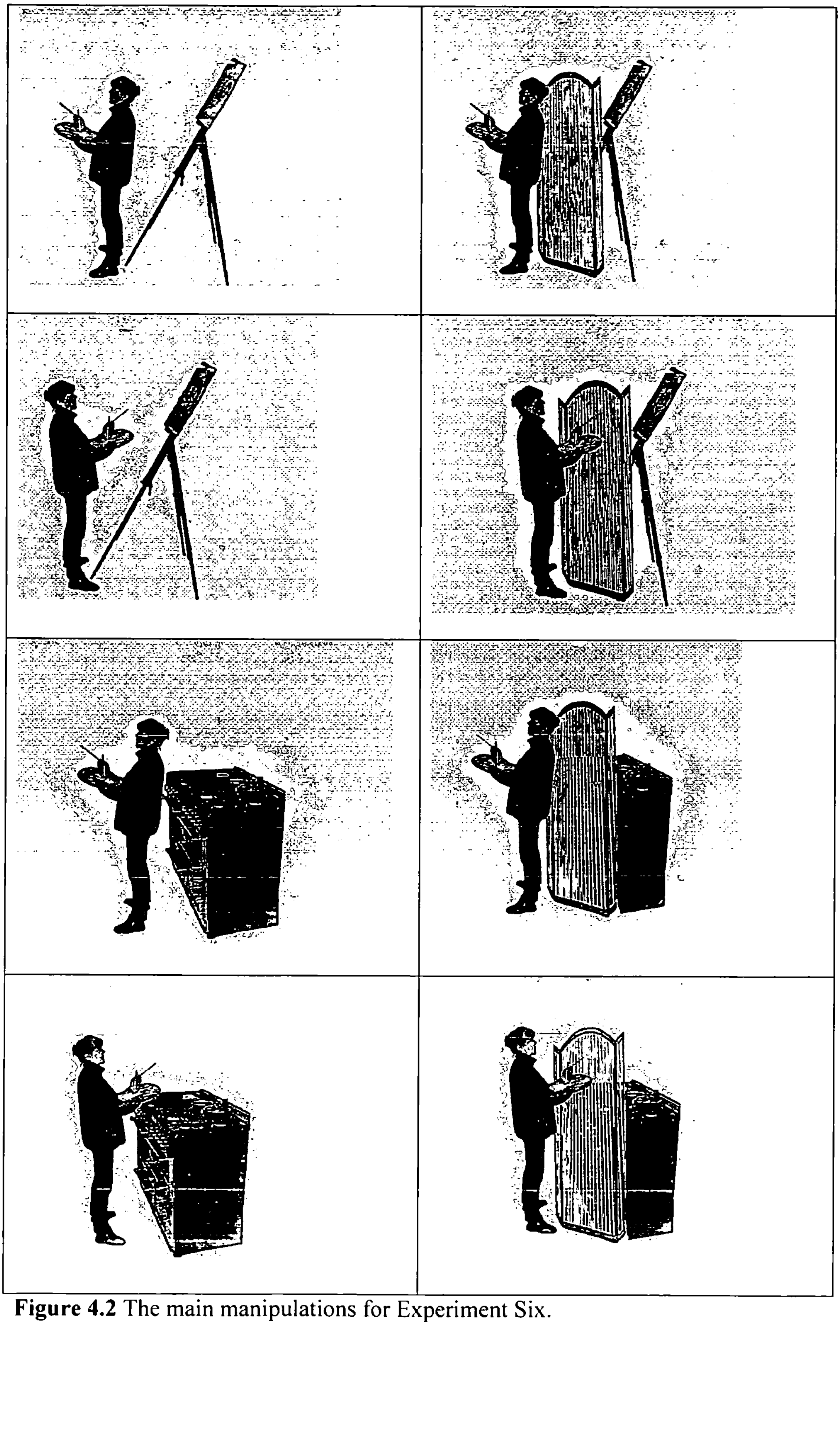


Figure 4.2 The main manipulations for Experiment Six.

4.1.1.2 Procedure

The procedure of administration of Experiment Six is identical to that of all previous experiments in this section of the thesis. Each participant received an individual test packet containing all eight randomised experiments in their native languages.

4.1.1.3 Design

The four factor design used in this experiment was the same for all factors across languages apart from differing numbers of levels in the fourth factor. A 2 (object association) x 2 (obstruction) x 2 (orientation) x 5, 7 or 5 _(ad-position) within-participants design was used for the investigation (see Table 4.1).

Table 4.1 *The ad-positions used for each language group in Experiment Six*

English	In front of	Behind	At	near	to the left of
Finnish	edessä, edellä	takana, perässä, jäljessä	äärellä	Lähellä	(vasemmalla)
Spanish	Delante	detras	en	cerca	izquierdas

4.1.1.3.1 Main Manipulations

Factor 1: Object Association

Two levels of object association were used (see Figure 4.2). The located object and reference object were functionally related (easel – artist) or unrelated (cooker – artist).

Factor 2: Obstruction

Two levels of obstruction were manipulated in the scenes (see Figure 4.2). In the 'obstructed' condition there was a screen positioned between the located object (artist) and the reference object (easel/cooker). In contrast, in the 'non-obstructed' condition there was no screen illustrated between the figure and reference objects.

Factor 3: Orientation

Two levels of orientation were used (see Figure 4.2). The located object (artist) was either positioned facing towards the reference object (easel/cooker), or the located object was depicted facing away from the reference object.

Factor 4: Ad-position of sentence

There were five levels of ad-positions in use for the English group (see Table 4.1). The five English sentences under each scene were of the form: 'The artist is *in front of* the easel/cooker'. There were seven levels of ad-positions in use for the Finnish group (see Table 4.1). The seven Finish sentences under each scene were of the form: 'Taiteilija on maalaustelineen/hellan *edessä*'. However, *vasemmalla* (*to the left of*) was accidentally omitted from some of the trials hence the results were only analysed for seven ad-positions rather than eight*. Finally, there were five levels of ad-positions in use for the Spanish group (see Table 4.1). The five Spanish sentences under each scene were of the form: 'El artista está *delante* del caballete/de la cocina'.

* An error occurred during the printing process of the whole series of tests in which the final sentence (containing the Finnish to the left of ad-position) on some of the pages did not fit onto the A4 sheet.

4.1.2 Results for Experiment Six

In this experiment a repeated measures analysis of variance was carried out separately for each language group. The chosen alpha level is .05 throughout all the statistical analyses in this thesis. Throughout the cross-linguistic section of this thesis, Tukey (HSD) was the follow-up analysis of choice when further investigation was required. The results of each separate four-way ANOVA are reported individually below for each language group in separate sections which include tables of Mean ratings. Furthermore, the full ANOVA tables can be found in the Appendix Three.

4.1.2.1 ENGLISH

The mean ratings by condition are displayed in Table 4.2.

Table 4.2 *The mean ratings of the English group for each condition in Experiment Six(N=17).*

Obj. Assoc.	**Obstruction between Obj.**	**Orient.**	**Ad-position** *front*	*behind*	*at*	*left of*	*near*
Easel	No Obstruction	Away	5.18	1.94	4.65	3.35	6.65
		Facing	6.65	2.00	6.12	3.18	6.18
	Obstruction	Away	3.94	2.00	3.88	3.06	6.12
		Facing	5.76	2.53	4.65	3.71	6.65
Stove	No Obstruction	Away	4.53	1.59	4.41	3.24	6.35
		Facing	6.65	1.76	5.88	3.18	6.47
	Obstruction	Away	4.41	2.00	4.12	3.12	6.00
		Facing	5.53	1.76	4.47	3.18	6.41

A significant main effect of Obstruction, $F(1,16) = 12.02$, $p<0.01$, MSE = 1.56 was present. The scenes with an obstruction (M = 4.16) were rated lower than the scenes without (M = 4.50). There was also a main effect of Orientation, $F(1,16) = 25.55$, $p<0.001$, MSE = 2.47. The scenes where the objects were facing (M = 4.64) each other were rated higher than the ones in which the two objects had their fronts pointing in the same direction (M = 4.03). Furthermore, a main effect of Ad-position $F(4,64) = 28.08$, p<0.001, MSE = 14.68 was found, in which *in front of* (M = 5.33), *at* (M = 4.77), and *near* (M = 6.35) had higher ratings than *behind* (M = 1.95) and *to the left of* (M = 3.25).

Additionally there was a significant two-way interaction between Obstruction x Ad-position F(4,64) = 5.24, p<0.01, MSE = 1.94 (Figure 4.3). The ad-positions *behind* (obstructed M = 2.07, non-obstructed M = 1.82) and *to the left of* (obstructed M = 3.26, non-obstructed M = 3.24) get similarly low ratings in both the obstructed and non-obstructed scenes. Furthermore, the ratings for *near* (obstructed M = 6.29, non-obstructed M = 6.41) do not differentiate between obstructed and non-obstructed scenes although in this case the received ratings are equally high for both. However, *in front of* (obstructed M = 4.91, non-obstructed M = 5.75) and *at* (obstructed M = 4.28, non-obstructed M = 5.26) get significantly lower ratings (p<0.05) when an interaction (functional relationship) between the reference object and located object is obstructed and higher ratings when it is not obstructed. Therefore, there is clear functional sensitivity for the ad-positions *in front of* and *at*. In relation to the effects on ad-position *in front of*, support is provided for the prediction that the intrinsic frame of reference is adopted more readily when a functional relationship is not blocked. Also, interestingly *at* has a similar effect-pattern to *in front of* even though it is usually considered a topological or proximity term rather than a projective. However, the prediction that the relative frame of reference (*to the left of*) would be adopted more readily when a functional relationship is obstructed than when it is not, did not receive support.

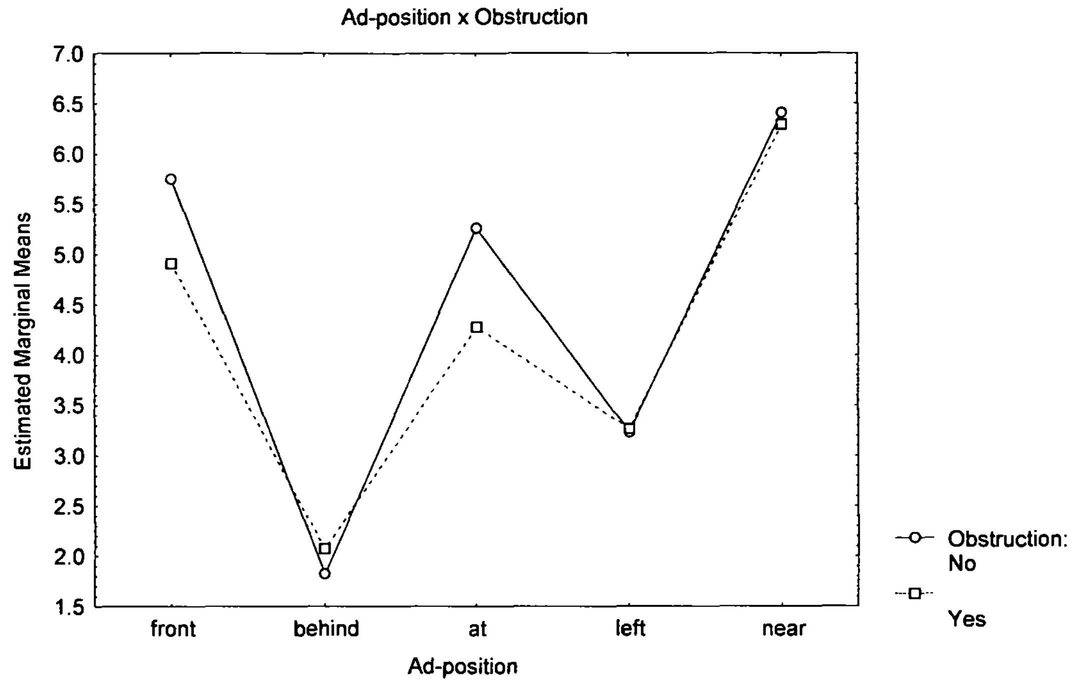


Figure 4.3 *Significant two-way interaction between Obstruction x Ad-position for the English group in Experiment Six.*

There is also a significant interaction between Orientation x Ad-position $F(4,64) = 9.04$, $p<0.001$, $MSE = 1.78$ (Figure 4.4). This pattern mirrors the pattern of effects for Obstruction x Ad-position. Again *behind* (away M = 1.88, facing M = 2.01) and *to the left of* (away M = 3.19, facing M = 3.31) have non-discriminating low rating levels regardless of orientation. Also, *near* (away M = 6.28, facing M = 6.43) has similar high rating levels regardless of orientation. In contrast, the perceived appropriateness of *in front of* (away M = 4.51, facing M = 6.15) and *at* (away M = 4.26, facing M = 5.28) are again influenced detrimentally when the objects in the scene are facing away from each other, and rated significantly higher ($p<0.001$) when the objects are facing each other. This again suggests that *in front of* and *at* are more appropriate for describing scenes in which interaction and functional relationships between objects are facilitated. Furthermore, this effect lends support for the preference of the intrinsic frame of reference when a functional relationship between the objects is present. However, the relative reference frame (to the left of) did not show a sensitivity to orientation which was against the predictions of the experimental hypothesis.

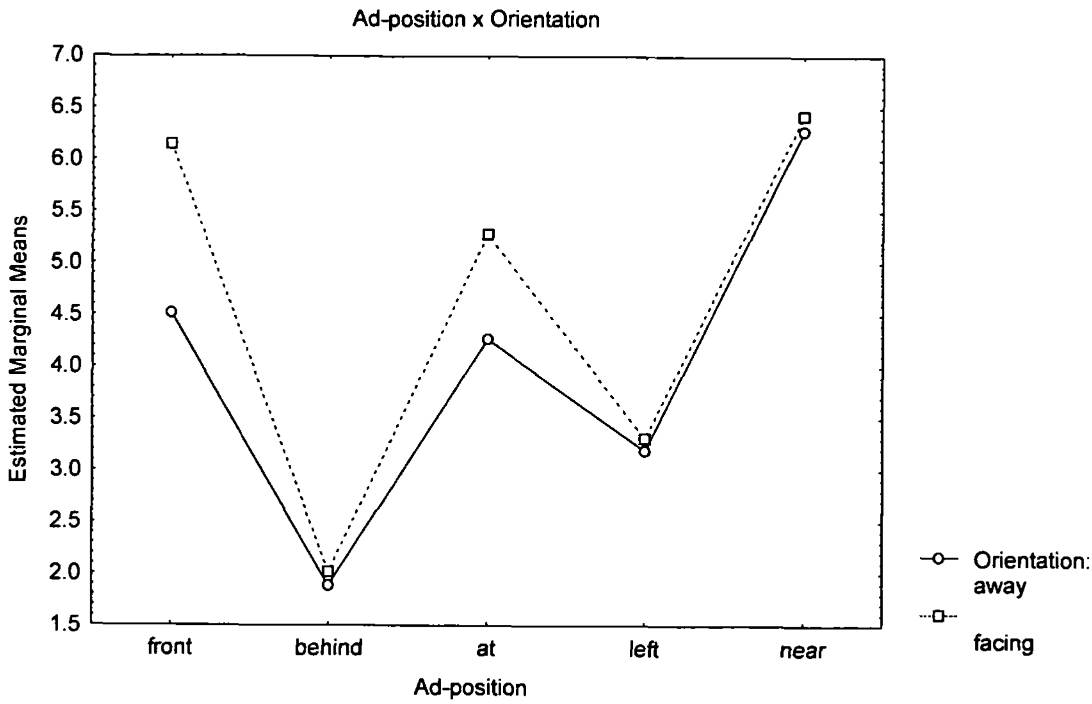


Figure 4.4 **A** *Significant two-way interaction between Orientation x Ad-position for the English group in Experiment Six.*

There was also a significant three-way interaction between Obstruction x Orientation x Object Association, $F(1,16) = 11.70$, $p<0.01$, $MSE = 0.60$ (Figure 4.5). In general, as could be expected the scenes displaying objects facing one another are rated higher than the scenes in which objects are facing away from one another. However, when this interaction is inspected more carefully in the facing towards condition the scenes in which there was an object association (easel/artist) present were rated at equal levels regardless of level of obstruction (non-obstructed M = 4.82, obstructed M = 4.66), whereas when there was no object association present (stove/artist) the ratings were significantly higher ($p<0.01$) in the non-obstructed condition (M = 4.79) than in the obstructed condition (M = 4.27).

However, in the generally lower rated oriented away from condition when there is no object association (artist/stove) present, both obstructed (M = 3.93) and non-obstructed (M = 4.02) scenes get equally low ratings. However, when there is an object association present (artist/easel) in the facing away from conditions the non-obstructed scenes (M = 4.35) are rated significantly higher (p<0.01) than the obstructed scenes (M = 3.80).Hence, a different pattern emerged for the scenes in which there was an object association present. Although the scenes in which the objects were displayed facing one another were rated at equally high levels; the scenes showing the two objects not facing one another were rated at lower levels when an obstruction was present.

None of the other main effects or interactions were significant in this experiment.

It is worth noting that there was no significant interaction between Obstruction x Orientation x Ad-position as might have been expected from the findings of Richards (2001); where the tendency for adopting the intrinsic frame of reference (*in front of*) was emphasized when objects were oriented towards one another and additionally not obstructed.

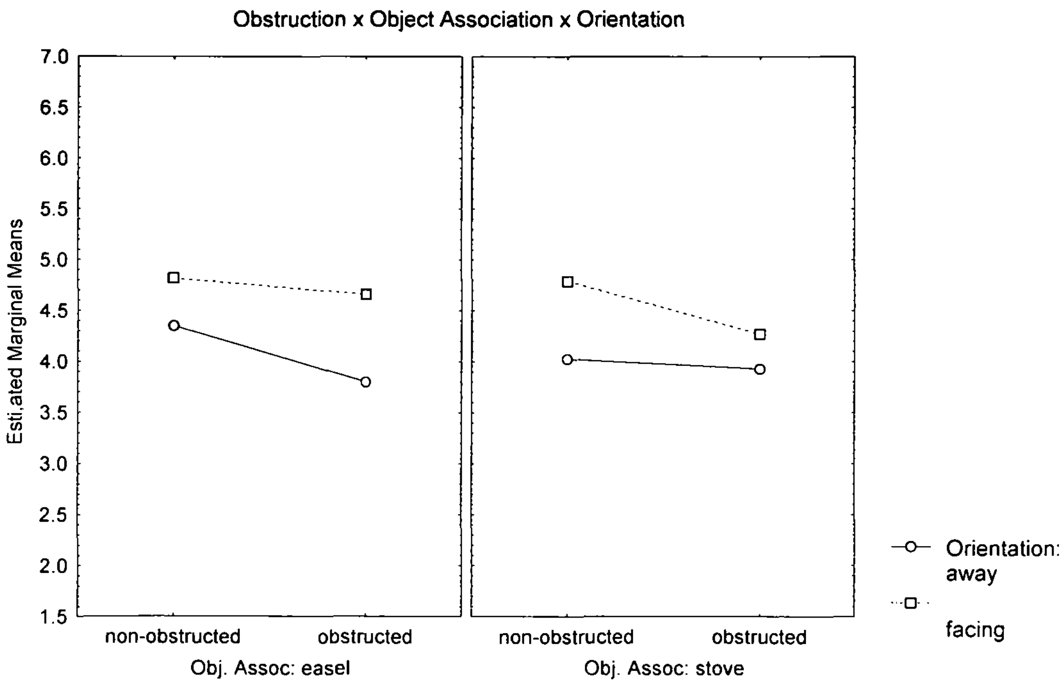


Figure 4.5 A *significant three-way interaction between Orientation x Object Association x Obstruction for English group in Experiment Six.*

4.1.2.2 FINNISH

The mean ratings by condition are displayed in Table 4.3.

Table 4.3 *The mean ratings of the Finnish group for each condition in Experiment Six (N=17).*

Obj. As.	Obstruction between Obj.	Orient.	Ad-position *edellä*	*Takana*	*äärellä*	*edessä*	*perässä*	*lähel.*	*jäljes.*
Easel	No Obstr.	Away	2.82	1.76	4.18	6.06	1.71	6.12	1.53
		Facing	2.35	2.94	6.76	6.18	1.88	6.29	2.00
	Obstr.	Away	2.59	2.18	4.35	5.29	2.00	5.94	1.71
		Facing	2.12	2.47	5.06	5.82	1.71	6.41	1.76
Cooker	No Obstr.	Away	3.18	2.47	4.47	6.47	1.59	6.18	2.06
		Facing	2.59	2.82	6.76	6.35	1.94	6.41	2.06
	Obstr.	Away	3.59	1.88	4.65	6.18	1.65	5.94	1.41
		Facing	2.41	1.94	6.29	5.88	1.41	6.41	1.59

A significant main effect of Obstruction $F(1,16) = 7.85$, $p<0.05$, MSE = 2.06 was found, in which the non-obstructed scenes (M = 3.86) were rated higher than the obstructed scenes (M = 3.59). Also, main effect of Orientation $F(1,16) = 7.47$, $p<0.05$, MSE = 3.08 was also found, in which the scenes where the objects were facing (M = 3.88) each other were rated higher than when the located object was facing away (M = 3.57) from the reference object. Furthermore, a main effect of Ad-position $F(6,96) = 46.95$, $p<0.001$, MSE = 12.01 was found. The ad-position *edessä* (*in front of* M = 6.03) was rated much higher than the other Finnish front term *edellä* (*in front of* M = 2.71). Also, *äärella* (*at* M = 5.32) and *lähellä* (*near* M = 6.21) were rated highly, whereas *takana* (*behind* M = 2.31) *perässä* (*behind* M = 1.74) and *jäljessä* (*behind* M = 1.76) were rated lowest. This suggests that *edessä* is generally a more commonly used front term in Finnish at least in this experimental scenario.

There was also a significant two-way interaction between Obstruction x Orientation $F(1,16) = 5.24$, $p<0.05$, MSE = 1.35 (Figure 4.6). When the objects were facing away from one another both levels of obstruction were rated at similar low levels (obstructed M = 3.53, non-obstructed M = 3.61), whereas when the objects were facing each other the non-obstructed (M = 4.10) scenes were rated at significantly higher ($p<0.05$) levels than the obstructed (M = 3.66) scenes.

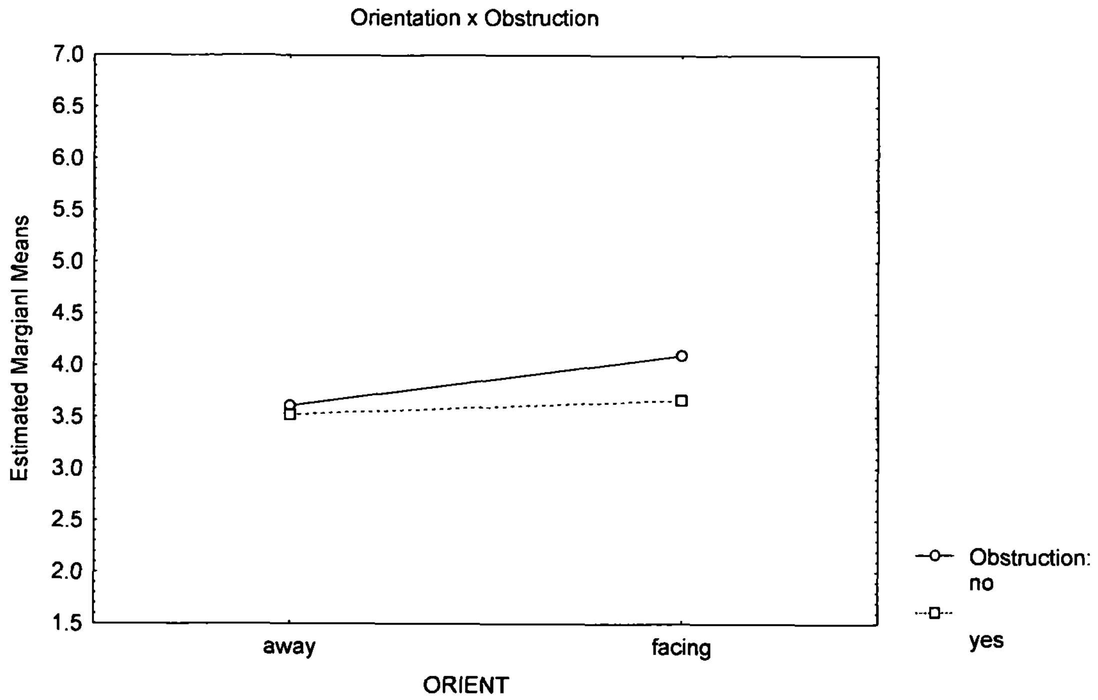


Figure 4.6 *A significant two-way interaction between Orientation x Obstruction for the Finnish group in Experiment Six.*

Finally, there was a significant interaction between <u>Orientation x Ad-position</u> $F(6,96) = 6.64$, $p<0.001$, MSE = 2.92 (Figure 4.7). For the Finnish *in front of* terms there seems to be a general preference for *edessä* which has nearly equal ratings for both orientation levels (facing M = 6.06, away M = 6.00), whereas *edellä* receives much lower ratings in general showing slightly elevated ratings, although not quite significantly ($p>0.05$), for the facing away (M = 3.04) condition than for the facing towards (M = 2.37) condition. This suggests that regardless of whether or not functional interaction is enabled between the objects an intrinsic reference frame in the form of *in front of* = *edessä* can be adopted. In contrast, the much lower rated *edellä* seems to be functionally a bit more sensitive in that it is perceived as more appropriate for describing scenes in which the objects are oriented away from one another. This may be that *edellä* is more suitable for describing a relationship in which one object is following another or at least ordered in a way which depicts that the located object is in the lead of the reference object (as found by Coventry and Frias-Lindqvist, 2005). Hence scenes in which an object is illustrated facing the back of another object may simply be exemplifying a different type of functional relationship between two objects.

The Finnish *behind* terms are rated much lower than *edessä* (*in front of*) with *perässä* (facing M = 1.74, away M = 1.74) and *jäljessä* (facing M = 1.85, away M = 1.68) presenting similar rating levels, while *takana* shows a slight, although not significant, discrimination between orientation in that the facing towards (M = 2.54) condition where interaction between the objects is facilitated gets higher ratings than the facing away (M = 2.07) condition. The ad-position *lähellä* (*near*) shows an even subtler elevation (not significant) in ratings for the facing towards (M = 6.38) condition in comparison to the facing away (M = 6.04) condition, however this discrepancy was significant ($p<0.001$) for the ad-position *äärella* (*at*: facing M = 6.22, away M = 4.41). This suggests that *äärella* (at) is sensitive to facilitation of a (functional) relationship between the objects.

None of the other main effects or interactions were significant in this experiment.

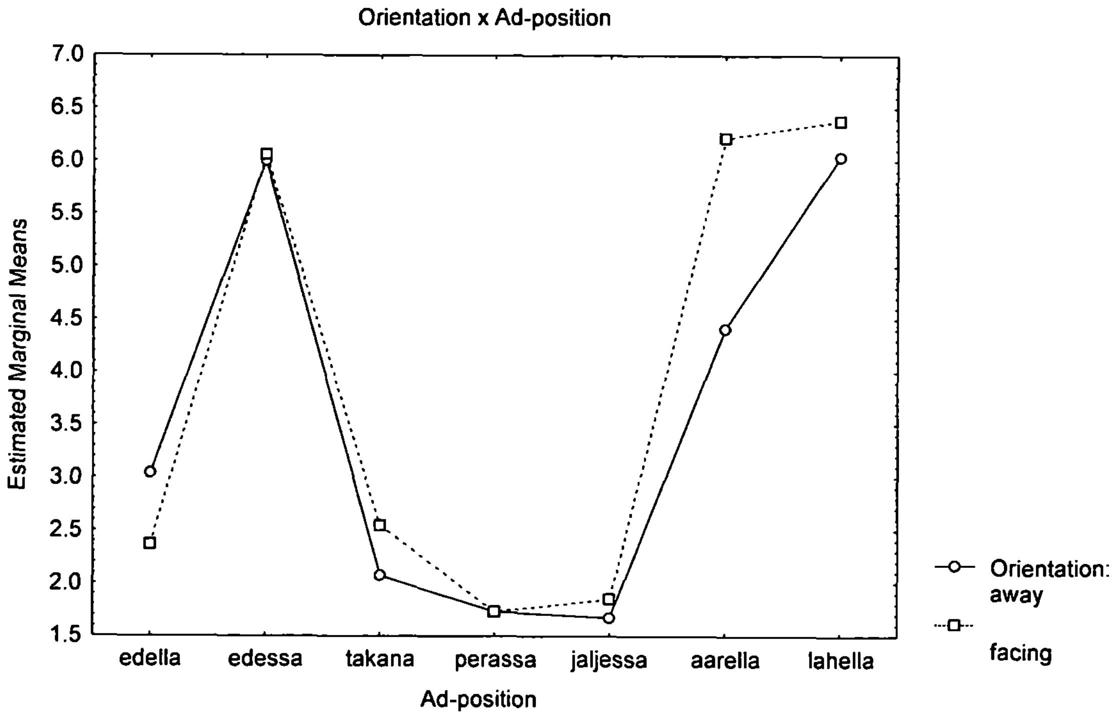


Figure 4.7 *A Significant two-way interaction between Ad-position x Orientation for the Finnish group in Experiment Six.*

4.1.2.3 SPANISH

The mean ratings by condition are displayed in Table 4.4.

Table 4.4 *The mean ratings of the Spanish group for each condition in Experiment Six (N=17).*

Object Association	**Obstruction Between Objects**	**Orientation**	**Ad-position** *delante*	*detras*	*en*	*izquierda*	*cerca*
Easel	No Obstruction	Away	4.88	1.88	1.71	2.59	5.53
		Facing	6.18	2.12	2.12	1.94	5.53
	Obstruction	Away	5.18	1.94	1.88	2.59	5.41
		Facing	5.47	1.82	2.00	2.47	5.53
Cooker	No Obstruction	Away	5.18	1.65	3.59	2.59	5.71
		Facing	5.82	1.71	4.29	1.88	4.82
	Obstruction	Away	4.71	2.29	3.76	2.53	5.65
		Facing	5.59	1.65	3.06	2.29	4.82

There was a significant main effect of Ad-position $F(4,64) = 22.65$, $p<0.001$, $MSE = 17.14$ where *delante* (*in front of* M = 5.38) and *cerca* (*near* M = 5.38) are rated the highest, whereas, *en* (*at* M = 2.80), *izquierda* (*to the left of* M = 2.36) and *detras* (*behind* M = 1.88) have lower ratings.

Additionally there was a significant two-way interaction between Orientation x Ad-position $F(4,64) = 4.43$, $p<0.01$, MSE = 1.87 (Figure 4.8). The terms *detras* (*behind:* facing M = 1.82, away M = 1.94) and *en* (*at:* facing M = 2.87, away M = 2.74) were rated low and there was hardly any discrimination between orientation levels. Furthermore, *cerca* (*near*) received high ratings in general and *izquierdas* (*to the left of*) received quite low ratings. Nonetheless, both terms displayed slightly higher ratings (although difference was not significant $p>0.05$) when the objects were facing away (*izquierdas* M = 2.57, *cerca* M = 5.57) from one another than when they were facing towards (*izquierdas* M = 2.15, *cerca* M = 5.18) each other. However this pattern was the opposite for *delante* (*in front of*) in that it was considered significantly more appropriate ($p<0.05$) for describing a scene which depicts the objects facing towards (M = 5.76) each other than away (M = 4.99) from one another. This supports the predictions that the intrinsic frame (*in front of* = *delante*) of reference would be adopted more readily than when objects were positioned in a way in which they are able to interact with one another.

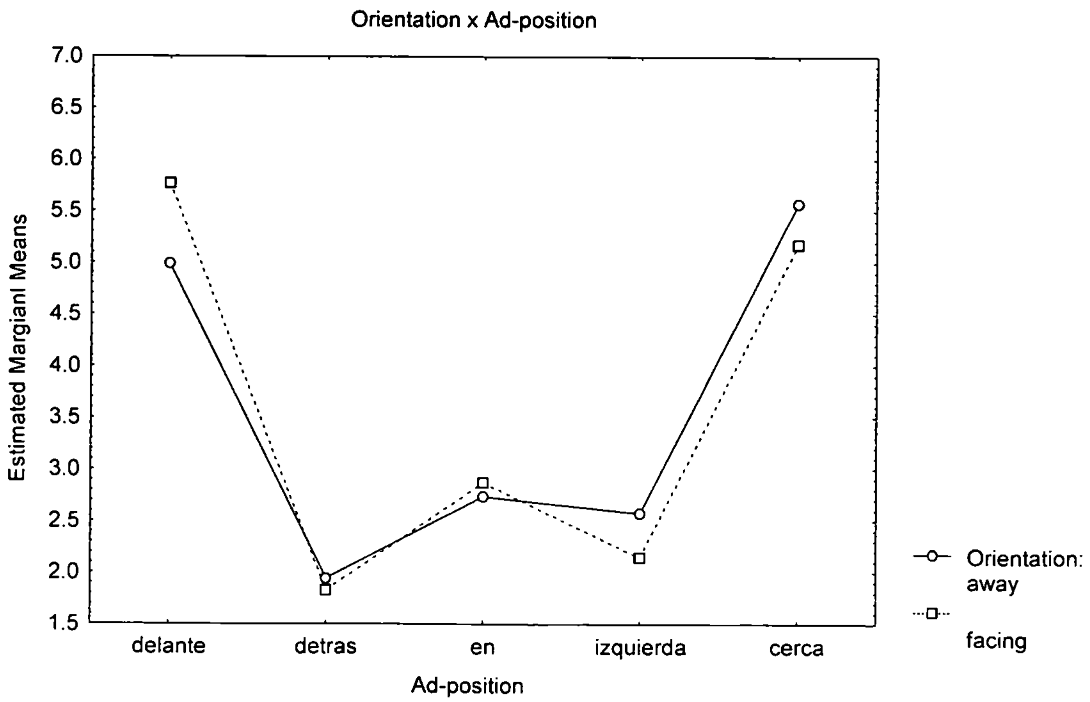


Figure 4.8 *A Significant two-way interaction between Orientation x Ad-position for Spanish group in Experiment Six.*

Also, an interaction between Object Association x Ad-position $F(4,64) = 7.07$, $p<0.001$, $MSE = 3.45$ was present (Figure 4.9). *Delante* (easel M = 5.43, cooker M = 5.32) and *cerca* (easel M = 5.50, cooker M = 5.25) received highest rating levels with hardly any differentiation between levels of object association. In contrast, *detras* (easel M = 1.94, cooker M = 1.82) and *izquierda* (easel M = 2.40, cooker M = 2.32) have low rating levels also showing hardly any distinction between levels of object association. However, *en* is viewed as the significantly ($p<0.01$) more appropriate descriptor when the reference object is a cooker (M = 3.68) than when it is an easel (M = 1.93). This may seem surprising initially since the located object is always an artist who might be thought to be more appropriately paired with an easel, however it is possible that the Spanish language has a strong association between the spatial term *en* (*at*) and a cooker. In other words it may simply be much more natural to say that someone is *at* a cooker than *at* an easel in Spanish regardless of whether the relationship between reference and located object is an ideal example of a functional relationship (artist/easel) or not (artist/cooker). Hence, no support has been provided for an effect of object association. None of the other main effects or interactions were significant in this experiment.

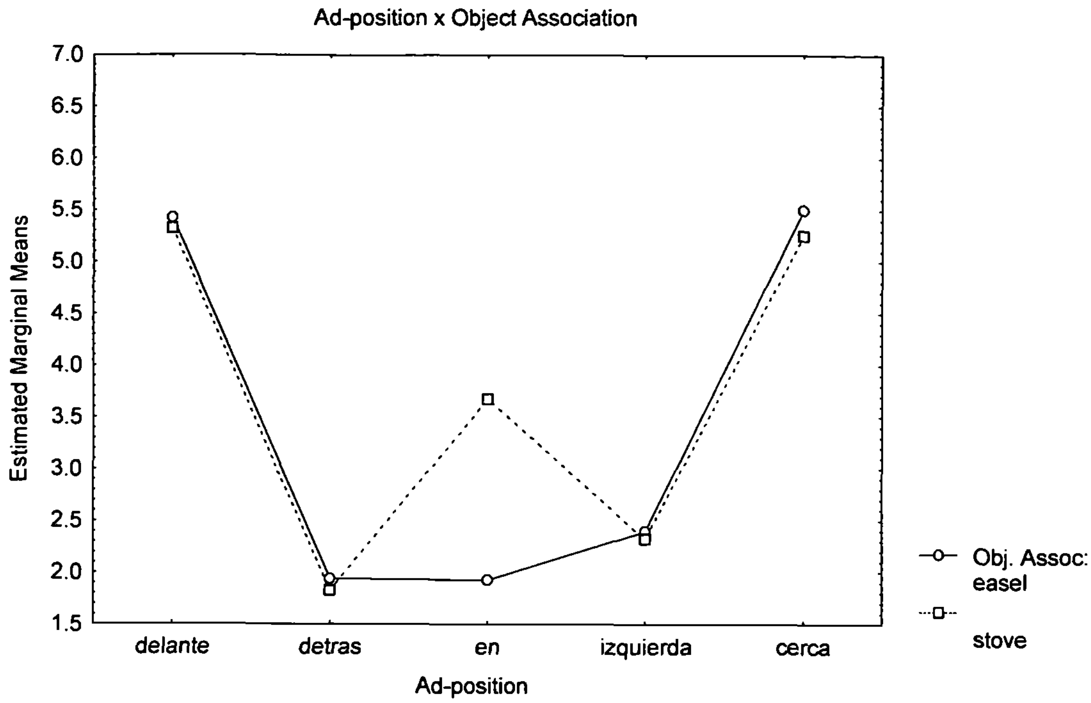


Figure 4.9 *A Significant two-way interaction between Object Association x Ad-position for the Spanish group in Experiment Six.*

4.1.3 Experiment Six Discussion

A summary of all the main-effects and interactions that were found in Experiment Six throughout all three language groups can be found below in Table 4.5.

Table 4.5 *Significant main effects and interactions across language groups in Experiment Six (artist).*

	English	Finnish	Spanish
Main Effects			
Object Association			
Obstruction	X	X	
Orientation	X	X	
Ad-position	X	X	X
2-way interactions			
Obj. As. x Obstruction			
Obj. As. x Orientation			
Obj. As. x Ad-position			X
Obstruction x Orientation		X	
Obstruction x Ad-position	X		
Orientation x Ad-position	X	X	X
3-way interactions			
Obj. As. x Obstruction x Orientation	X		
Obj. As. x Obstruction x Ad-position			
Obj. As. x Orientation Ad-position			
Obstruction x Orientation x Ad-position			
4-way interactions			
Obj. As. x Obstruction x Orientation x Ad-position			

In conclusion, facilitation of a functional relationship by manipulating object orientation was not found to produce quite the effects that were expected despite significant interactions between orientation and ad-position being present across all three language groups (see Table 4.5). The English interaction does provide support for the hypothesis that the intrinsic frame of reference (in front of) would be preferred when the objects were facing one another rather than when they were pointed away from each other. However, the relative frame of reference (to the left of) did not show discrimination between levels of orientation. Therefore, nonfunctional relations did not instantiate the relative frame of reference as was predicted and consequently the results did not support Richards (2000) or Carlson-Radvansky and Radvansky (1996).

Furthermore, the interaction between orientation and ad-position for Finnish was much more complex, not least as a result of the availability of more lexical items corresponding to the English *in front of* and *behind* terms. The indications were that for the *in front of* term *edessä* the Finns did not show a distinction between conditions in which function was enabled or not enabled by orientation. This suggests that the instantiation of the intrinsic frame of reference is not functionally sensitive for *edessä* which is at odds with the hypothesis, whereas, the other *in front of* term *edellä* was generally the less preferred ad-position possibly because it is more appropriate for describing spatial relations when objects are moving or potentially mobile while the scenes of Experiment Six displayed only one potentially dynamic object (artist) paired with a static object (easel/stove). However, there were slight indications that the marginally higher ratings for *edellä* indicated a preference for the scenes in which the located object was facing away from the reference object, which might be viewed as ideal positioning for objects on the move or following one another in order. However, due to an error it was not possible to analyse data investigating the substantiation of the relative frame of reference since the Finnish *to the left of* term (*vasemmalla*) was not included in the rating task.

Finally, the results from the Spanish group do provide support for the effects of orientation on reference frame instantiation. Orientation has the effect of facilitating a functional interaction as was predicted in that the intrinsic frame of reference (*delante* =

in front of) is activated significantly more often when the objects are facing towards one another; whereas, although the relative frame of reference (*izquierda = to the left of*) was enabled more often by a nonfunctional relationship in which the objects were facing away from one another, this difference was not significant.

One final observation that is worth mentioning about the cross-linguistically significant Orientation x Ad-position interaction is the effect of orientation on the ad-position *at* (and its cross-linguistic equivalents). For both the English and Finnish language groups *at* and *äärella* are both sensitive to facilitation of a functional relationship between the reference and located object. In other words when a functional relation is enabled by orienting the objects towards one another *at* and *äärella* both receive significantly higher ratings than when they were oriented away from one another. In contrast, the Spanish *at* term: *en* does not show any such functional sensitivity through the manipulation of object orientation. These findings for each language group, apart from Spanish, generally mirror the effect pattern that was expected to be found cross-linguistically for the *in front of* terms.

The only significant interaction between obstruction and ad-position was found for the English group. These results mirrored those found between orientation and ad-position very closely, and therefore also only supported the prediction that the facilitation of a functional interaction would instantiate the use of an intrinsic frame of reference (in front of), but did not support the prediction that not enabling a functional interaction would trigger the use of the relative frame of reference (to the left of) instead. This would perhaps suggest that the other language groups simply were not as easily effected by the presence (or lack of) a screen as obstruction.

Finally, the only significant effect of functional relation between reference object and located object through object association was found for the Spanish group. This did not however coincide with the prediction that when objects are functionally related (artist/easel) then the ratings would be higher for *delante* (*in front of*) than for scenes in which the objects were not related to one another (artist/stove). In fact, while the results indicated that there seemed to be no discrimination between reference objects for *delante*, there was a strong effect for *en* (*at)* which suggested that when the objects are NOT functionally related then *en* was more appropriate for describing the relationship. This could, however, simply be an effect of the Spanish language in that it could be more common to describe a person being *at* the stove than *at* the easel and even though an artist is not as functionally linked to a stove he/she is nonetheless a person. In general the manipulation of Object Association in this experiment across all languages was perhaps not extreme enough to produce a strong enough effect of functional differences in the reference object - located object relationship.

Experiment Seven (Postman)

4.1.4 Method

The administration of Experiment Seven is identical to that used for all earlier experiments. Again each language group (English, Spanish and Finnish), consisting of 17 participants each, were given the same scenes to rate. The same groups of participants were used throughout the cross-linguistic test series.

4.1.4.1 Materials

Experiment Seven had a total of eight scenes that consisted of images previously used by Richards (see Figure 4.10). This Experiment was part of a series of eight cross-linguistic experiments that were all administered at once (eighty-five scenes in the full experimental series). All materials were presented in the same way throughout the cross-linguistic section.

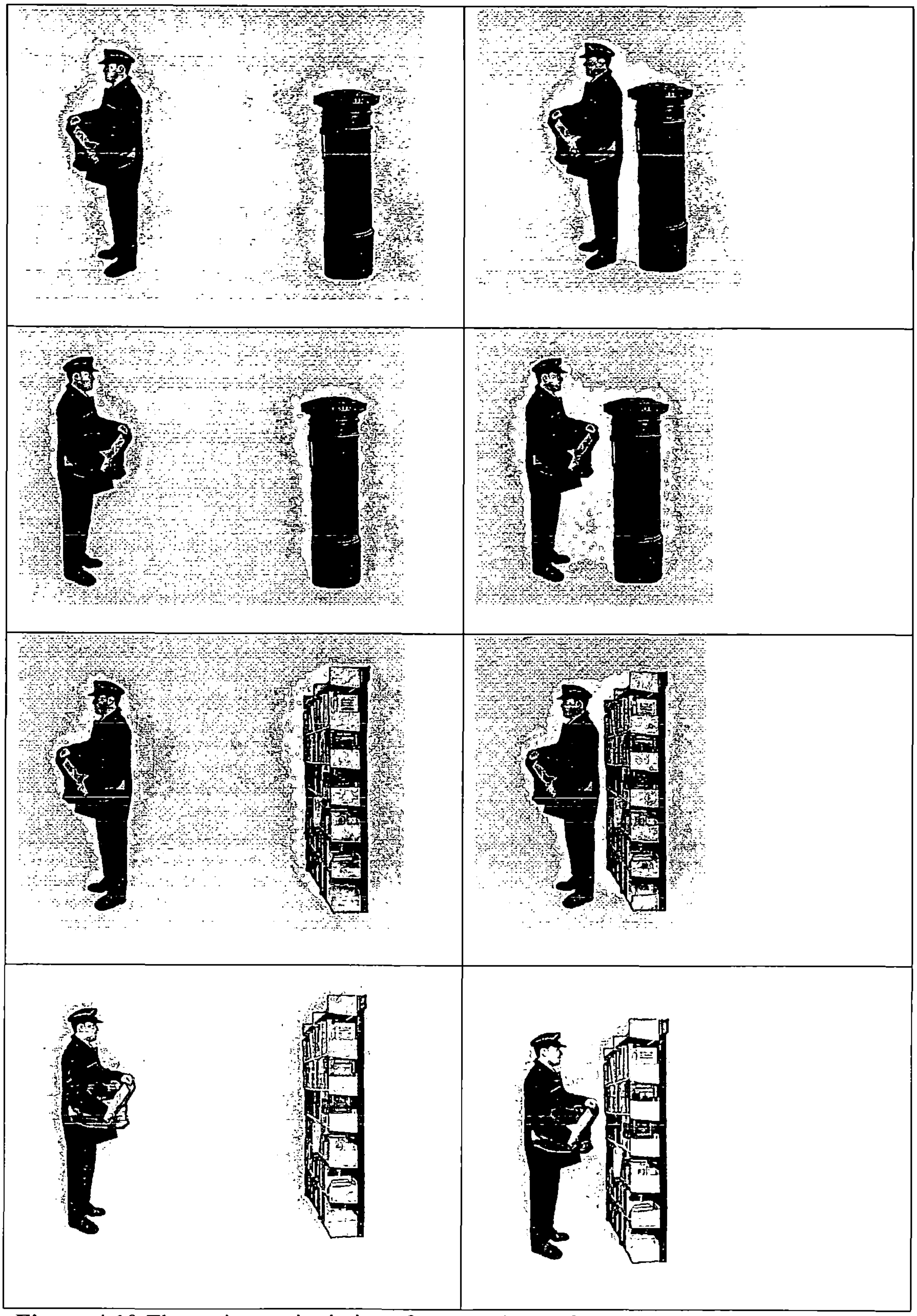


Figure 4.10 The main manipulations for Experiment Seven.

4.1.4.2 Procedure

The procedure of administration of Experiment Seven is identical to that of all previous experiments in this section of the thesis. Each participant received an individual test packet containing all eight randomised experiments in their native languages.

4.1.4.3 Design

The four factor design used in this experiment was the same for all factors across languages apart from the differing number of levels in the fourth factor. A 2 (object association) x 2 (proximity) x 2 (orientation) x 5, 7 or 5 (ad-position) within-participants design was used for the investigation (see Table 4.6).

Table 4.6 *The ad-positions used for each language group in Experiment Seven*

English	In front of	Behind	At	near	to the left of
Finnish	edessä, edellä	takana, perässä, jäljessä	äärellä	lähellä	(vasemmalla)
Spanish	Delante	detras	en	cerca	izquierdas

4.1.4.3.1 Main Manipulations

Factor 1: Object Association

Two levels of object association were used (see Figure 4.10). The located object and reference object were either functionally related (postman - post-box) or unrelated (postman – bookshelf).

Factor 2: Proximity

Two levels of proximity were manipulated (see Figure 4.10). In the 'far' condition the located object (postman) was located about 7.5 cm away from the reference object (bookshelf/post-box). In the 'near' condition the located object was positioned about 0.3 cm away from the reference object.

Factor 3: Orientation

Two levels of orientation were used (see Figure 4.10). The located object (postman) was either depicted facing towards the reference object (bookshelf/post-box), or facing away from the reference object.

Factor 4: Ad-position of sentence

There were five levels of ad-positions in use for the English group (see Table 4.6). The four English sentences under each scene were of the form: 'The postman is *in front of* the bookshelf/post-box'. There were seven levels of ad-positions in use with the Finnish group (see Table 4.6). The eight Finnish sentences under each scene were of the form: 'Postinkantaja on kirjahyllyn/postilaatikon *edessä.*' However, *vasemmalla* (*to the left of*) was again accidently omitted from some of the trials hence the results were only analysed for seven sentences. Finally, there were five levels of ad-positions in use with the Spanish group (see Table 4.6). The five Spanish sentences under each scene were of the form: 'El cartero está *delante* de la estanteria/buzón.

4.1.5 Results

In this experiment a repeated measures analysis of variance was carried out separately for each language group. The chosen alpha level is .05 throughout all the statistical analyses in this thesis. Throughout the cross-linguistic section of this thesis, Tukey (HSD) was the follow-up analysis of choice when further investigation was required. The results of each separate four-way ANOVA are reported individually below for each language group in separate sections which include tables of Mean ratings. Furthermore, the full ANOVA tables can be found in the Appendix Three.

4.1.5.1 ENGLISH

The mean ratings by condition are displayed in Table 4.7.

Table 4.7 *The mean ratings of the English group for each condition in Experiment 7 (N=17).*

Object Association	Prox.	Orient.	Ad-position *front*	*Behind*	*at*	*left of*	*near*
Bookshelf	Far	Away	4.53	1.65	3.41	3.59	5.47
		Facing	6.06	1.71	3.76	2.59	5.59
	Near	Away	5.59	1.65	4.82	2.71	6.59
		Facing	6.41	1.71	6.35	3.06	6.29
Postbox	Far	Away	4.12	1.47	2.35	3.35	5.06
		Facing	5.88	1.71	4.29	3.29	5.41
	Near	Away	5.41	1.88	4.88	3.41	6.71
		Facing	6.53	1.35	6.47	3.12	6.06

A significant main effect of Proximity, $F(1,16) = 46.87$, $p<0.001$, $MSE = 2.24$, was found with the near ($M = 4.55$) condition being rated higher than the far ($M = 3.76$) condition. There was also a main effect of Orientation, $F(1,16) = 8.72$, $p<0.01$, $MSE = 3.95$, present in which the condition where the reference object and located object were facing ($M = 4.38$) each other was rated higher than when they were facing away ($M = 3.93$) from one another. Additionally a main effect of Ad-position $F(4,64) = 32.42$, $p<0.001$, $MSE = 13.15$ was present. The ad-positions *in front of* ($M = 5.57$) and *near* ($M = 5.90$) were rated as the most appropriate and *at* ($M = 4.54$) also received reasonably high ratings, whereas *behind* ($M = 1.64$) and *to the left of* ($M = 3.14$) displayed lower rating levels throughout.

There was a significant interaction between Proximity x Ad-position $F(4,64) = 13.99$, $p<0.001$, $MSE = 2.09$ (Figure 4.11). The ad-positions *behind* (far $M = 1.63$; near $M = 1.65$) and *to the left of* (far $M = 3.21$; near $M = 3.07$) received similarly low rating levels regardless of the level of proximity. In contrast, the ad-position *at* showed a significant discrepancy ($p<0.001$) in that the near condition ($M = 5.63$) was rated clearly higher than the far condition ($M = 3.46$). Additionally, the ad-positions *in front of* (far $M = 5.15$; near $M = 5.99$) and *near* (far $M = 5.38$; near $M = 6.41$) had relatively high ratings throughout showing a significant tendency ($p<0.05$) for higher ratings in the near scenes than in the far scenes. The effect for *in front of* supports the hypothesis that when a functional relationship is facilitated by a near location between objects then people are more likely to adopt an intrinsic frame of reference than when the objects are far away from one another. However, the far proximity condition did not instantiate the adoption of the relative frame of reference any more than the close proximity condition did.

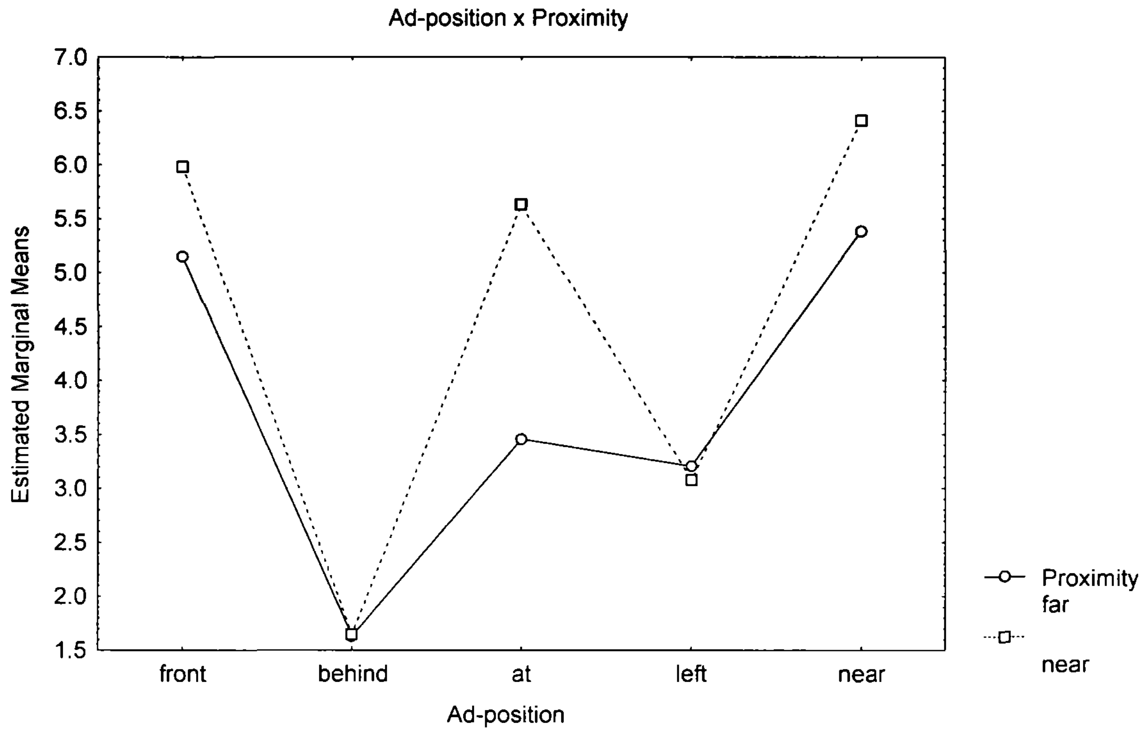


Figure 4.11 *A significant two-way interaction between Proximity x Ad-position for the English group in Experiment Seven.*

There was also a significant interaction between <u>Orientation x Ad-position</u> $F(4,64) = 9.79$, $p<0.001$, $MSE = 2.27$ (Figure 4.12). The terms *behind* (away $M = 1.66$; facing $M = 1.62$) and *to the left of* (away $M = 3.26$; facing $M = 3.01$) receive similarly low levels at both levels of orientation, although there is a slight dip (not significant p>0.05) in the ratings for *to the left of* if the objects are depicted facing each other. This does not really support the prediction that when a functional relationship is not facilitated by object orientation towards one another then a relative frame of reference would be more readily instantiated. Additionally, the ratings for *near* (away M = 5.96; facing M = 5.84) are equally high regardless of level of orientation. However, *in front of* (away M = 4.91; facing M = 6.22) and *at* (away M = 3.87; facing M = 5.22) show significant (p<0.001) discrimination between levels of orientation in that when the objects are facing each other the ratings are higher than when they are facing away from one another. The effect for *in front of* supports the prediction that when object interaction is enabled through the ideal orientation of the objects, then it is more likely for people to opt for an intrinsic frame of reference than when the objects are facing away from one another.

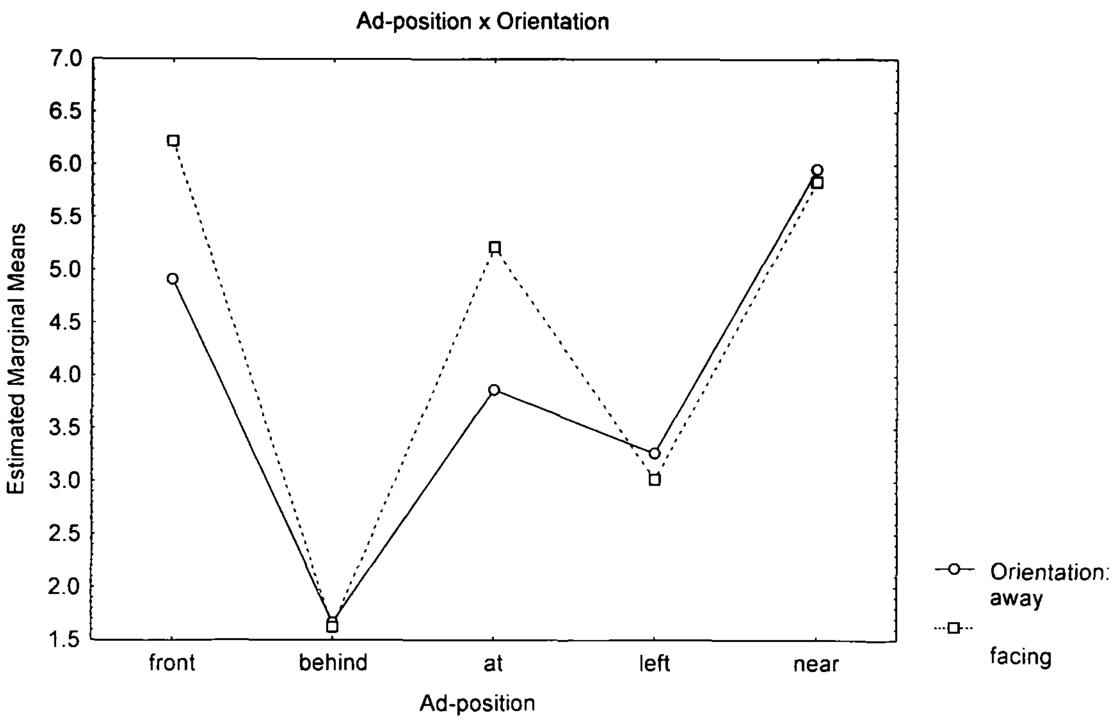


Figure 4.12 *A significant two-way interaction between Orientation x Ad-position for the English group in Experiment Seven.*

Furthermore, there was a significant three-way interaction between Object Association x Proximity x Orientation F(1,16) = 9.35, p<0.01, MSE = 0.89 (Figure

4.13). Unsurprisingly, the conditions in which the objects were depicted facing towards one another received higher ratings than the conditions in which the located object was positioned facing away from the reference object even thought this effect was collapsed across ad-positions. For the facing towards condition both object association conditions displayed a similar pattern in which ratings were significantly lower (p<0.01) at the far proximity levels (bookshelf M = 3.94, postbox M = 4.12) than in the near condition (bookshelf M = 4.76, postbox M = 4.71). The facing away condition also showed a similar effect in which regardless of whether there was an object association or not the ratings decreased significantly (p<0.01) in the far condition (bookshelf M = 3.73, postbox M = 3.27) in comparison to the near condition (bookshelf M = 4.27, postbox M = 4.46) . This discrepancy between levels of proximity was however the most marked for the facing away scenes when there was an object association present (postbox – postman). This suggests that since the two objects are typically expected to interact with one another, positioning the located object so that it is not able to fulfil its function with the reference object easily is likely to decrease the appropriateness of any of the spatial terms.

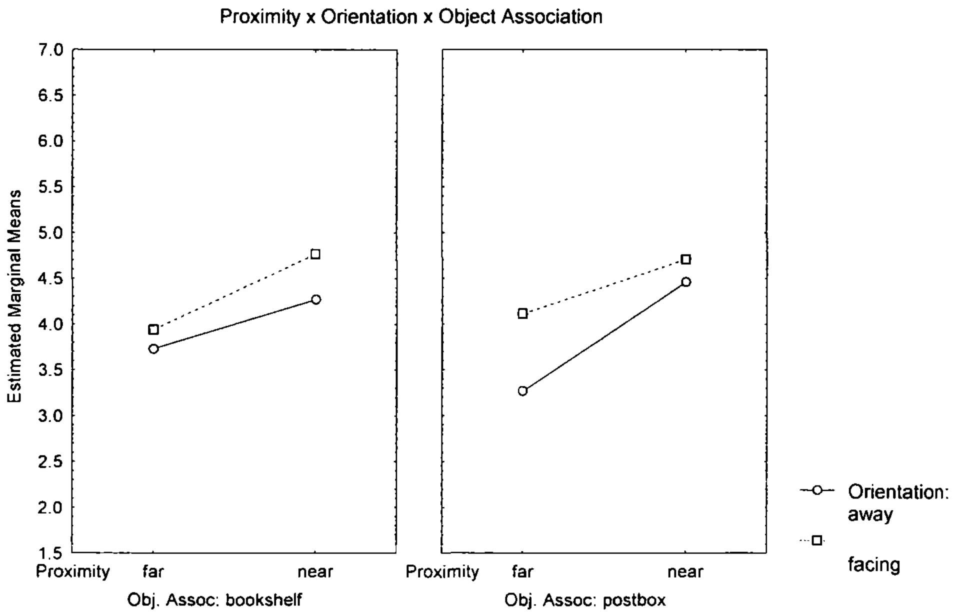


Figure 4.13 *Above is a significant Three-way interaction between Proximity x Orientation x Object Association for the English group in Experiment Seven.*

There was also a significant interaction between Object Association x Orientation x Ad-position $F(4,64) = 2.65$, $p<0.05$, $MSE = 0.50$ (Figure 4.14). The ad-position *near* (bookshelf/away M = 6.03; bookshelf/facing M = 5.94; post-box/away M = 5.88, post-box/facing M = 5.74) is rated at equally high levels in both object association conditions and both levels of orientation. Additionally, the ad-position *behind* (bookshelf/away M = 1.65; bookshelf/facing M = 1.71; post-box/away M = 1.68, post-box/facing M = 1.53) is rated at equally low levels regardless of levels of orientation or object association. However, the ad-position *in front of* (bookshelf/away M = 5.06; bookshelf/facing M = 6.24; post-box/away M = 4.76, post-box/facing M = 6.21) displays a similar significant ($p<0.001$) degree of differentiation between levels of orientation for both object association levels in which the condition where the objects are facing each other are deemed as most appropriate. This again is in accord with the hypothesis that when a functional relationship is enabled by appropriate orientation then it is more likely for people to adopt the intrinsic frame of reference. However, the effects of object association on the perceived functional relationship between objects did not seem to cause any significant influence on the pattern of effect for adopting an intrinsic frame of reference. However, only a subtle (not significant $p>0.05$) discrimination of orientation was apparent for the rating of *to the left of* (bookshelf/away M = 3.15; bookshelf/facing M = 2.82; post-box/away M = 3.38, post-box/facing M = 3.21) in which the facing away condition seemed slightly preferred to facing towards condition with this distinction being marginally more marked in the no object association condition (postman - book-shelf), this did not really provide support for the hypothesis that the instantiation of a relative frame of reference would be likely when the object function is not facilitated by object orientation.

Finally, it seems that the ad-position *at* shows the most discrimination between level of orientation in relation to whether the relationship between the located object and reference object is functional or is not functional through object association. When a non-functional object association relationship (bookshelf/away M = 4.12; bookshelf/facing M = 5.06) is portrayed in a scene there is a significant ($p<0.001$) preference for the facing towards scenes in comparison to the facing away from scenes. However, when the relationship between the two objects is functional through object association (post-box/away M = 3.62, post-box/facing M = 5.38) the discrimination between levels of orientation is even more visible ($p<0.001$).

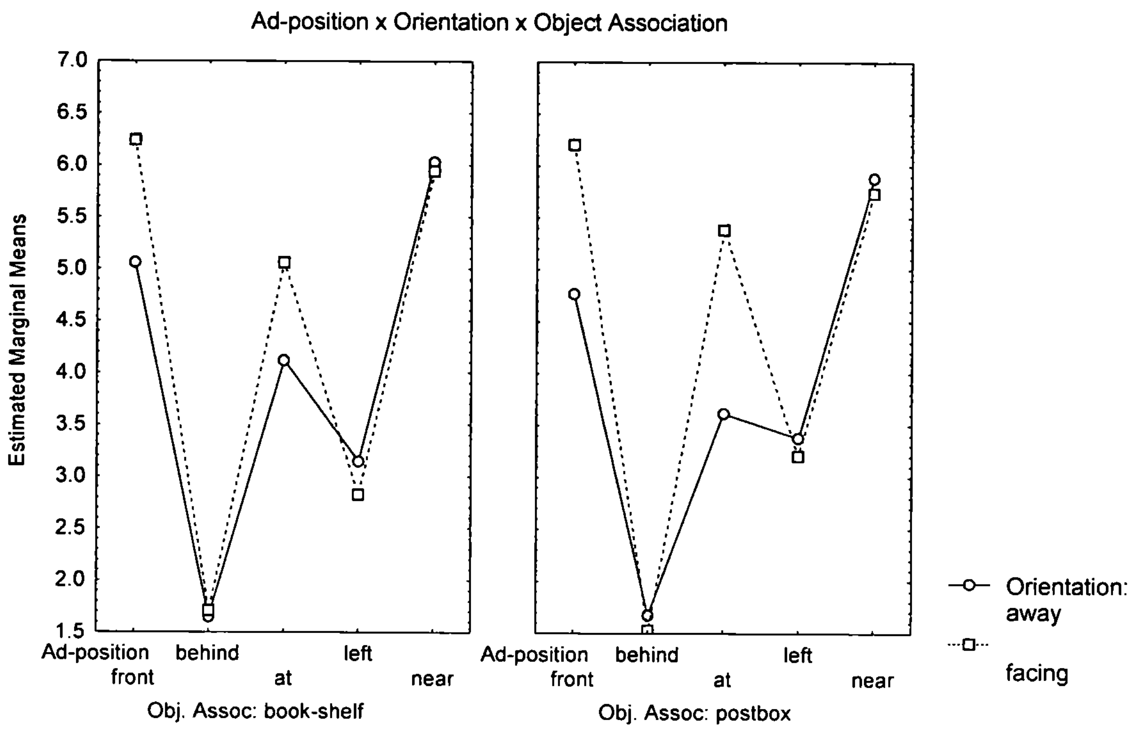


Figure 4.14 *Above is a significant Three-way interaction between Ad-position x Orientation x Object Association for the English group in Experiment Seven.*

There was also a significant three-way interaction between <u>Proximity x Orientation x Ad-position</u> $F(4,64) = 3.22$, $p<0.05$, MSE = 0.96 (Figure 4.15). The ad-position *behind* (far/away M = 1.56, far/facing M = 1.71; near/away M = 1.76, near/facing = 1.53) was rated at a similarly low rate through levels of proximity and orientation. The ad-position *to the left of* shows no distinction between levels of orientation in the near condition (away M = 3.06, facing M = 3.09) and also in the far condition the facing towards (M = 2.94) condition was rated at a similar level, whereas in the facing away (M = 3.47) condition the rating levels are elevated although not significantly ($p>0.05$). This does not really lend support for the hypothesis that when objects are oriented away from one another a relative frame of reference is more likely to be adhered to. However, unsurprisingly *near* is rated as more appropriate in the near proximity level than in the far condition with an elevation (although not significant $p>0.05$) of ratings for the away (M = 6.65) orientation in comparison to the facing towards (M = 6.18) orientation, whereas the effect pattern was only slightly opposite in the far condition (away M = 5.26, facing M = 5.50). The ad-position *at* is also rated more highly in the near proximity level (away M = 4.85, facing M = 6.41) than in the far condition (away M = 2.88, facing M = 4.03) displaying a consistent pattern of significantly ($p<0.01$) elevated ratings of appropriateness when the objects are facing towards each other in comparison to when they are facing away. Also, *in front of* is considered generally more appropriate in the near condition (away M = 5.50, facing M = 6.47) than in the far condition (away M = 4.32, facing M = 5.97) again showing an effect pattern in which scenes where the objects were facing towards each other were rated significantly ($p<0.01$) higher than when they were facing away. This provides support for the prediction that when a functional interaction is enabled by orienting the objects towards one another then an intrinsic frame of reference is facilitated, however this effect seems to be somewhat emphasised by proximity in that when objects are further away from one another the more influence the facing towards orientation has on ratings.

None of the other main effects or interactions were significant in this experiment.

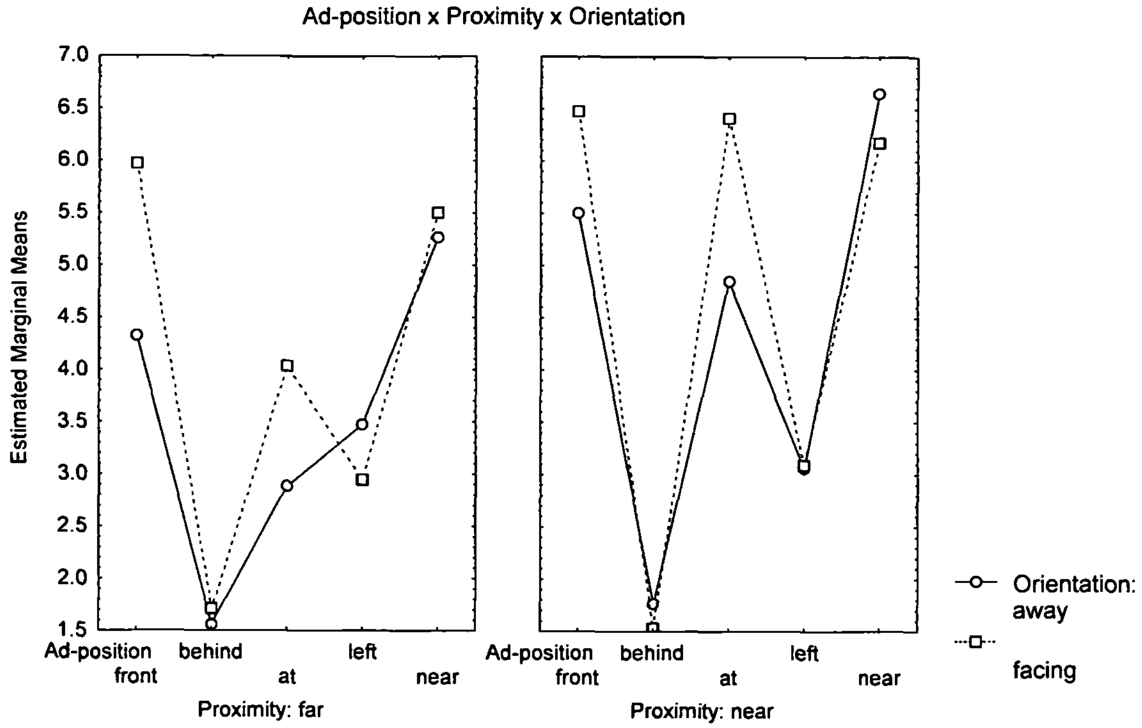


Figure 4.15 *Above is a significant Three-way interaction between Adposition x Proximity x Orientation for the English group in Experiment Seven.*

4.1.5.2 FINNISH

The mean ratings by condition are displayed in Table 4.8.

Table 4.8 *The mean ratings of the Finnish group for each condition in Experiment Seven (N=17).*

Object Associationn	**Prox.**	**Orient.**	*edell ä*	*takana*	*äärellä*	*edessä*	*peräss ä*	**Ad- position** *lähellä*	*jäljes .*
Book-shelf	Far	Away	3.41	2.18	3.18	5.24	2.12	5.47	1.47
		Facing	2.71	1.88	4.12	5.47	1.82	5.47	1.59
	Near	Away	3.35	2.06	5.00	7.00	1.76	6.76	1.94
		Facing	2.06	2.00	6.12	6.24	1.88	6.59	1.94
Postbox	Far	Away	4.47	2.00	2.71	5.29	1.53	5.35	1.41
		Facing	1.88	2.41	4.18	5.82	1.65	5.29	1.71
	Near	Away	2.94	1.71	5.24	6.06	1.71	6.53	1.82
		Facing	2.71	2.47	6.47	6.53	1.65	6.71	1.76

There was a significant main effect of <u>Proximity</u> $F(1,16) = 28.64$, $p<0.001$, $MSE = 3.13$ in which the near condition ($M = 3.89$) was rated higher than the far condition ($M = 3.28$). There was also a main effect of <u>Ad-position</u> $F(6,96) = 51.61$, $p<0.001$, $MSE = 9.72$ in which the behind terms *takana* ($M = 2.09$), *perässä* ($M = 1.76$) and *jäljessä*

(M = 1.71) were rated at a rather low level. The near term *lähellä* (M = 6.02) and one of the in front of terms *edessä* (M = 5.96) received much higher rating levels and *äärellä* (at M = 4.63) was rated quite highly as well. However, *edellä* (M = 2.94) the other in front of term was rated lower in appropriateness.

Also, there was a significant two-way interaction between Proximity x Ad-position $F(6,96) = 11.46$, $p<0.001$, MSE = 2.39 (Figure 4.16). The ad-positions *takana* (far M =2.12, near M = 2.06), *perässä* (far M = 1.78, near M = 1.75) and *jäljessä* (far M = 1.54, near M = 1.87) were rated at low levels with no real distinction between levels of proximity. Also, *edellä* (far M = 3.12, near M = 2.76) displays low rating levels with only a minor difference between proximity levels. However, the other in front of term *edessä* (far M = 5.46, near M = 6.46) and the near term *lähellä* (far M = 5.40, near M = 6.65) show higher appropriateness ratings and a significant ($p<0.01$) distinction between proximity levels favouring the near condition over the far condition. This was however also the pattern for the ad-position *äärella* (far M = 3.54, near M = 5.71) with an even more marked distinction ($p<0.001$) between proximity levels. The effect for the Finnish *in front of* term *edessä* is in accord with the prediction that enabling a functional interaction by positioning the objects at a close proximity to one another would instantiate the use of the intrinsic reference frame more readily than when the objects are placed further away from one another.

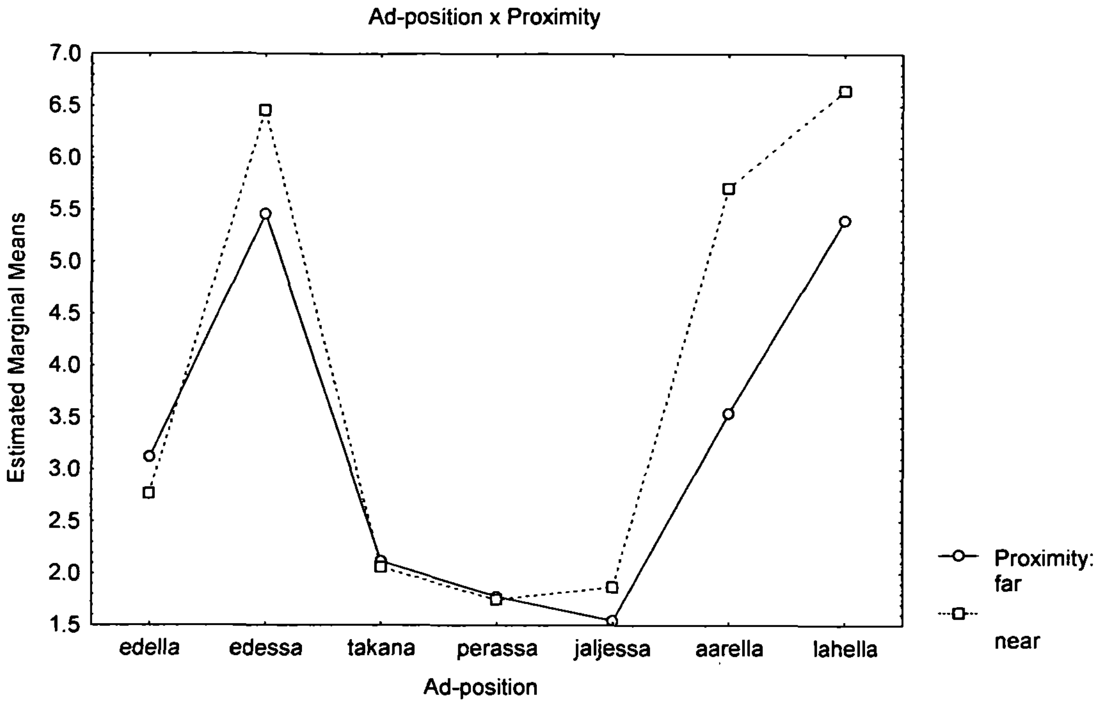


Figure 4.16 *A Significant two-way interaction between Ad-position x Proximity for the Finnish group in Experiment Seven.*

Additionally, a significant effect between Orientation x Ad-position $F(6,96) = 8.38$, $p<0.001$, MSE = 1.97 was present (Figure 4.17). The ad-positions *edessä* (away M =5.90, facing M = 6.01) and *lähellä* (away M = 6.03, facing M = 6.01) were rated at equally high levels in both conditions of orientation. Hence, the results for the effect on the *in front of* term *edessä* do not provide support for the hypothesis that an intrinsic frame of reference would be adopted more readily when a functional interaction is facilitated by appropriate orientation, because there is no real discrimination between orientations. Also, *takana* (away M = 1.99, facing M = 2.19), *perässä* (away M = 1.78, facing M = 1.75) and *jäljessä* (away M = 1.66, facing M = 1.75) were rated at similarly low levels throughout conditions of orientation. However, there is a significant ($p<0.01$) distinction between levels of orientation for the term *edellä* in which the facing away (M = 3.54) condition is perceived as more appropriate than the facing towards (M = 2.34) condition. This again is in accord with the suggestion that the *in front of* term *edellä* is most appropriate for describing scenes in which one object is 'following' the other. However, the discrimination between orientations shows an opposite pattern for the term *äärellä* in which the facing towards (M = 5.22) condition is significantly ($p<0.01$) favoured in comparison to the facing away from condition (M = 4.03).

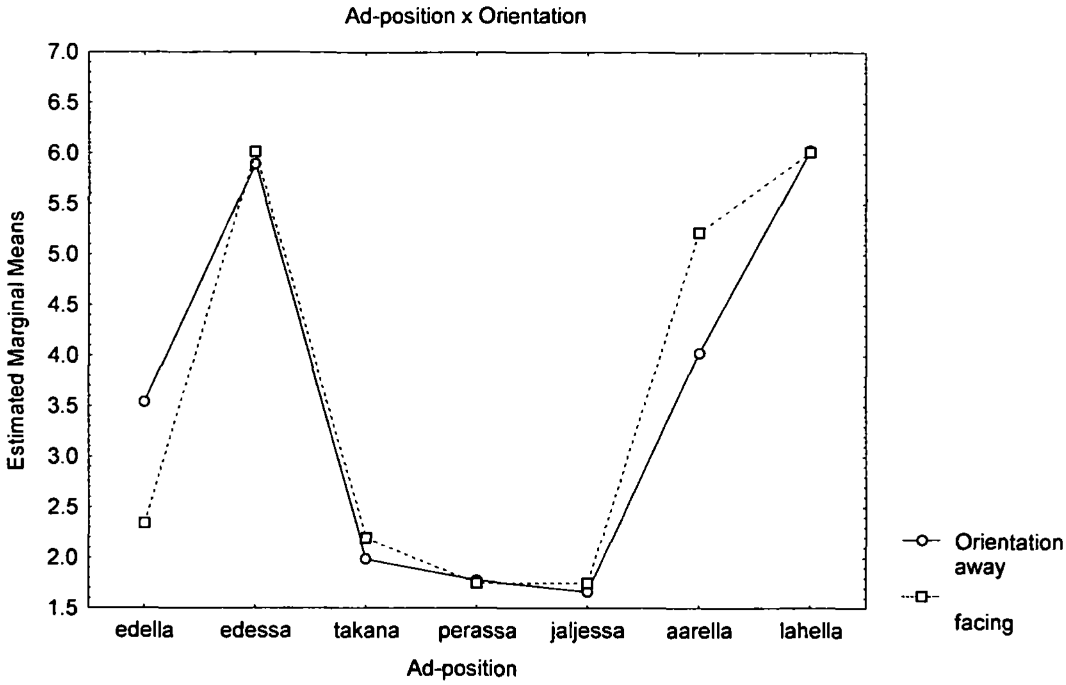


Figure 4.17 *A Significant two-way interaction between Ad-position x Orientation for the Finnish group in Experiment Seven.*

Additionally, there was a significant four-way interaction between <u>Object Association x Proximity x Orientation x Ad-position</u> $F(6,96) = 2.69$, $p<0.05$, MSE = 1.17 (Figure 4.18).

For follow-up analyses the data set was divided into seven sections by ad-position for which separate 3-way analyses were carried out, and also further Tukey HSD analyses were conducted in some cases.

In general the three behind terms are rated at low levels throughout conditions and none of the terms interact significantly with object association, proximity, and orientation when the data was divided by ad-position.

Perässä: far/book-shelf/away M = 2.12, far/book-shelf/facing M = 1.82; far/post-box/away M = 1.53, far/post-box/facing M = 1.65; near/book-shelf/away M = 1.76, near/book-shelf/facing M = 1.88; near/post-box/away M = 1.71, near/post-box/facing M = 1.65.

Jäljessä: far/book-shelf/away M = 1.47, far/book-shelf/facing M = 1.59; far/post-box/away M = 1.41, far/post-box/facing M = 1.71; near/book-shelf/away M = 1.94, near/book-shelf/facing M = 1.94; near/post-box/away M = 1.82, near/post-box/facing M = 1.76.

Takana: far/book-shelf/away M = 2.18, far/book-shelf/facing M = 1.88; far/post-box/away M = 2.00, far/post-box/facing M = 2.41; near/book-shelf/away M = 2.06, near/book-shelf/facing M = 2.00; near/post-box/away M = 1.71, near/post-box/facing M = 2.47.

Out of the two in front of terms *edessä* is visibly preferred in comparison to *edellä* throughout the whole experiment. For *edessä* (far/book-shelf/away M = 5.24, far/book-shelf/facing M = 5.47; far/post-box/away M = 5.29, far/post-box/facing M = 5.82; near/post-box/away M = 6.06, near/post-box/facing M = 6.53) there seems to be very little distinction of orientation throughout the conditions with perhaps a tendency to rate the facing towards conditions slightly more favourably than the facing away conditions (although not a significant difference $p>0.05$). Nonetheless, there seems to be an exception for *edessä* (near/book-shelf/away M = 7.00, near/book-shelf/facing M = 6.24) in that there was a slight distinction for orientation in the scenes with bookshelves where the proximity was at the near level showing higher (although not significant $p>0.05$) rating levels for the facing away orientation than for the facing towards condition.

Furthermore, the ad-position *edellä* displays a preference for rating scenes as more appropriate throughout all conditions of the experiment when the located object and reference object are facing away from each other (far/book-shelf/away M = 3.41, far/book-shelf/facing M = 2.71; far/post-box/away M = 4.47, far/post-box/facing M =

1.88; near/book-shelf/away M = 3.35, near/book-shelf/facing M = 2.06; near/post-box/away M = 2.94, near/post-box/facing M = 2.71). However, this pattern of differentiation is only significant ($p<0.05$) in the far condition when the post-box is the reference object. Again this suggests that the ad-position *edellä* is most appropriate for describing a relationship in which the reference object 'follows' the located object hence the instantiation of an intrinsic frame of reference does not require the traditional face to face orientation between two objects.

The ad-position *äärellä* (at) displays a consistent, although not significant ($p>0.05$), differentiation pattern for object orientation throughout the experiment in which the facing toward condition produces higher appropriateness ratings than the facing away condition (far/book-shelf/away M = 3.18, far/book-shelf/facing M = 4.12; far/post-box/away M = 2.71, far/post-box/facing M = 4.18; near/book-shelf/away M = 5.00, near/book-shelf/facing M = 6.12; near/post-box/away M = 5.24, near/post-box/facing M = 6.47). Whereas, the near term *lähella* (far/book-shelf/away M = 5.47, far/book-shelf/facing M = 5.47; far/post-box/away M = 5.35, far/post-box/facing M = 5.29; near/book-shelf/away M = 6.76, near/book-shelf/facing M = 6.59; near/post-box/away M = 6.53, near/post-box/facing M = 6.71) is rated consistently at high appropriateness levels throughout and shows very little differentiation ($p>0.05$) between levels of orientation, however the rating levels are unsurprisingly elevated at the near proximity levels.

None of the other main effects or interactions were significant in this experiment.

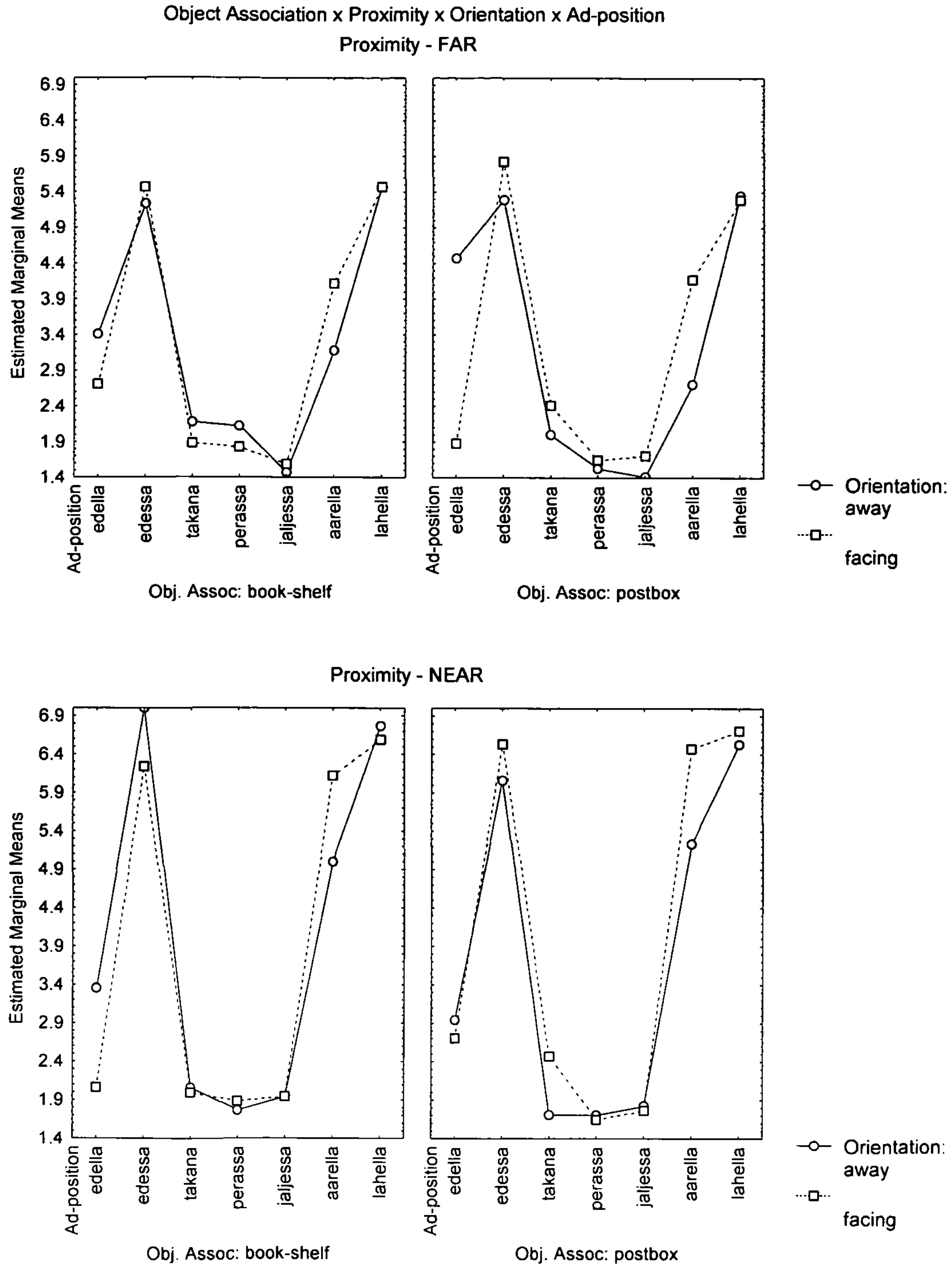


Figure 4.18 *A Significant four-way interaction between Ad-position x Object Association x Orientation x Proximity for the Finnish group in Experiment Seven.*

4.1.5.3 SPANISH

The mean ratings by condition are displayed in Table 4.9.

Table 4.9 *The mean ratings of the Spanish group for each condition in Experiment Seven (N=17).*

Object Association	Prox.	Orient.	Ad-position *Delante*	*detrás*	*en*	*izquierda*	*cerca*
Bookshelf	Far	Away	4.65	1.94	1.94	2.53	5.00
		Facing	6.29	1.59	1.82	1.88	4.82
	Near	Away	5.53	2.00	2.47	2.41	5.41
		Facing	6.06	1.65	2.53	2.24	5.53
Postbox	Far	Away	5.47	1.82	1.88	2.35	4.76
		Facing	5.94	2.29	2.18	1.88	4.94
	Near	Away	5.59	1.94	2.41	2.82	5.82
		Facing	6.24	2.12	3.06	1.88	4.82

A significant main effect of Proximity $F(1,16) = 12.52$, $p<0.01$, MSE = 1.45 was present where the near condition (M = 3.63) was rated higher than the far condition (M = 3.30). Also, a significant effect of Ad-position $F(4,16) = 22.13$, $p<0.001$, MSE = 20.19 was present in which *delante* (*in front of* M =5.72) and *cerca* (*near* M = 5.14) were rated as most appropriate, whereas *detras* (*behind* M = 1.92), *en* (*at* M = 2.29) and *izquierda* (*to the left of* M = 2.25) received lower ratings.

Furthermore, there was a significant two-way interaction between Orientation x Ad-position $F(4,64) = 3.06$, $p<0.05$, MSE = 2.96 (Figure 4.19). The terms *delante* (away M = 5.31, facing M = 6.13) and *cerca* (away M = 5.25, facing M = 5.03) were rated highest, however only *delante* showed some differentiation (non-significant $p>0.05$) between levels of orientation where the facing towards orientation was rated highest, whilst *cerca* had similar ratings on both conditions. The terms *detras* (away M = 1.93, facing M = 1.91), *en* (away M = 2.18, facing M = 2.40) and *izquierda* (away M = 2.53, facing M = 1.97) were rated as less appropriate with only *izquierda* displaying slight discrimination (non-significant $p>0.05$) between levels of orientation in that the facing away orientation was rated as more appropriate.

None of the other main effects or interactions were significant in this experiment.

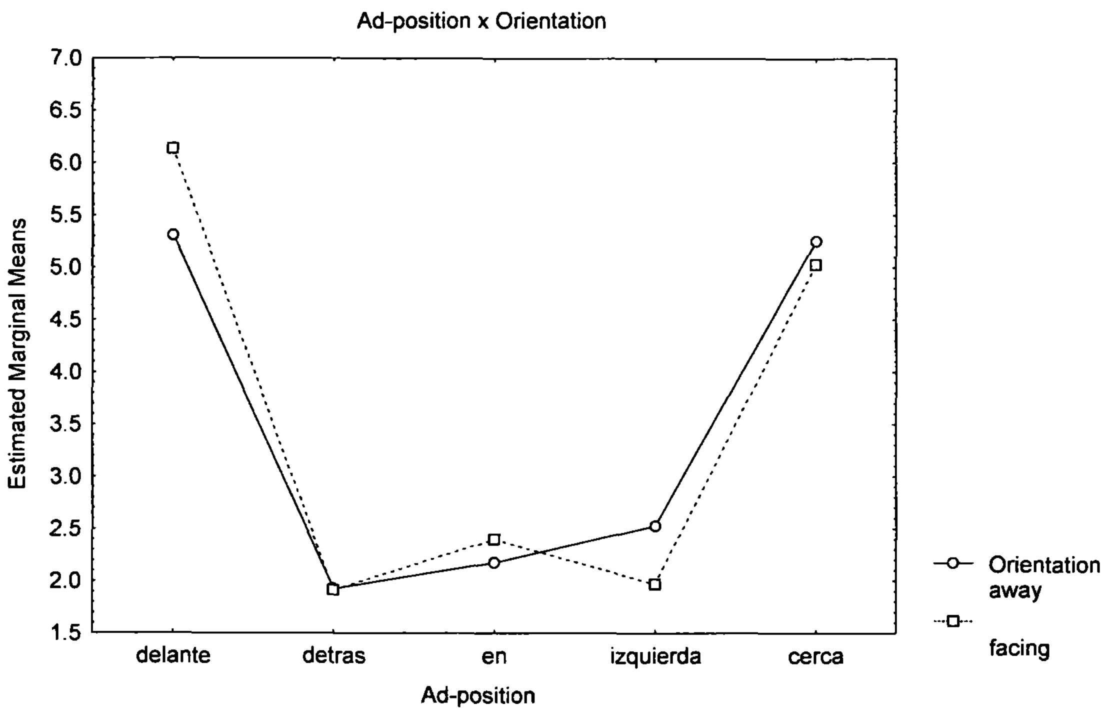


Figure 4.19 *A Significant two-way interaction Between Ad-position x Orientation for the Spanish group in Experiment Seven.*

4.1.6 Discussion for Experiment Seven

A summary of all the main-effects and interactions that were found in Experiment Seven throughout all three language groups can be found below in Table 4.10.

Table 4.10 *Summary of all significant effects in Experiment Seven.*

	English	Finnish	Spanish
Main Effects			
Object Association			
Proximity	X	X	X
Orientation	X		
Ad-position	X	X	X
2-way interactions			
Obj. As. x Proximity			
Obj. As. x Orientation			
Obj. As. x Ad-position			
Proximity x Orientation			
Proximity x Ad-position	X	X	
Orientation x Ad-position	X	X	X
3-way interactions			
Obj. As. x Proximity x Orientation	X		
Obj. As. x Proximity x Ad-position			
Obj. As. x Orientation x Ad-position	X		
Proximity x Orientation x Ad-position	X		
4-way interactions			
Obj. As. x Proximity x Orientation x Ad-position		X	

Across all three languages some support was revealed for the experimental predictions (see Table 4.10). The hypothesis that enabling a functional interaction between two objects by appropriate orientation would facilitate the use of an intrinsic frame of reference was supported by the results of the only the English group. This was shown by significantly higher rating levels for the ad-position *in front of* when the objects were facing towards one another. Furthermore, while the Spanish *delante* displayed a similar pattern the effect was not significant. In contrast, there was no real discrimination between orientations for the Finish *in front of* term *edessä*. There was, however, apparent discrimination between orientations for the other *in front of* term *edellä*. This pattern supported the prediction that *edellä* would be rated higher when the located object is oriented away from the reference object (fronts of both objects pointing in the same direction). As mentioned earlier, this is very likely to be related to the notion that *edellä* is more appropriate for describing the spatial relationship of a moving or potentially moving scene in which one object would be following the other or as they would be ordered in a queue. The prediction that by making a functional relationship less likely by orienting objects away from one another would encourage the adoption of the relative frame of reference was supported by the Spanish group but not at a significant level. This was indicated by higher ratings for the ad-positions *izquierda* (*to the left of*) when the objects were facing away from one another.

Furthermore, it was hypothesized that when a functional relationship is enabled by positioning objects nearer one another it would be more likely for people to adopt an intrinsic frame of reference than when the objects were located far from one another. This prediction was in accord with the findings that English *in front of* and Finnish *edessa* were rated more highly when the objects were at near locations to one another than when they were further away. However, the second Finnish in front of term *edella,* did not show such support as there was no discrimination between levels of proximity hence although *edella* seems to be sensitive to orientation it does not seem to be to proximity. The Spanish term *delante* did not support the predictions for the effects of proximity. Furthermore, neither of the languages (English and Spanish) in which the ad-position *to the left of* (or equivalent) was present in the experimental manipulations, presented any clear evidence that making a functional relationship between objects more unlikely by positioning them at a far proximity, would encourage the instantiation of a relative frame of reference. Finally no real indications were found in any of the language groups that would suggest that a functional relationship between objects (postman/postbox) would be more likely to facilitate the activation of an intrinsic frame of reference than a non-functional object relationship (postman/bookshelf).

4.2 Rationale for Experiment Eight (car/shop)

The beginning of this chapter summarises a number of studies looking at the interactions between geometric and extra-geometric variables and how they have an effect on the comprehension and production of horizontal axis projective terms and touches upon the work produced by Coventry and Frias-Lindqvist (2005). Here however the study is covered in more detail as it has had influence on the design of Experiment Eight as well as the work carried out by Carlson-Radvansky and Radvansky (1996) and Richards (2000).

Coventry and Frias-Lindqvist (2005) have conducted an experiment which was designed to examine the interplay between movement and geometric variables such as alignment and orientation and how they effect the comprehension of the horizontal axis terms *in front of* and *behind* and Finnish equivalents *edessä/edellä* and *takana/perässä/jäljessä*. As expected they found that there are cross-linguistic differences in the way that factors effect the language used to describe the scenes. The experiment was comprised of scenes in which two cars were located on a roundabout and the orientation and alignment of the cars were manipulated in addition to varying motion. Participants were then asked to rate sentences which were of the form '*the coloured car is adposition the white car*' for English (and '*värillinen auto on valkoisen auton adposition*' for Finnish). An interesting aspect that was revealed was that the

English *in front of* term and the Finnish counterparts *edessä/edellä* were rated more highly when the cars were moving if there was a reference frame conflict (when the cars were facing one another), but not when the orientations of both vehicles were so that both car fronts were pointing towards the direction they would potentially be driving. This was thought to be a result of movement providing an added cue to encourage the adoption of an intrinsic frame of reference despite the orientation of the cars being less than ideal. There was also an interesting effect between orientation and ad-position for the Finnish group in which the analyses uncovered that the ad-position *edellä* (*in front of*) was rated higher when the objects were oriented with their fronts pointed towards the same direction rather than when they were facing one another, whereas no such discrepancy was visible for the other *in front of* term *edessä*. Also, the ad-position *in front of* for the English group was rated higher when the object orientation was such that their fronts were pointing in the same direction. The Finnish linguist Urpo Nikanne (2003) predicted that the ad-position *edellä* would be more appropriate for describing dynamic scenes, whilst *edessä* would be most appropriate for describing static scenes. Although this was not completely supported by the results of the work by Coventry and Frias-Lindqvist (2005), it could be that this was due to both the reference object and located objects being cars so that regardless of the presence of motion they may be viewed as objects with the potential to move even when static. Hence, when the objects were oriented with their fronts pointing in the same direction it could be suggested that they were ideally positioned for *potential* movement resulting in *edellä* being considered most appropriate.

Generally, both the English and Finnish *behind* terms were rated highest when they were positioned with their fronts pointing in the same direction. Again, as with the *front* terms it was found that the English term *behind* and the Finnish counterparts *takana/perässä/jäljessä* were rated more highly when the cars were moving if there was a reference frame conflict (when the cars were facing one another). Also, the prediction made by Nikanne (2003) that the Finnish *behind* terms *jäljessä* and *perässä* would be more appropriate for describing scenes involving motion while the behind term *takana* would be most appropriate for describing static scenes, received some support from the effects found in the study. This was not, however very straightforward as the effects indicated that while *takana* did not show discrimination between static and dynamic scenes, *jäljessä* and *perässä* had slightly elevated ratings when the cars were moving. Hence, it seems that *jäljessä* and *perässä* are slightly more appropriate for describing dynamic scenes, whereas *takana* is suitable for describing scenes whether they display moving objects or not. The greater appropriateness of *jäljessä* and *perässä* when describing moving objects is however further restricted by indications that this is mainly the case when there are reference frame conflicts present (objects facing one another).

While Experiment Eight has been motivated by the work of Coventry and Frias-Lindqvist the design differs quite extensively. Instead of viewing the scenes from above all scenes were shown to participants in profile view and none of the conditions involved actual motion as the study was a pencil and paper task rather than a computer animation. Also, alignment and proximity were not manipulated but orientation remained a factor of interest. Furthermore, potential animacy of reference object and located object were added as factors; rather than simply manipulating two cars both the reference object and the located figure object could be either a car or a shop. A shop was added to the present design as a contrast for the car, in order to allow an inspection of whether there would be a conceptual affect (knowledge of dynamic-kinematic routine) when the object either has the potential to move or not.

Leading on from the findings of Carlson-Radvansky and Radvansky (1996), Richards (2000) and especially Coventry and Frias-Lindqvist (2005), the following hypotheses were developed. The first prediction was that the Finnish *in front of* term *edellä* would display an emphasized distinction between orientations, in that it would be more appropriate for describing any scene, regardless of potential object animacy (whether a shop or car), in which the located object is pointing with its front positioned in the same direction as the reference object front (as if taking the lead). In contrast, *edessä* was generally predicted to show less distinction between the orientation conditions (located object facing away or toward the reference object).

The second cross-linguistic prediction was that people's awareness for dynamic kinematic routines, would lead to higher rating levels for the *in front of* terms across the three language groups being displayed when the located object is oriented so that its front is pointed in the same direction as the front of the reference object when both objects are cars. In contrast, when both objects were shops the scenes in which the located and reference objects were facing toward one another (as might be expected on the high-street) were expected to have higher ratings of the *in front of* terms across all three language groups. The thought was that conceptual knowledge of different object functions would influence which orientation would be most likely to facilitate a natural relation between objects and therefore instantiate the use of the intrinsic frame of reference (i.e. *in front of* terms across languages).

4.2.1 Method

The administration of Experiment Eight is identical to that used for all earlier experiments described in the previous sections. Again each language group (English, Spanish and Finnish), consisting of 17 participants each, were given the same scenes to rate. The same groups of participants were used throughout the cross-linguistic test series.

4.2.1.1 Materials

Experiment Eight had a total of eight scenes that consisted of clip art images (see Figure 4.21). This Experiment was part of a series of eight cross-linguistic experiments that were all administered at once (eighty-five scenes in the full experimental series). All materials were presented in the same way throughout the cross-linguistic section.

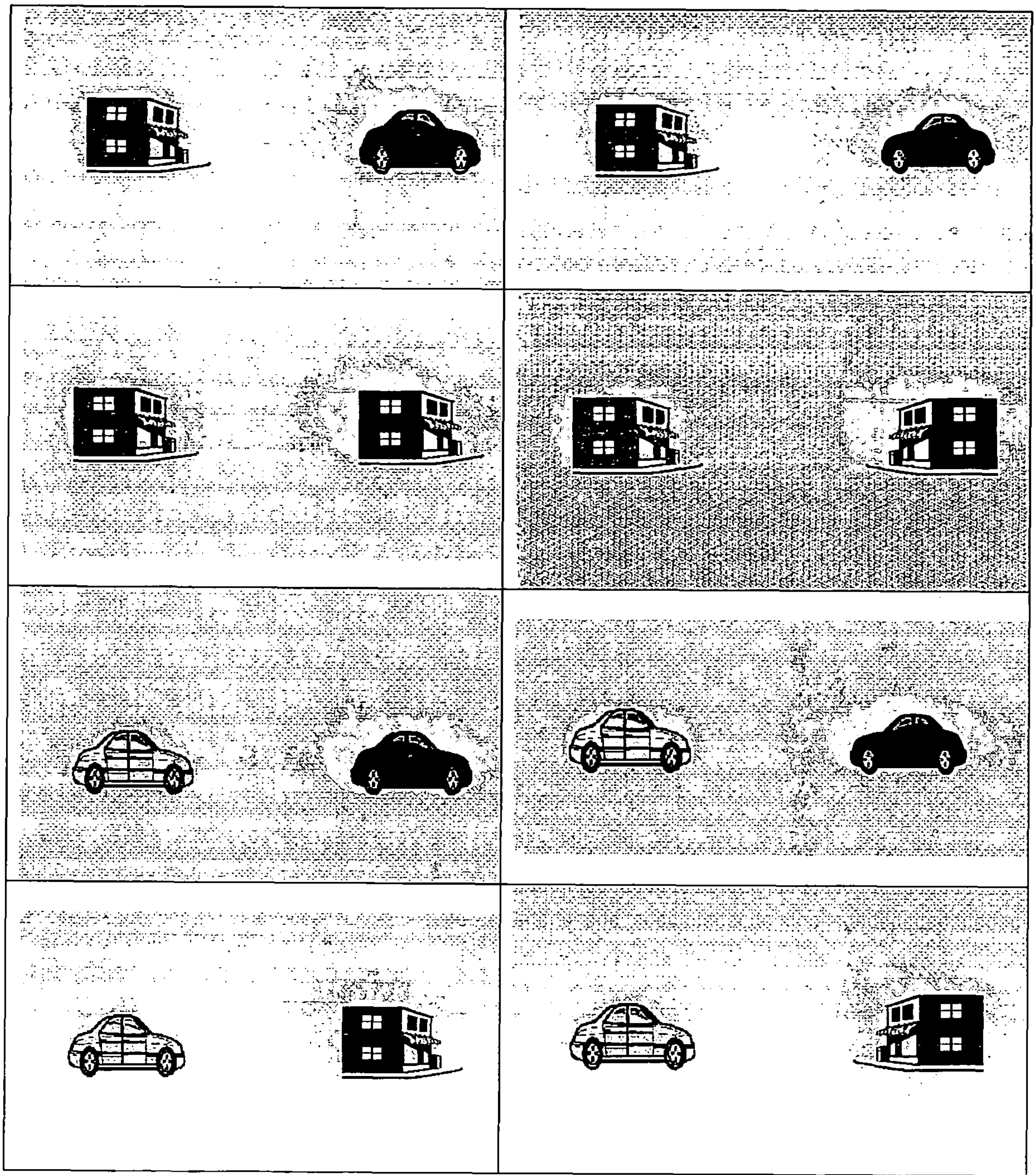


Figure 4.20 The main manipulations for Experiment Eight.

4.2.1.2 Procedure

The procedure of administration of Experiment Eight is identical to that of all previous experiments in this section of the thesis. Each participant received an individual test packet containing all eight randomised experiments in their native languages.

4.2.1.3 Design

The four factor design used in this experiment was the same for all factors across languages apart from differing numbers of levels in the fourth factor. A 2 (reference object) x 2 (figure object) x 2 (orientation) x 2, 5 or 2 (ad-position) within-participants design was used for the investigation (see Table 4.11).

4.2.1.3.1 Main Manipulations

Factor 1: Animacy of Reference object

There were two levels of reference object. The reference object, which was located on the left side of the scene with its front facing to the right of the page, could be either a white car or a grey shop. The car represents an object with potential to move, whereas, the shop depicts a clearly static object (See Figure 4.21).

Factor 2: Animacy of Located object

Again, there were two levels of located object. The located object was positioned on the right side of the scene. This could also be either a black car or a black shop, representing the animate versus inanimate. (See Figure 4.21)

Factor 3: Orientation of Located object

Two levels of orientation were used. The located object (car/shop) was either depicted facing away from the reference object (car/shop), or positioned facing towards it. (See Figure 4.21)

Factor 4: Ad-position of sentence

There were two levels of ad-position in use in the English experiment (see Table 4.11). The two English sentences under each scene were of the form: 'The black car is *in front of* the white car.' However, there were five levels of ad-position in use for the Finnish group (see Table 4.11). The five Finnish sentences under each scene were of the form: 'Musta auto on valkoisen auton *edessä*'. Finally, there were two levels of ad-position in use for the Spanish group (see Table 4.11). The two Spanish sentences under each scene were of the form: 'El coche negro está *detrás* del coche blanco'.

Table 4.11 *The ad-positions used for each language group in Experiment Eight*

English	in front of	Behind
Finnish	edessä, edellä	takana, perässä, jäljessä
Spanish	Delante	detras

4.2.2 Results

The results of each separate four-way ANOVA are reported individually below for each language group in separate sections which include tables of Mean ratings. Furthermore, the full ANOVA tables can be found in the Appendix Three.

4.2.2.1 ENGLISH

The mean ratings by condition are displayed in Table 4.12.

Table 4.12 *The mean ratings of the English group for each condition in Experiment Eight (N=17).*

Reference Object	Located Object	Orientation	Ad-position *behind*	*Front*
Car	Car	Away	1.13	6.63
		Facing	1.56	5.81
	Shop	Away	1.50	6.44
		Facing	2.06	6.31
Shop	Car	Away	1.69	6.25
		Facing	1.69	6.19
	Shop	Away	1.25	4.50
		Facing	1.63	4.38

There was a main effect of Reference Object Animacy $F(1,15) = 7.48$, $p<0.05$, $MSE = 2.01$, in which the car ($M = 3.93$) was generally rated as more appropriate than the shop ($M = 3.45$). There was also a main effect of Ad-position $F(1,16) = 100.01$, $p<0.001$, $MSE = 11.56$, in which *behind* ($M = 1.56$) was rated at lower levels than *in front of* ($M = 5.81$).

Furthermore, there was a significant two-way interaction between Located Object Animacy x Reference Object Animacy $F(1,15) = 16.50$, $p<0.001$, $MSE = 1.67$ (Figure 4.22). The ratings for the located object when it was a car were relatively level in both reference object conditions (car $M = 3.78$, shop $M = 3.95$). Whereas, when the located object was a shop it received significantly ($p<0.01$) higher rating levels when the reference object was a car ($M = 4.08$), however the ratings decrease visibly when the reference object was another shop ($M = 2.94$).

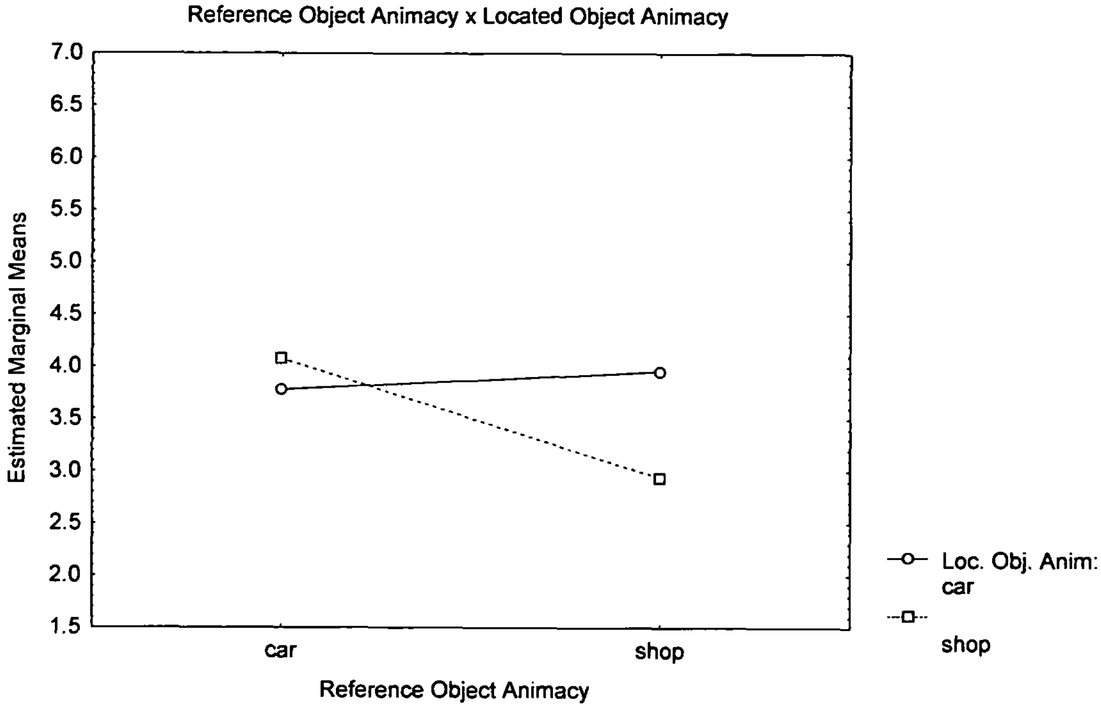


Figure 4.21 A *Significant two-way interaction between Reference Object Animacy x Located Object Animacy for the English group in Experiment Eight.*

There was also a significant interaction between <u>Located Object Animacy x Ad-position</u> $F(1,15) = 6.86$, $p<0.05$, MSE = 1.92 (Figure 4.23). The ad-position *behind* (car M = 1.57, shop M = 1.61) was rated at equally low levels regardless of what the Located object was. In contrast, *in front of* was rated at significantly ($p<0.001$) higher levels with a significant ($p<0.05$) discrimination between Located Object Animacy, in that the car (M = 6.22) had elevated ratings in comparison to the shop (M = 5.41).

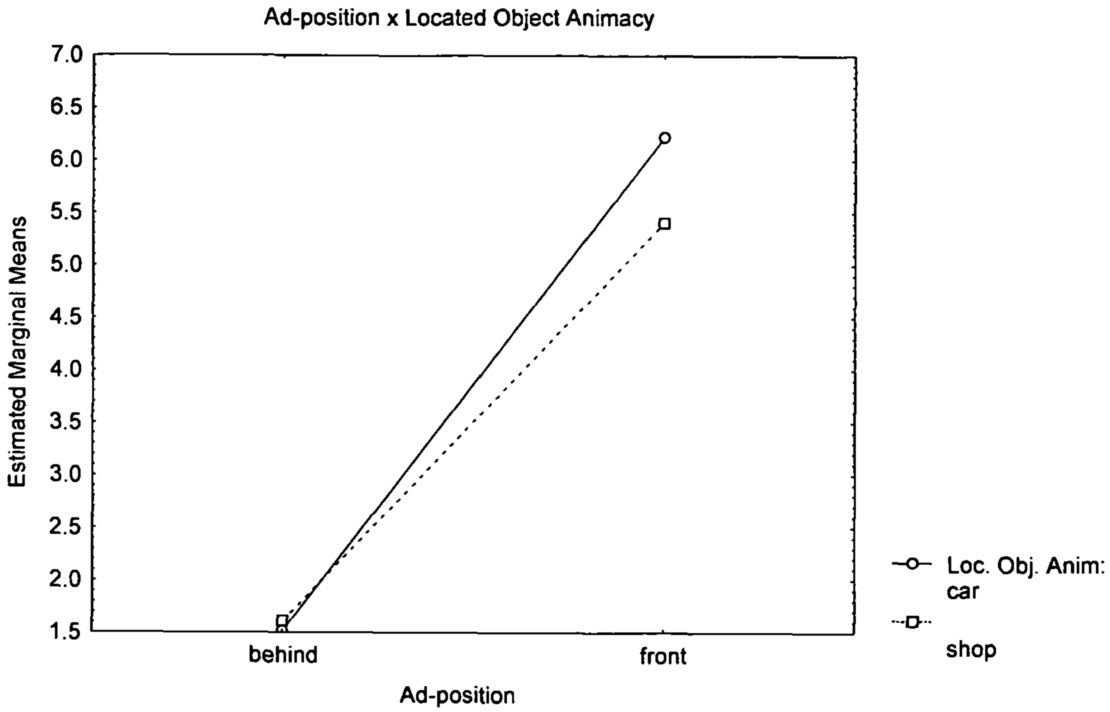


Figure 4.22 *Significant two-way interaction between Ad-position x Located Object Animacy for the English group in Experiment Eight.*

Additionally, there was a significant interaction between <u>Reference Object Animacy x Ad-position</u> $F(1,15) = 11.20$, $p<0.001$, $MSE = 1.34$ (Figure 4.24). A similar pattern to that reported above emerges again in which the ad-position *behind* (car M = 1.56, shop M = 1.56) was rated at equally low levels regardless of what the reference object was. In contrast, *in front of* was rated at significantly ($p<0.001$) higher levels with a significant ($p<0.05$) discrimination between reference objects in that the car (M = 6.30) had elevated ratings in comparison to the shop (M = 5.33).

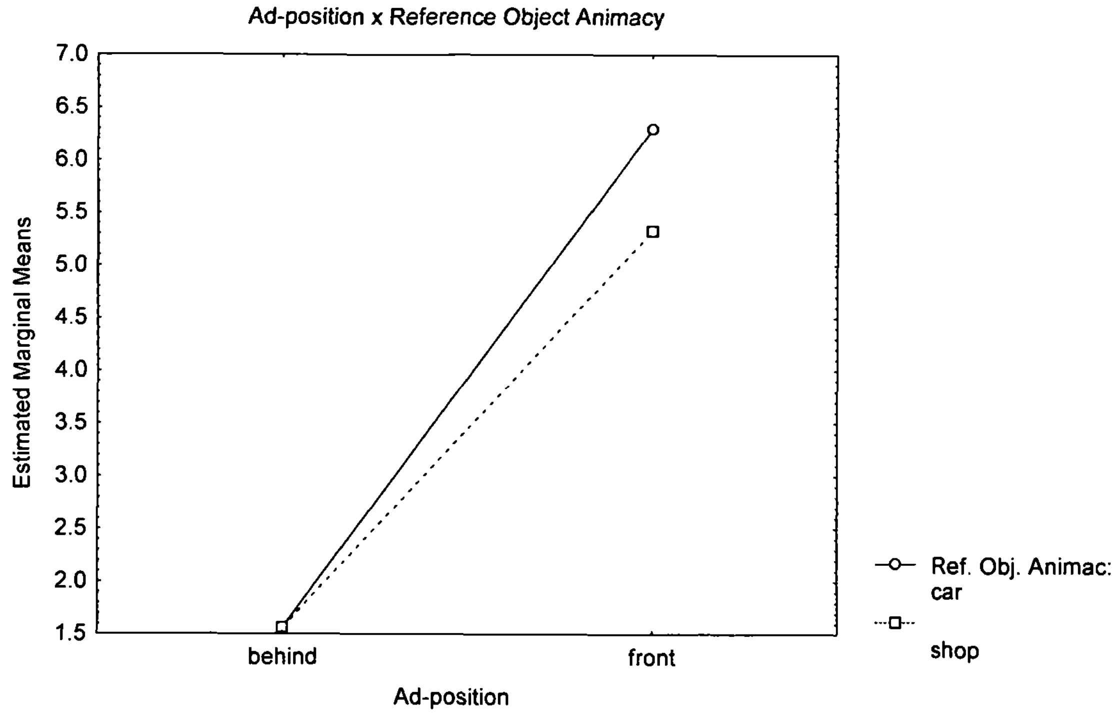


Figure 4.23 *A Significant two-way interaction between Reference Object Animacy x Ad-position for the English group in Experiment Eight.*

There was also a significant interaction between Orientation x Ad-position $F(1,15) = 4.90$, $p<0.05$, MSE = 1.28 (Figure 4.25). The ad-position *behind* gets ratings of a similarly low level for both levels of orientation (away M = 1.39, facing M = 1.73). Furthermore, the ad-position *in front of* is rated at significantly ($p<0.001$) higher levels regardless of orientation but also not depicting distinguishing between orientations (away M = 5.95, facing M = 5.67).

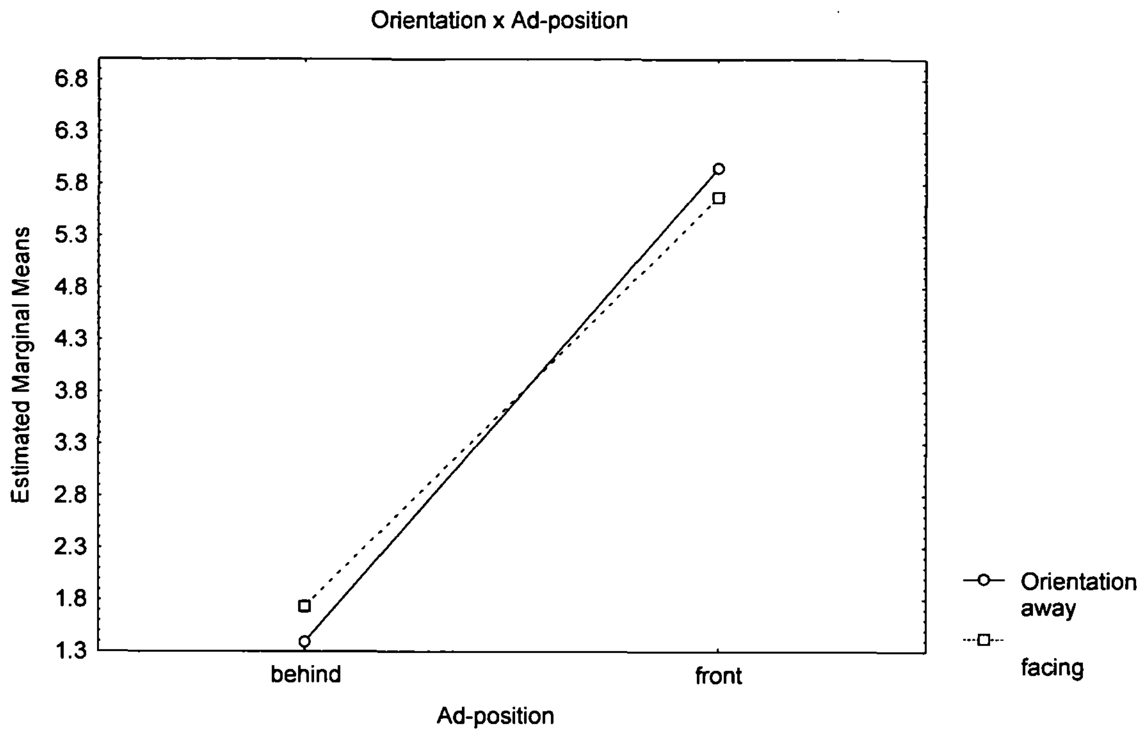


Figure 4.24 *A Significant two-way interaction between Orientation x Ad-position for the English group in Experiment Eight.*

There was also a nearly significant three-way interaction between Located Object Animacy x Reference Object Animacy x Ad-position $F(1,15) = 4.01$, $p = 0.064$, $MSE = 1.56$ (Figure 4.26). The ad-position *behind* gets similar low rating levels for both reference objects when the located object is either a car (car M = 1.34, shop M = 1.69) or a shop (car M =1.78, shop M =1.44). However, *in front of* gets a differentiating pattern of rather high appropriateness levels; when the reference object is a shop it is rated higher when the located object positioned in front of it was a car (M = 6.22) rather than another shop (M = 4.41). In contrast, *in front of* was rated at similar levels when the reference object is a car regardless of which level of located object (car M = 6.22, shop M = 6.38) is in question. This differentiation (although not quite significant) may be a result of people perceiving it to be more appropriate to park a car in front of a car or a shop rather than having a shop placed in front of another shop.

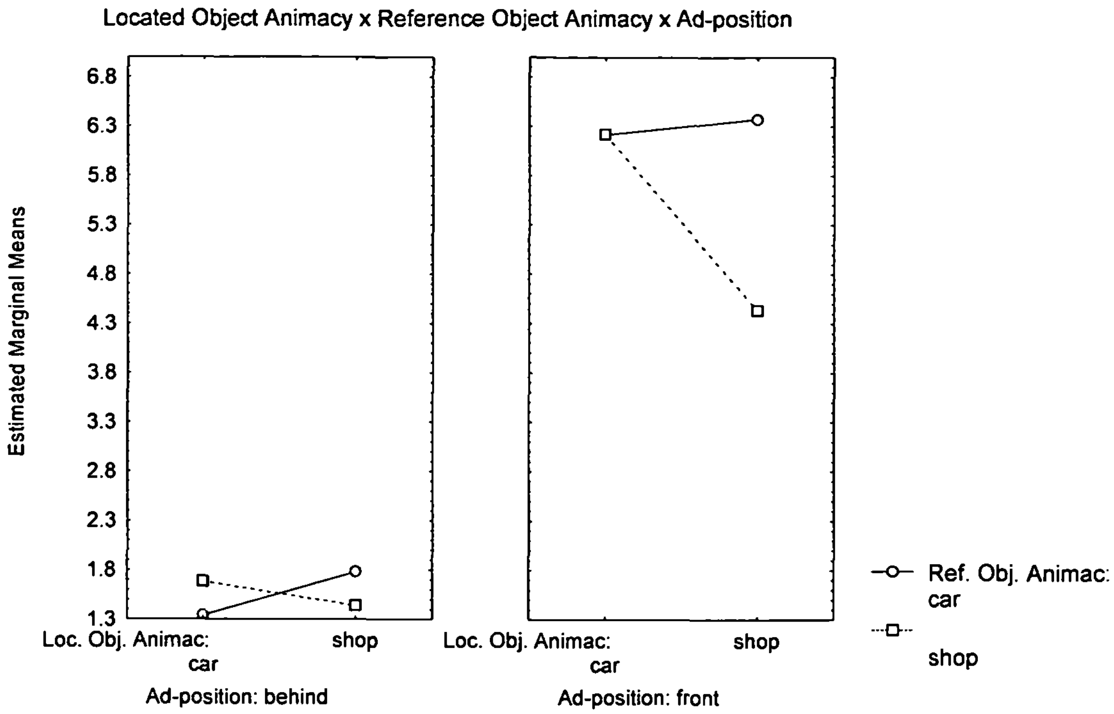


Figure 4.25 A *Nearly significant three-way interaction between Located Object Animacy x Reference Object Animacy x Ad-position for the English group in Experiment Eight.*

None of the other main effects or interactions were significant, therefore very little was found to support the experimental predictions.

4.2.2.2 FINNISH

The mean ratings by condition are displayed in Table 4.13.

Table 4.13 *The mean ratings of the Finnish group for each condition in Experiment Eight (N=17).*

Reference Object	Located Object	Orient.	*Edessä*	*edellä*	Ad-position *Takana*	*perässä*	*Jäljes.*
Car	Car	Away	6.00	5.94	1.65	1.71	1.41
		Facing	5.41	1.82	1.88	1.82	2.12
	Shop	Away	4.71	4.35	2.41	2.29	2.00
		Facing	5.94	3.59	2.41	1.41	1.88
Shop	Car	Away	5.41	4.24	1.41	1.71	1.41
		Facing	5.71	2.12	1.59	1.82	1.76
	Shop	Away	5.47	4.65	1.76	1.53	1.71
		Facing	4.88	2.88	2.65	2.18	2.24

There were significant main effect of Orientation $F(1,16) = 5.04$, $p<0.05$, MSE = 2.69 in which the scenes where the located object was facing away (M = 3.09) from the reference object were rated higher than scenes in which they were facing (M = 2.81) towards each other. There was also a main effect of Ad-position $F(4,64) = 34.17$, $p<0.001$, MSE = 10.26. The behind terms *takana* (M = 1.97), *perässä* (M = 1.81) and *jäljessä* (M = 1.82) were generally rated at low levels, whereas for the front terms *edessä* (M = 5.44) received the highest appropriateness ratings followed by *edellä* (M = 3.70).

A significant two-way interaction was also present between Orientation x Ad-position $F(4,64) = 14.83$, $p<0.001$, MSE = 2.67 (Figure 4.27). While the front term *edessä* was rated at a very high level there were no real differences in rating levels between away (M = 5.40) and facing (M = 5.49) orientations. In contrast, the front term *edellä* showed a significant ($p<0.001$) distinction between levels of orientation in that facing away (M = 4.79) was rated at much higher levels than facing towards (M = 2.60). The effects for the two Finnish in front of terms are in accordance with the hypothesis. The Finnish behind terms were all rated at low levels in both levels of orientation with only *takana* (away M = 1.81, facing M = 2.13) and *jäljessä* (away M = 1.63, facing M = 2.00) showing a slight, although not significant ($p>0.05$), elevation in the facing toward condition while *perässä* (away M = 1.81, facing M = 1.81) showed no distinction between the two orientations.

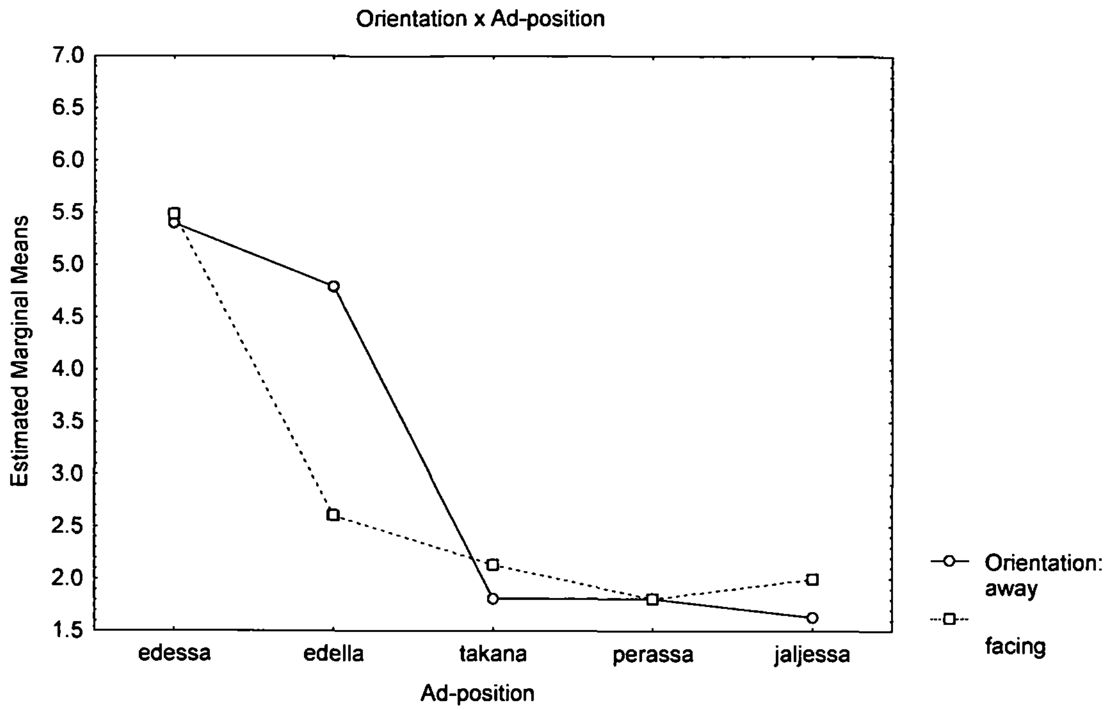


Figure 4.26 *A Significant two-way interaction between Orientation x Ad-position for the Finnish group in Experiment Eight.*

Additionally, there was also a significant three-way interaction between Located Object x Orientation x Ad-position $F(4,64) = 4.61$, $p<0.01$, MSE = 1.42 (Figure 4.28). The front term *edessä* was rated highly but did not show discrimination between levels of orientation in either level of located object (car/away M = 5.71, car/facing M = 5.56; shop/away M = 5.09, shop/facing M = 5.41). In contrast, the other front term *edellä* illustrated significant differentiation between levels of orientation in that generally the scenes in which the located object was facing away from the reference object had higher ratings than the scenes in which they were facing towards each other. This differentiation between orientations was stronger in the scenes in which the located object was a car ($p<0.001$ away M = 5.09, facing M = 1.97) than when it was a shop ($p<0.01$ away M = 4.50, facing M = 3.24). Although this pattern was significant in both cases, it makes sense since *edellä* has been predicted to be more appropriate for describing potentially mobile objects, hence the stronger discrimination between orientations when the located object was a car. A car pointing with its front away from the reference object is in the ideal position for motion. Hence, the results were once again in accord with the prediction that *edellä* is most appropriate for describing a scene in which the objects have the fronts oriented in the same direction.

However, the three behind terms were rated at quite low levels throughout indicating no significant differentiation between levels of orientation for when either the car (*takana*/away M = 1.53, *takana*/facing M = 1.74; *perässä*/away M = 1.71, *perässä*/facing M = 1.82; *jäljessä*/away M = 1.41, *jäljessä*/facing M = 1.94) or the shop (*takana*/away M = 2.09, *takana*/facing M = 2.53; *perässä*/away M = 1.91, *perässä*/facing M = 1.79; *jäljessä*/away M = 1.85, *jäljessä*/facing M = 2.06) were the located object.

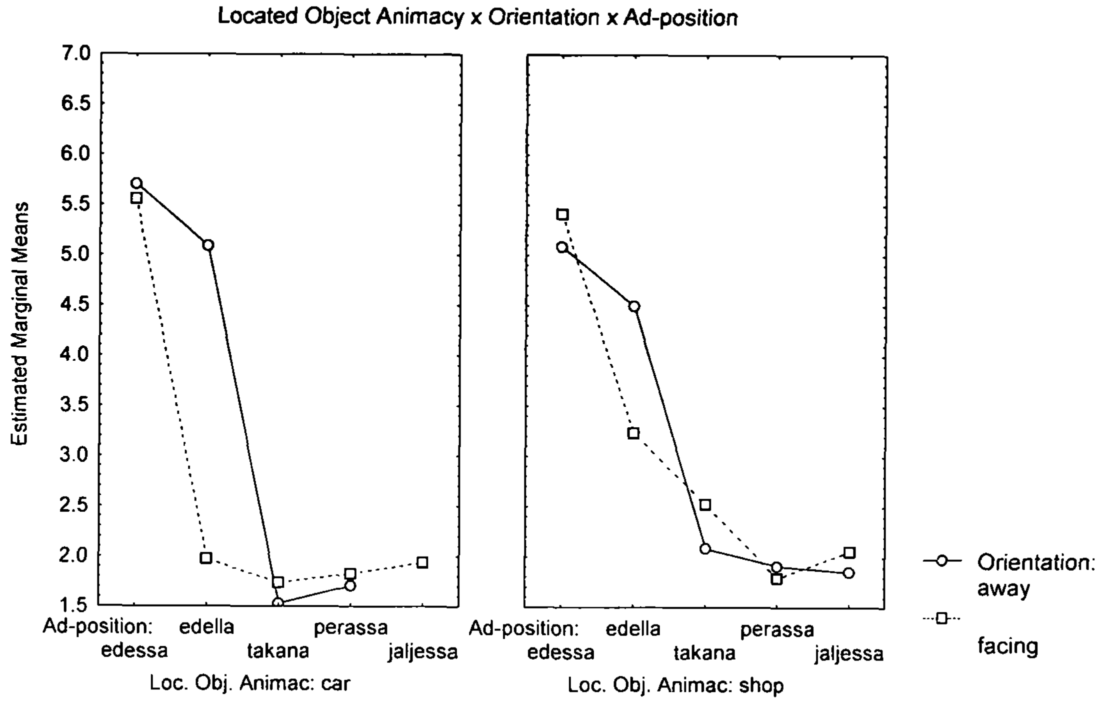


Figure 4.27 *A Significant three-way interaction between Located Object Animacy x Orientation x Ad-position for the Finnish group in Experiment Eight.*

Finally, there was also a significant four-way interaction between Reference Object x Located Object x Orientation x Ad-position $F(4,64) = 9.21$, $p<0.001$, MSE = 1.13 (Figure 4.29). The front term *edessä* did not show much discrimination between levels of orientation across located object and reference object conditions (car/car/away

M = 6.00, car/car/facing M = 5.41; shop/car/away M = 5.41, shop/car/facing M = 5.71; shop/shop/away M = 5.47, shop/shop/facing M = 4.88). However, there seemed to be an exception for the *edessä* ratings to be higher for the facing towards conditions when the located object was a shop and the reference object was a car (car/shop/facing M = 5.94, car/shop/away M = 4.71), a Tukey post-hoc comparison determined that this difference was not significant ($p>0.05$).

In contrast, the other front term *edellä* illustrated clear differentiation between levels of orientation in that generally the scenes in which the located object was facing away from the reference object had higher ratings than the scenes in which they were facing towards each other. This differentiation between orientations was significant ($p<0.01$) in all scenes (car/car/away M = 5.94, car/car/facing M= 1.82; car/shop/away M = 4.35, car/shop/facing M = 3.59; shop/shop/away M = 4.65, shop/ shop /facing M = 2.88) except when the located object was a shop and the reference object was a car ($p>0.05$; away M = 4.24, facing M = 2.12). This in general makes sense since *edellä* has been predicted to be more appropriate for describing potentially mobile objects. However, when the scene depicts a shop in front of a car it would be deemed as unrealistic for the shop to be taking on the role of leading the way for the car as it is a naturally static object. This all lends support for the experimental predictions for this specific Finnish term.

However, the three behind terms were rated at quite low levels throughout indicating no significant ($p>0.05$) differentiation between levels of orientation for when the car was the reference object and another car was the located object (*takana*/away M = 1.65, *takana*/facing M = 1.88; *perässä*/away M = 1.71, *perässä*/facing M = 1.82; *jäljessä*/away M = 1.41, *jäljessä*/facing M = 2.12); or a car was the reference object with a shop as the located object (*takana*/away M = 2.41, *takana*/facing M = 2.41; *perässä*/away M = 2.29, *perässä*/facing M = 1.41; *jäljessä*/away M = 2.00, *jäljessä*/facing M = 1.88); or a shop was the reference object displayed with another shop (*takana*/away M = 1.76, *takana*/facing M = 2.65; *perässä*/away M = 1.53, *perässä*/facing M = 2.18; *jäljessä*/away M = 1.71, *jäljessä*/facing M = 2.24); or a shop was the reference object and the located object was a car (*takana*/away M = 1.41, *takana*/facing M = 1.59; *perässä*/away M = 1.71, *perässä*/facing M = 1.82; *jäljessä*/away M = 1.41, *jäljessä*/facing M = 1.76).

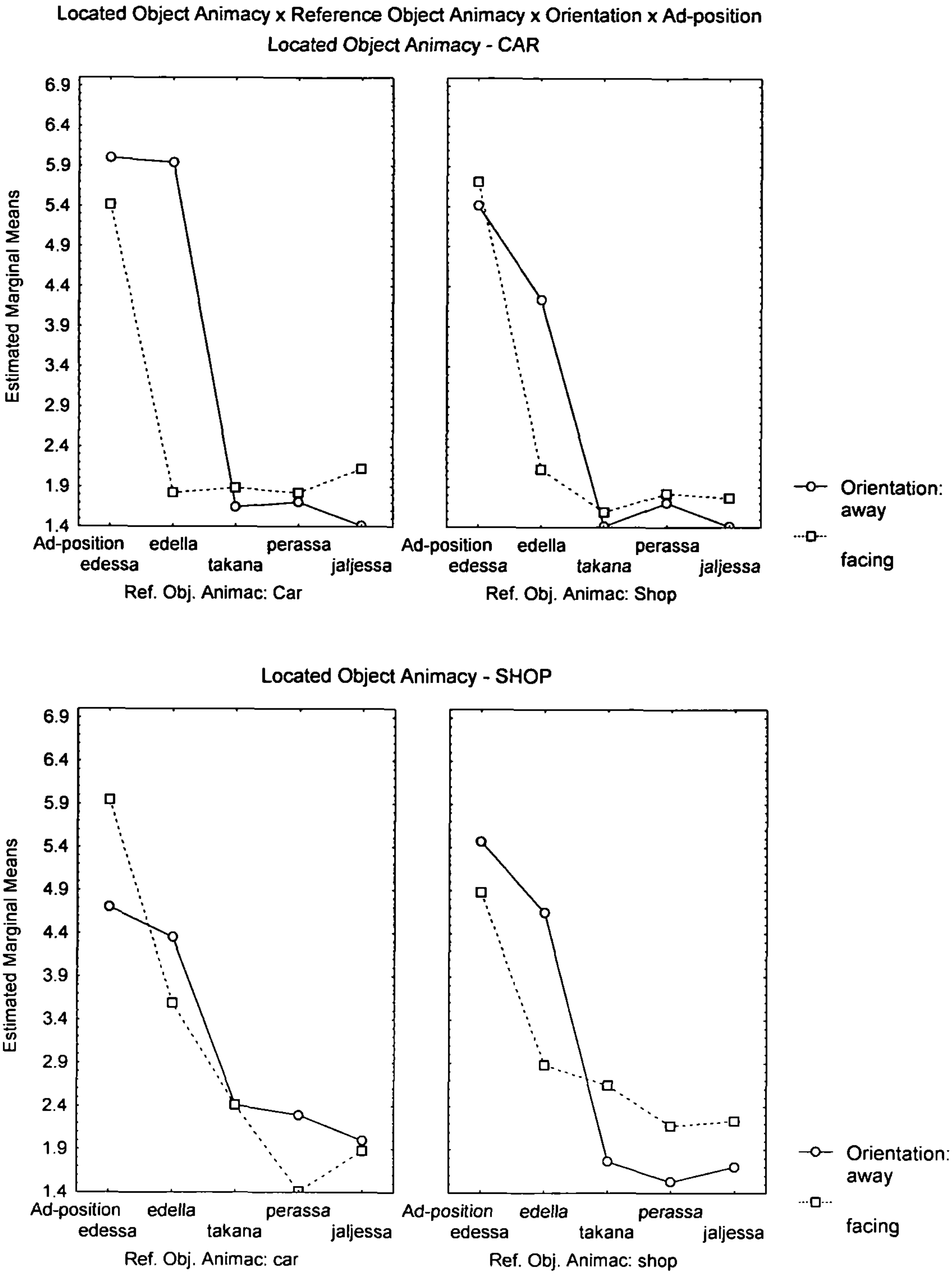


Figure 4.28 *A Significant four-way interaction between Located Object Animacy x Reference Object Animacy x Orientation x Ad-position for the Finnish group in Experiment Eight.*

4.2.2.3 SPANISH

The mean ratings by condition are displayed in Table 4.14.

Table 4.14 *The mean ratings of the Spanish group for each condition in Experiment Eight (N=17).*

Reference Object	Located Object	Orientation	Ad-position *detrás*	*delante*
Car	Car	Away	1.82	6.59
		Facing	1.29	5.41
	Shop	Away	1.65	5.00
		Facing	1.82	5.65
Shop	Car	Away	2.00	5.41
		Facing	1.76	6.18
	Shop	Away	2.00	6.00
		Facing	1.65	5.71

A significant main effect of Ad-position was found $F(1,16) = 41.33$, $p<0.001$, MSE = 26.23 in which *detras* (*behind* M = 1.75) was rated lower than *delante* (*in front of* M = 5.74).

Furthermore, there was a significant three-way interaction between Reference Object x Located Object x Orientation $F(1,16) = 9.79$, $p<0.01$, MSE = 1.49 (Figure 4.30). When the located object was a shop and the two objects were facing towards one another the ratings were at very similar levels regardless of reference object (car M = 3.74, shop M = 3.68). In contrast, in the facing one another orientation there was a clear discrepancy when the located object was a car showing much higher rating levels when the reference object was a shop (M = 3.97) than when it was a car (M = 3.35). The pattern was similar when the located figure object was a shop and the objects were oriented with their fronts pointed in the same direction; the interaction showed that when the reference object was a shop (M = 4.00) the rating levels were again elevated whereas when the reference object was a car (M = 3.32) they were lower. However, when the located object was a car and the objects were oriented so that their fronts were pointed in the same direction the scenes with a car as a reference object (M = 4.21) were rated higher than when a shop was the reference object (M = 3.71). These effects were however collapsed across ad-position. Surprisingly the post-hoc analysis did not reveal any specific significant differences.

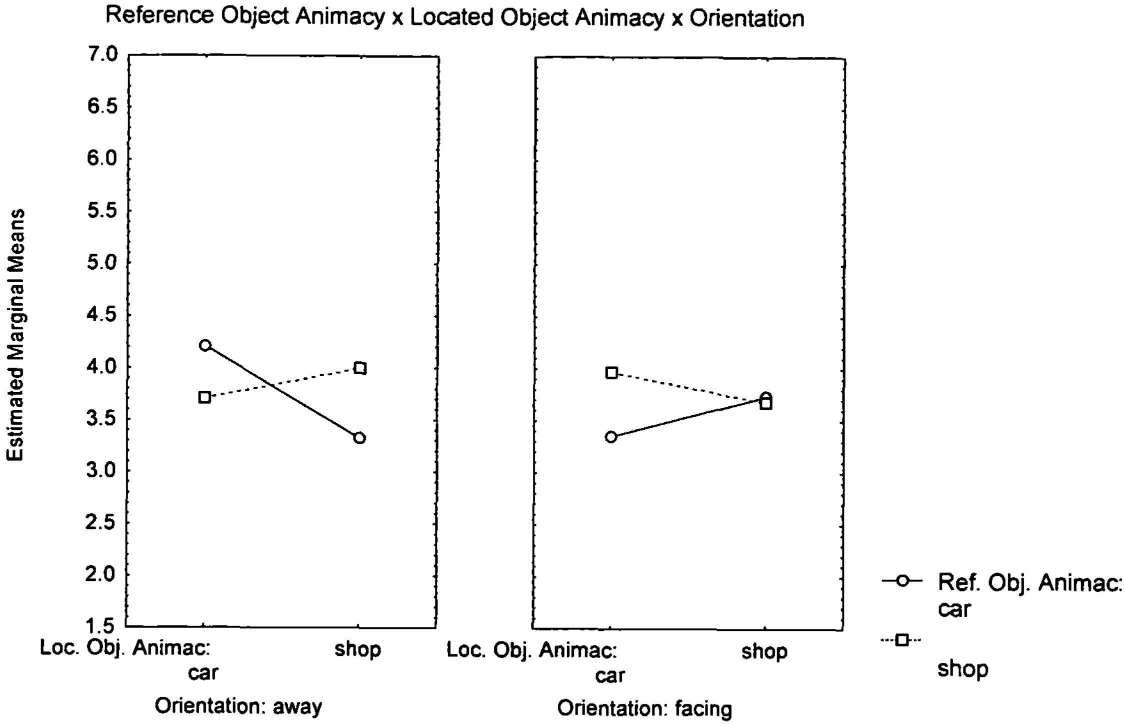


Figure 4.29 *A Significant three-way interaction between Reference Object Animacy x Located Object Animacy x Orientation for the Spanish group in Experiment Eight.*

Finally, there was a marginally significant four-way interaction between <u>Reference Object Animacy x Located Object Animacy x Orientation x Ad-position</u> $F(1,16)=3.53$; $p=.0787$, MSE = 1.28 (Figure 4.31). When the located object was a car and reference object was another car both the generally lower rated *detras* (away M = 1.82, facing M = 1.29) and the higher rated *delante* (away M = 6.59, facing M = 5.41) show a slight discrepancy in ratings favouring the scenes when the located was oriented facing away from the reference object rather than towards it. This pattern was not very apparent when the located as well as the reference object were both shops (*detras:* away M = 2.00, facing M = 1.65; *delante:* away M = 6.00, facing M = 5.71).

However, when the located object was a car but the reference object was a shop *detras* received nearly the same levels of ratings for both orientations (away M = 2.00, facing M = 1.76). However, in the same scene the ad-position *delante* (away M = 5.41, facing M = 6.18) was considered a slightly more appropriate depictor when the located object was facing towards the reference object than away from it. This pattern was also visible when the located object was a shop and the reference object was a car *(detras:* away M = 1.65, facing M = 1.82; *delante:* away M = 5.00, facing M = 5.65). This pattern of effect provides marginal support for the prediction that potentially mobile objects would instantiate the adoption of an intrinsic frame of reference (*in front of term: delante*) more readily when the object orientation was so that both reference object and located object fronts are pointed in the same direction. However, the prediction that static object relationships (in this case static paired with a potentially mobile object) would be more appropriately described by *in front of* terms when they are facing one another allowing for an ideal interaction was not supported, although there was a mild differentiation showing elevated *delante* ratings when a combination of static and mobile objects were presented.

None of the other main effects or interactions were significant in this experiment.

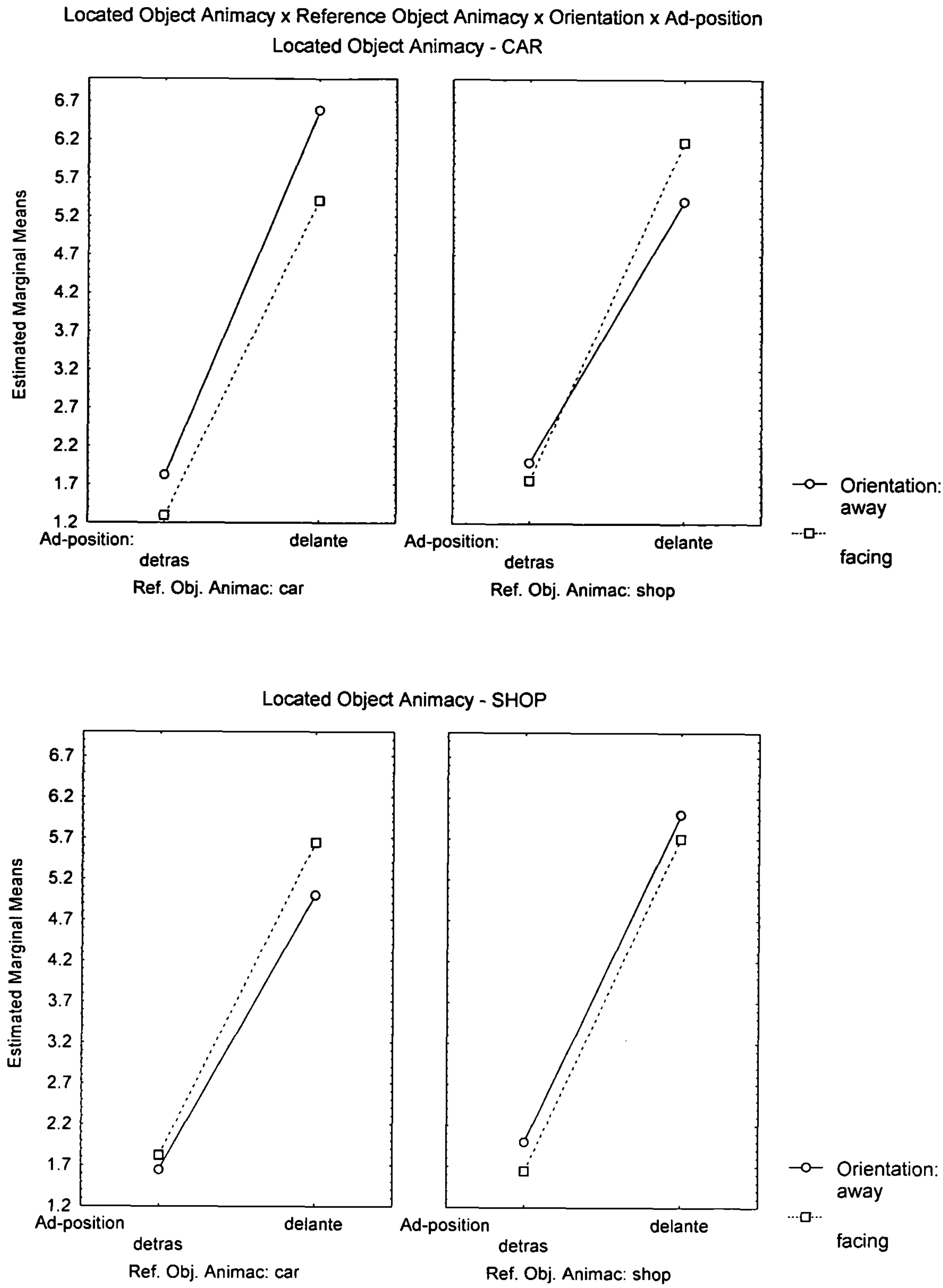


Figure 4.30 *A marginally significant four-way interaction between Reference Object Animacy x Located Object Animacy x Orientation x Ad-position for the Spanish group in Experiment Eight.*

4.2.2 Discussion for Experiment Eight

A summary of all the main-effects and interactions that were found in Experiment Seven throughout all three language groups can be found below in Table 4.15.

Table 4.15 *Summary of all significant and (marginally significant) effects in Experiment Eight.*

	English	Finnish	Spanish
Main Effects			
Reference Object	X		
Located Object			
Orientation		X	
Ad-position	X	X	X
2-way interactions			
Ref. Obj. x Loc. Obj.	X		
Ref. Obj. x Orientation			
Fig. Obj. x Orientation			
Ref. Obj. x Ad-position	X		
Loc. Obj. x Ad-position	X		
Orient. x Ad-position	X	X	
3-way interactions			
Ref. Obj. x Loc. Obj. x Orientation			X
Ref. Obj. x Loc. Obj. x Ad-position	(X)		
Ref. Obj. x Orientation x Ad-position			
Loc. Obj. x Orientation x Ad-position		X	
4-way interactions			
Ref. Obj. x Loc. Obj. x Orientation x Ad-position		X	(X)

In general only some of the experimental predictions were supported by the results for the different language sections of Experiment Eight. Unsurprisingly the Finnish *in front of* terms displayed a finer discrimination of spatial organization due partly to there being more lexical items available. As predicted, the Finnish in front of term *edellä* did show distinction between orientation as the term was generally considered more appropriate for describing scenes in which both objects were oriented such that their fronts were pointing in the same direction. This is in accordance with the prediction that *edellä* would be more appropriate for describing potentially animate scenes or scenes in which objects are positioned as though in order in a queue. Furthermore, as expected the other Finnish in front of term *edessä* did not generally show much discrimination between orientations. It does however appear that *edessä* can generally be used to describe a broader variety of geometric scenes than *edellä.*

The second cross-linguistic hypothesis of effects of dynamic-kinematic routines and orientation was not really provided support. Although the Spanish group did show the expected pattern of higher rating levels for the *in front of* term *delante,* when the located object was oriented so that its front was pointed in the same direction as the front of the reference object when both objects were cars. The other two language groups did not even provide this pattern of effect. Furthermore, the hypothesis that when both objects were shops the scenes in which the located and reference objects were facing toward one another would display higher ratings of the *in front of* terms did not receive any support from any of the language groups. Thus, very little support was found for the idea that conceptual knowledge of different object functions would influence which orientation would be most likely to facilitate a natural relation between objects and therefore instantiate the use of the intrinsic frame of reference (i.e. *in front of* terms: *edessä/edellä, delante*).

The English language group did not produce any support for the experimental predictions and only marginal support was gained from the Spanish group.

4.2.3 Summary of Experiments Six, Seven and Eight

In conclusion, reference frame assignment was found to be effected by a number of factors across languages. When orientation was manipulated so that two objects were positioned facing one another enabling a functional relationship, both the English and Spanish groups displayed the adoption of the intrinsic frame of reference (*in front of, delante*). In contrast, the expected Finnish front term *edessä* did not display such a differentiation between different object orientations. Additionally, as was expected *edellä* was the preferred descriptor in scenes where objects were oriented with there fronts pointing in the same direction. Furthermore, the instantiation of the relative frame of reference when objects were facing one another was not found at a significant level for any of the languages, although the pattern was suggested by a slight although non-significant rating level for *to the left of* and *izquierda* for both the English and Spanish groups respectively (postman experiment).

The manipulation of the functional relationship between objects by adding an obstruction between them only seemed to influence the English group, as they were found to be more likely to adopt an intrinsic frame of reference (*in front of*) when the obstruction was not present rather than when it was there, while other languages did not really differentiate between whether the obstruction was there or not. However, the relative frame of reference (*to the left of* and *izquierda)* was not more likely to be adopted by either of the language groups with the lexical item available (Spanish, English), when the obstruction was present rather than not.

The manipulation of object association did not noticeably influence reference frame adoption regardless of whether the objects were associated (postman/postbox, artist/easel) or not (postman/bookshelf, artist/stove). Both the English and Finnish groups were more likely to adopt an intrinsic frame of reference (in front of, *edessä)* when the objects were placed at a near proximity to one another rather than at a far proximity, this did not however seem to be the case with the Spanish group. Furthermore, the Finnish front of term *edellä* did not show much discrimination between levels of proximity even though it was clearly sensitive to the manipulation of orientation. Additionally the far proximity level did not make it more likely for participants in any of the language groups (where the option was available) to adopt the relative frame of reference.

The final experiment in which potential object animacy was manipulated in addition to orientation did not find substantial support for the cross-linguistic hypothesis. Although the Spanish group did produce the expected pattern that when the cars were oriented so that both fronts were pointing in the same direction, ratings for *delante* were all rated slightly higher. This may suggest that this positioning is ideal for two potentially mobile objects since they would then be able to drive after one another, whereas there were no real discrepancies for in front of terms between orientation when two shops were depicted facing one another. However this interaction was not quite significant. This may result from the fact that the functional relationship between this type of static object was not salient enough.

Furthermore as expected, the Finnish in front of term *edellä* showed differentiation between orientation as the term was generally considered more appropriate for describing scenes in which both objects, regardless of whether potentially mobile or not, were oriented such that their fronts were pointing in the same direction. This is in accordance with the prediction that *edellä* would be more appropriate for describing potentially animate scenes OR in which even static objects were positioned 'in order'. Furthermore, as expected the other Finnish in front of term *edessä* did not generally show much discrimination between orientations for either potentially mobile or static reference or located objects.

Chapter 5

5.0 Examining Non-verbal Spatial Conceptualisation

The first few chapters of this thesis endeavoured to shed some light and provide answers to the first core question we set out to address at the outset of the thesis: 1) *To what extent are the different factors influencing spatial language, the same cross-linguistically?* The cross-linguistic experiments have shown that extra-geometric parameters are important across a range of languages. The present chapter aims to establish whether object knowledge effects are also important for the non-linguistic realm: 2) *Do extra-geometric factors only influence spatial language, or do they also affect memory for spatial object relationships?*

Furthermore, one of the final issues that is turned to in this chapter concerns what is sometimes called linguistic relativity. In other words, to what extent do the representations underlying spatial language determine the representations underlying non-linguistic spatial judgment or *vice versa*? The perceptual deterministic view holds that there is a single spatial representation system which underlies both spatial language and non-verbal spatial representation. Alternatively, some take the view that spatial language can in fact shape spatial representation (e.g. Choi et. al., 1999; Bowerman, 1996; Bowerman & Choi, 2001; Pederson et. al., 1998; Whorf, 1956). Some interesting research has looked more closely into these issues concentrating on projective terms for which languages often differ more radically from one another. For example, Pederson, Danziger, Wilkins, Levinson, Kita, and Senft (1998) tested speakers across a range of languages with varying reference frame use and found a correspondence between reference frame use in language and reference frame use on a range of 'non-linguistic' tasks. For instance, participants were shown spatial arrangements and were requested to make judgments about what constituted the "same" spatial arrangement after the participant was turned 180 degrees. This was achieved by asking them to either reproduce the arrangement, or to select a drawing from a range of drawings which matched the original layout. They found that speakers of i.e. Tzeltal performed the nonlinguistic tasks using an absolute frame of reference (i.e. north, south, east, west), whereas speakers of i.e. English and Dutch would often use a relative frame (viewer centered) for the same tasks.

Thus, it would appear that language may bias the coding of nonlinguistic spatial relationship categories, suggesting the possibility that spatial representations underlying spatial language and nonverbal spatial judgment may be the same. This would be consistent with the idea that viewers use the same kind of spatial mental model to perform non-linguistic spatial tasks that they use when encoding spatial relations in the language. While some have taken these results as clear evidence for linguistic relativity (e.g. Pederson et al., 1998), the interpretation of the results remains controversial (see, e.g. Li & Gleitman, 2000). However, the findings from the tasks used by Pederson et al. are consistent with Slobin's thinking-for-speaking hypothesis. In other words, that language directs attention to some aspects of a visual scene, while diminishing attention to other aspects leading to a weaker version of the Whorfian hypothesis (Slobin, 1996).

Munnich, Landau and Dosher (2001) suggest that the relationship between spatial representation for language and spatial representation for nonlinguistic spatial tasks is rather complex and their work will be discussed in the section below, which provides the background and inspiration for the non-verbal investigations of this thesis.

5.1 Rationale and Design for Experiments Nine and Ten

The introductory chapter of this thesis briefly mentioned some of the work (Hayward & Tarr,1995; Munnich, Landau & Dosher, 2001; Crawford, Regier, & Huttenlocher, 2000) that has investigated the similarities/differences in the structuring of space for both memory and language systems. This section of the thesis aims to provide more details about some of the work carried out by Hayward and Tarr (1995) in particular, since their experiments provide the basis for later studies (e.g., Munnich, Landau and Dosher, 2001), and also for the present experiments in this chapter. In addition to the Hayward and Tarr experiments, we also consider in some detail the work conducted by Munnich, Landau and Dosher (2001) and Crawford, Regier, & Huttenlocher (2000).

Hayward and Tarr (1995) had previously conducted research which suggested that axial structures play an important role in both spatial language and memory. They set out to provide evidence that the foundational aspects of non-linguistic spatial representation could be reflected in spatial language, suggesting correspondence between the two systems. Hayward and Tarr asked native English speakers to either describe the position of a located object in relation to the reference object in one of their experiments, or to rate the appropriateness of a set of spatial terms in describing that location in another of their experiments. They positioned the reference object in the middle grid cell of a 7 x7 grid (not visible to participants), and the located object occupied any of the other 48 grid cells. Three different reference and located object displays were used (see Figure 5.1): a circle relative to a square computer icon; a flying bird or a swimming fish relative to a floating raft; and two offices in a building in which the figure office was always relative to "John's" office.

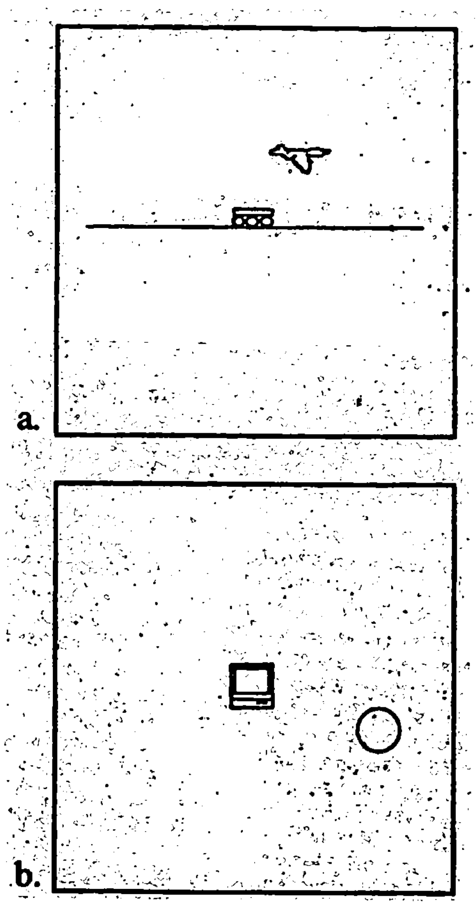


Figure 5.1 Examples of stimulus displays used in the Hayward and Tarr work (adapted from Hayward and Tarr, 1995).

It is important to note that the direction of the fish and bird is not mentioned nor does there seem to be any manipulation of orientation. In general, they found that vertical terms such as *'above'* and *'below'*, were most often produced and received highest appropriateness ratings when the located object was situated along the vertical axis of the reference object. Also, horizontal terms such as *'left'* and *'right'*, were preferred along the reference object's horizontal axis. These results are almost identical to those reported by Logan and Sadler (1996) in an experiment in which they endeavoured to assess the parts of space that corresponded to regions of greatest acceptability for specific spatial terms, using a production task (see Figure 5.2). They found that when participants were instructed to draw an 'X' at specific relations to the reference object (e.g. 'Draw an X *above* the box'), the linguistic categories seemed to centre along the reference object's horizontal and vertical axes similarly to what Hayward and Tarr found.

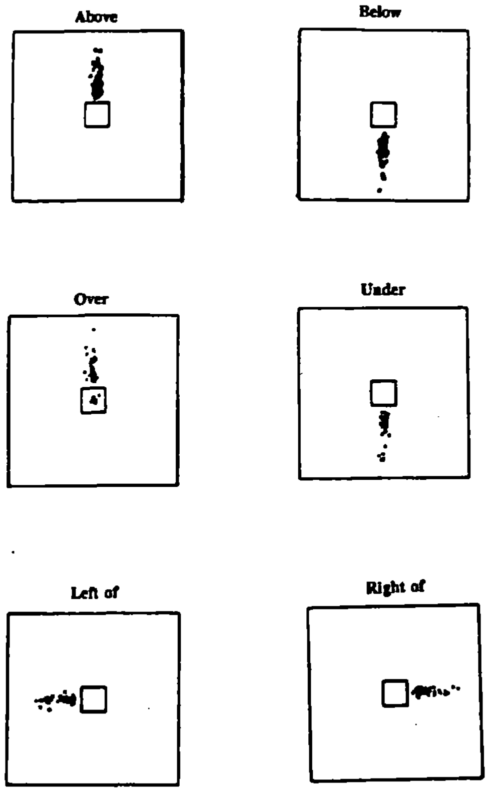


Figure 5.2 Data from *above,below,under,left of,* and *right of* from work conducted by Logan and Sadler (1996). Each dot represents the centre of an X drawn by a different participant to stand in the relation to the central box that is specified above each frame by a spatial term (adapted from Logan & Sadler, 1996).

For the non-verbal memory task Hayward and Tarr (1995) used the above mentioned grid layout to position the same object relationships as used in the language task. In one experiment the participants were asked to reproduce the location of the located object, whereas in another experiment they were asked to make same/different judgements after viewing two scenes in sequence (separated by a mask). The same/different judgement task was added to avoid any possible motor-effects, because the experimenters were concerned that the participants might be using e.g. computer screen boundaries for reference when reproducing location. The findings from the non-verbal studies were in accord with the patterns found for the language tasks, in that those locations (vertical/horizontal axis of reference object) that were most consistently named by the English spatial terms were also most accurately remembered. Hayward and Tarr also mention in their discussion of the results that in the memory task participants were found to be more accurate when judging "same" trials than they were for "different" trials. In 82% of the "same" trials participants were correct, whereas, they were correct only for 58% of the "different" trials. The task was generally rather difficult as the overall frequency of "same" judgements (78%) was clearly higher than the frequency of "different" judgements (28%). This could be due to the fact that the shift of the located object that they mention for the 'different' trials was a mere 2.5 mm (which is only 1/4 of the diameter of the circle used as a located object). However, the method section of this series of studies was a little vague about the exact scale of the whole lay-out.

Munnich and colleagues (2001) carried out research similar to the Hayward and Tarr (1995) study to determine, whether *cross-linguistic* differences would produce corresponding non-linguistic differences. Munnich et al. decided to compare Japanese and Korean speakers' performance on verbal and non-verbal tasks with the data from English speakers on the same tasks. The aim was to test three possible explanations:

1. Non-linguistic representations might serve as a basis for spatial language.
2. The two systems might independently draw upon the same set of spatial properties.
3. Spatial language may possibly shape non-linguistic spatial representation.

The first experiment in the series conducted by Munnich et al. (2001), used a design very similar to that used by Hayward and Tarr apart from the fact that the 'invisible' grid according to which all the object relationships were positioned consisted of 9 x 9 cells of which the reference object occupied the central 3 x 3 grid cells, and the smaller located object was positioned in one of the remaining 72 cells (see Figure 5.3). The design section of this series of experiments was clear about the scale of the lay-out:

each grid cell was 0.5 inches (1.27 cm) square and the whole grid was 4.5 inches (11.43 cm) square. The reference object was always a square, whereas, the figure object could either be a square or a circle.

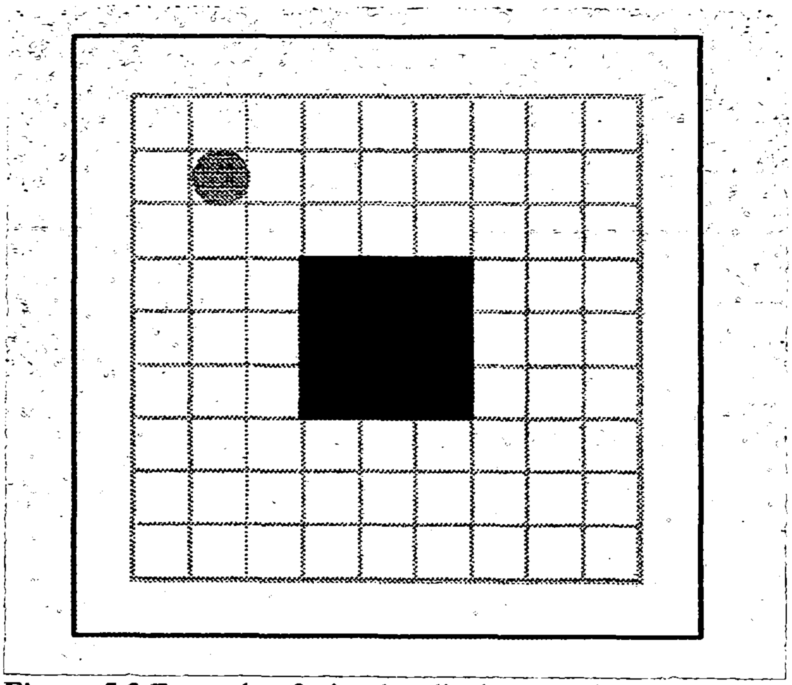


Figure 5.3 Example of stimulus display used in the Munnich et al. experiments (adapted from Munnich, Landau & Dosher, 2001).

In brief Munnich et al. found in their language tasks that although categorical use of axial terms and contact terms was apparent cross-linguistically, there was a difference in application of contact terms. While Japanese speakers used contact terms symmetrically around all sides of the reference object, English speakers used contact terms more frequently on the top side of the reference object. However, the results from the memory tasks displayed higher accuracy rates cross-linguistically for locations named most consistently by axial and contact terms in the language task. Importantly, the cross-linguistic differences in spatial language did not lead to differences in the non-linguistic encoding of location. Therefore, Munnich et al. conclude that 'spatial language and spatial memory engage the same kinds of spatial properties, suggesting similarities in the foundation of the two systems.' They also state that 'the two systems appear partially independent' since not all spatial properties were preserved across languages or across memory tasks. It is also worth noting that although clear patterns of effects emerged from the memory experiments, the intensity of these effects was elevated since the proportion correct for each location was collapsed across 'same' and 'different' trials. As previously noted by Hayward and Tarr (1995) people were more likely to make 'same' judgements than 'different' judgements due to difficulty of discrimination.

Finally, a mention of some work carried out by Crawford, Regier, & Huttenlocher (2000) is warranted. They suggest an alternative view to the two conclusions reached above, in that although 'a common underlying structure may influence both linguistic and non-linguistic categorisations of space, this structure plays different roles in these two types of categorisation' (p. 210 Crawford, Regier, & Huttenlocher, 2000). The results for some of their memory experiments indicated that while stimuli presented on the vertical and horizontal axes of the reference object were remembered most accurately, stimuli that were *not* positioned on the main cardinal axes of the reference object were remembered in locations biased diagonally away from the axes. Their research suggests that non-linguistic spatial categories do not map directly onto linguistic spatial categories, i.e. 'the prototypes of linguistic spatial categories correspond to the boundaries *between* non-linguistic spatial categories'. In other words, the prototypes for non-linguistic spatial categories are the diagonals for Crawford et al., in direct conflict to the view that the prototypes for both linguistic and non-linguistic spatial categories are *on* the cardinal axes (Hayward & Tarr, 1995).

Although the investigation carried out by Crawford et. al. (2000) was also inspired by the Hayward and Tarr (1995) research, one of the important differences was the circular lay-out in which the stimuli were organised in their relative positions, in contrast to the grid used previously (see Figure 5.4). There were other differences in methodology as well, for example the linguistic and non-linguistic tasks were administered at the same sitting: after the participant viewed a screen which always had a small TV as the reference object, and a dot as the located object, they responded with a verbal appropriateness rating, after which the dot and reference object reappeared in the middle of the screen and they were asked to place the dot (using a mouse) where they remembered seeing it.

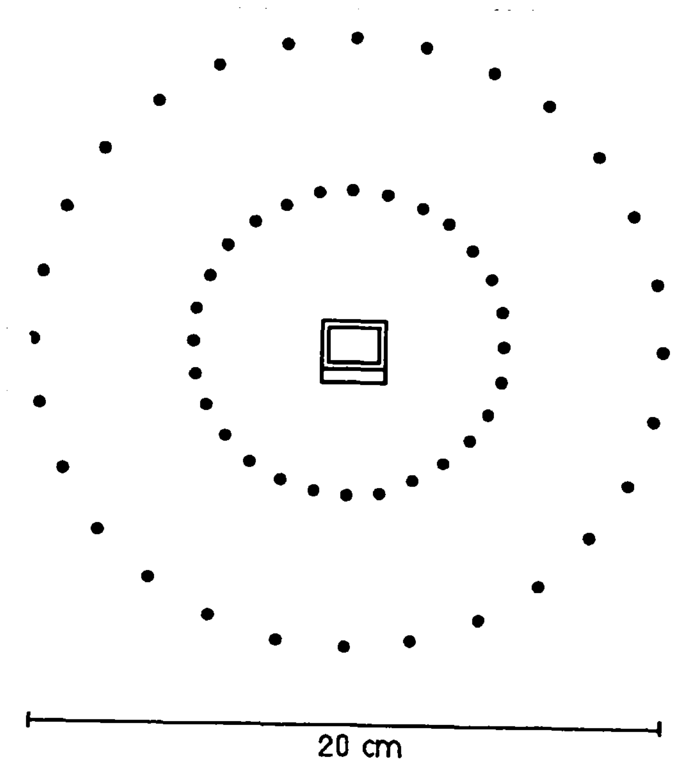


Figure 5.4 Example of stimulus locations used by Crawford, Regier, & Huttenlocher (2000).

Experiments Nine and Ten of the present thesis have been inspired by the work carried out by Hayward and Tarr (1995) and also by the others mentioned above. The aim in these two experiments was to shed further light on investigations about non-linguistic spatial categorisation and to also address one of the core questions of this thesis: *Do extra-geometric factors only influence spatial language, or do they also affect memory for spatial object relationships?* However, there were alterations made to the design and also to the analysis strategy from the methods stated above. Although the lay-out for positioning the located and reference objects was similar to that employed by

Hayward and Tarr the scale was larger (the grid was 20.15 cm^2) to try to make detection of relative location shifts (1.44 cm) easier for the participants. An experiment was conducted which involved a smaller shift (0.72 cm) for the different trials, which however, has not been reported here due to very poor detection rates. Furthermore, the data from the trials involving *same* trials is separately analysed from the *different* trials to try to disentangle detection rates, which would otherwise be elevated by the higher likelihood of the participants judging scenes as being the 'same' rather than 'different' (a problem mentioned by Hayward & Tarr, 1995). Also, in line with the core questions of this thesis one of the main focuses of interest is whether the extra-geometric factors that were found to be influencing spatial language would also be affecting non-verbal spatial conceptualisation. Therefore, the type of object manipulated was of great interest: A) In Experiment Nine a cloud was used as a relatively static reference object whilst the located object could be either another cloud or a potentially mobile bird with its beak pointing to either the right or to the left; B) In Experiment Ten again the reference object was a cloud and the located object was either another cloud or a potentially downwards mobile bomb or an upwards mobile rocket. Also, the direction of displacement of the located objects during the 'different' trials was in the direction of the axis of the potentially mobile objects' path of movement (e.g. Experiment Nine with the birds pointing to either the right or left also had different trials with shifts in those directions, whereas Experiment Ten with the bomb and rocket had different trials with shifts upwards and downwards).

The predictions in relation to these factors were as follows; (1) If the direction of located object potential movement has an effect on accuracy of memory it may lead to higher detection rates when the direction of the shift for the 'different' trials is against the direction of expected motion of the object. Also in line with this it would be likely for the relatively more stationary object (cloud) to elicit lower detection rates for locational shifts. (2) Another prediction for the current series of experiments is that when the located objects are positioned off the axes of the reference object then there would be higher detection accuracy of different trials in which the shift is towards the diagonal axis rather than away from it. This would support the view put forward by Crawford et al. (2000) that the cardinal axes which are the prototypical regions for verbal spatial categorization, are non-verbal category boundaries and instead the central category prototype is on the diagonal axes. However, it was also generally expected that the current experiments would produce higher accuracy rates of detection on the axes rather than off the axes of the reference object. Finally, assuming effects of both position of object with reference to the axes, and effects of object knowledge (i.e., potential motion of the bird/bomb, etc.), it was also of interest to establish the relative strengths of these effects.

Experiment Nine

5.1.1 Method

5.1.1.1 Participants

The twenty-two native (monolingual) English speaking participants were undergraduate or postgraduate students from The University of Plymouth and they received course credit or payment for their participation.

5.1.1.2 Design and Materials

Participants each viewed an individual computer screen on which the reference object was displayed in the centre of the screen, and a located object was viewed in another location on the screen. Both objects were positioned according to a 9 x 9 grid (never visible to participants) of which only the central 7 x 7 grid cells were ever occupied (see Figure 5.5). The reference object always occupied the central cell, whereas the located object appeared in any of the other 48 grid positions. Each grid space was 2.88 cm² and the area in which the objects appeared was 20.15 cm².

	1	2	3	4	5	6	7	
	8	9	10	11	12	13	14	
	15	16	17	18	19	20	21	
	22	23	24	X	25	26	27	
	28	29	30	31	32	33	34	
	35	36	37	38	39	40	41	
	42	43	44	45	46	47	48	

Figure 5.5 A diagram (not to scale) of the superimposed grid according to which both the reference object and located objects were positioned; X = reference object: ; 1 - 48 = located object: .

This resulted in a total of 48 different reference object-located object combinations. The reference object was always a white cloud, whilst the located object could be either a blue cloud, or a bird with its beak pointing to the right, or a bird with its beak pointing to the left. This resulted in a total of 144 different scenes which were then each viewed four times by the participants. The grand-total of 576 scenes were each presented to every participant in a randomised order. All stimuli appeared on a 17" colour monitor of a PC which was surrounded by a black mask to avoid effects from the pale frame edges of the computer screen. The screen background colour was also black on which a white cloud appeared as the reference object whilst the located objects (bird or cloud) were blue. The computer laboratory was also darkened to emphasise the located and reference objects appearing on the screen.

5.1.1.3 Procedure

Participants first viewed a computer screen which informed them that they would view two scenes separated by a mask after which they would be asked to make a judgement of whether the second scene displayed the same spatial relationship between the two objects as the first. At the beginning of each trial the participants were presented with a '+' sign in the middle of the screen (100ms), followed by the first scene (500 ms), a pattern mask (500 ms), the second scene (500 ms), and finally with a blank screen at which point they were to make their judgments by pressing specific keys representing 'same' or 'different' judgments. Each key press activated the next trial. To avoid visual persistence, within each trial the *whole* second scene was displaced vertically by 1.44 cm (a half of a grid cell) from the position of the first scene .

During half of the trials the key 'H' was pressed using the left index finger to represent 'same' judgments and 'J' was pressed using the right index finger to indicate 'different' judgements. For the other half of the trials the keys represented the opposite judgements to avoid any potential stimulus-response compatibility effects (for more discussion on this topic see Kornblum & Lee, 1995; Kim-Phuong & Proctor, 2002; Weeks, Proctor & Beyak, 1995). This swap of fingers was conducted conveniently after a half-way break in the experiment, which allowed the participants to leave the room and move about a bit to avoid fatigue. To reduce confusion between keys a label with 'S' (for same) or 'D' (for different) was also provided on each key.

The 144 scenes were presented four times to each participant for which the spatial relationship between the first and second scene in each trial was the same in one third of the trials and different in the other two thirds. The 'different' scenes were created by moving the located object by half a grid space (1.44 cm) either towards the right (1/3 of trials) or left (1/3 of trials) from its initial position in relation to the 'static' reference object. Even when the located object and reference object were in neighbouring grid cells they never touched even when the different scene positioned the located object nearer the reference object, due to both objects being adequately smaller than the grid-spaces they occupied.

5.1.1.4 Design

A 48 (location) x 3 (located object) x 3 (condition) within-participants design was used for the investigation. The location factor was strategically divided in various different ways for analyses by also excluding and including certain grid locations. These criteria will be discussed further in relation to the Results section analyses.

5.1.1.4.1 Main Manipulations

Factor 1: Location

Forty-eight levels of location for the located object were viewed (see Figure 5.5).

Factor 2: Located object

Three levels of located object potential animacy were manipulated (see Figure 5.5). The located object that was displayed was either a bird  pointing to the left (potential movement in that direction), or a bird  pointing to the right (potential movement in the opposite direction), or a  cloud (static object) (see Figure 5.5).

Factor 3: Condition

Three levels of condition were used: Same (both scenes of the trial were the same), Different Left (located object shift is towards the left in the second scene), Different Right (located object shift is towards the right in the second scene).

5.1.2 Results

In this experiment a repeated measures analysis of variance was carried out with the chosen alpha level at .05 throughout all the statistical analyses. The data has been divided for more strategic analyses according to various criteria. First of all, the positions on the location grid were investigated separately according to whether the figure was situated either on the cardinal axes (depicted in blue) or on the diagonal axes (depicted in green) (see Figure 5.6). In the current analysis the other conditions (depicted in black) were not included in the analyses to allow for a more focused investigation of extra-geometric effects. As noted in earlier studies (Munnich et al., 2001; Hayward & Tarr, 199) people were more likely to make 'same' judgements than 'different' judgements due to difficulty of discrimination. Therefore, rather than collapsing the data as done in past work, the current data was divided according to which condition had been used to allow disentanglement of the results: the *different* trials (including both right and left displacements) were analysed separately from the *same* trials.

				Vertical axis			
Diagonal Axis	1 (far)	2	3	4 (far)	5	6	7 (far)
	8	9 (medium)	10	11 (medium)	12	13 (medium)	14
	15	16	17 (near)	18 (near)	19 (near)	20	21
Horizontal Axis	22 (far)	23 (medium)	24 (near)	X	26 (near)	27 (medium)	28 (far)
	29	30	31 (near)	32 (near)	33 (near)	34	35
	36	37 (medium)	38	39 (medium)	40	41 (medium)	42
Diagonal Axis	43 (far)	44	45	46 (far)	47	48	49 (far)

Figure 5.6 A diagram of the *diagonal* and *cardinal* (vertical and horizontal) axes that were analysed separately for the current investigation. Also, the proximity division is illustrated.

5.1.2.1 Diagonal axes – Different trials

The results of the initial five-way ANOVA (located object x condition(diff. left/diff. right) x vertical location x horizontal location x proximity) of the diagonal grid locations (see Figure 5.7) for the *different* conditions is reported below preceded by the table of means (see Table 5.1) and full ANOVA table (see Table 5.2).

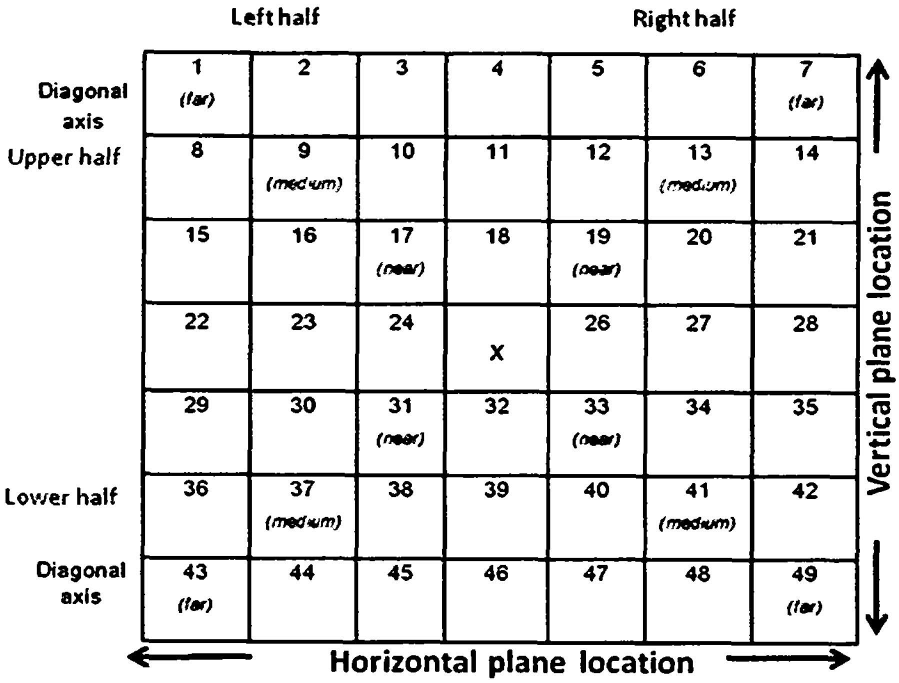


Figure 5.7 A diagram of the *diagonal* axes trials with proximity division illustrated. Also, the vertical and horizontal location division is outlined.

Table 5.1 *Means for each condition for the Diagonal axes – Different trials analysis for Experiment Nine*

Located Object	Condition	Vertical Location	Horizontal Location	Proximity	accuracy mean
Cloud	Different left	Lower	Left	near	0.40
				medium	0.27
				far	0.28
			Right	near	0.45
				medium	0.23
				far	0.24
		Upper	Left	near	0.34
				medium	0.31
				far	0.27
			Right	near	0.28
				medium	0.24
				far	0.27
	Different right	Lower	Left	near	0.47
				medium	0.20
				far	0.14
			Right	near	0.40
				medium	0.42
				far	0.26
		Upper	Left	near	0.50
				medium	0.27
				far	0.19
			Right	near	0.32
				medium	0.31
				far	0.22
Bird left	Different left	Lower	Left	near	0.41
				medium	0.24
				far	0.31
			Right	near	0.47
				medium	0.20
				far	0.23
		Upper	Left	near	0.43
				medium	0.24
				far	0.28
			Right	near	0.49
				medium	0.20
				far	0.25
	Different right	Lower	Left	near	0.55
				medium	0.24
				far	0.22
			Right	near	0.45
				medium	0.31

				far	0.25
		Upper	Left	near	0.56
				medium	0.18
				far	0.19
			Right	near	0.47
				medium	0.32
				far	0.28
Bird right	Different left	Lower	Left	near	0.40
				medium	0.28
				far	0.20
			Right	near	0.59
				medium	0.22
				far	0.25
		Upper	Left	near	0.41
				medium	0.25
				far	0.27
			Right	near	0.44
				medium	0.26
				far	0.24
	Different right	Lower	Left	near	0.42
				medium	0.32
				far	0.27
			Right	near	0.42
				medium	0.35
				far	0.23
		Upper	Left	near	0.47
				medium	0.24
				far	0.28
			Right	near	0.33
				medium	0.28
				far	0.27

Table 5.2 *The results of the 5-way Anova for the Diagonal axes – Different trials analysis in Experiment Nine*

	MS (error)	F value	Significance
Located Object (O)	0.04	1.41	ns
Condition-different (C)	0.08	0.74	ns
Vertical location (V)	0.04	1.31	ns
Horizontal location (H)	0.05	0.12	ns
Proximity (P)	0.20	29.36	***
O x C	0.05	0.21	ns
O x V	0.04	0.45	ns
C x V	0.03	0.02	ns
O x H	0.04	0.05	ns
C x H	0.43	0.04	ns
V x H	0.04	2.32	ns
O x P	0.05	3.53	*
C x P	0.04	4.17	*
V x P	0.04	1.77	ns
H x P	0.04	1.48	ns
O x C x V	0.05	0.11	ns
O x C x H	0.04	2.22	ns
O x V x H	0.06	1.73	ns
C x V x H	0.09	0.08	ns
O x C x P	0.05	2.54	*
O x V x P	0.03	1.37	ns
C x V x P	0.04	1.63	ns
O x H x P	0.04	1.29	ns
C x H x P	0.08	8.66	***
V x H x P	0.04	1.93	ns
O x C x V x H	0.03	1.77	ns
O x C x V x P	0.04	0.37	ns
O x C x H x P	0.03	0.36	ns
O x V x H x P	0.04	0.73	ns
C x V x H x P	0.04	0.19	ns
O x C x V x H x P	0.04	0.55	ns

Note: p>0.05: ns, p<0.05: *, p<0.01: **, p<0.001: ***

There was a significant main-effect of Proximity present, $F(2,42)=29.36$; $p<.001$, in which the near (M = 0.44) proximity level had higher accuracy rates than either the medium (M = 0.27) or far (M = 0.25) conditions.

Furthermore, there was a two-way interaction between Proximity x Located Object $F(4,84)=3.53$; $p<.05$, displayed in Figure 5.8. Positions where the located objects (bird left M = 0.48; bird right M = 0.44; blue cloud M = 0.40) were positioned near the reference object received higher accuracy rates overall, than positions where the located objects were positioned in the middle (blue cloud M = 0.28; bird right M = 0.28; bird left M = 0.24) and far (blue cloud M = 0.23, bird left M = 0.25, bird right M = 0.25) distances from the reference object. A separate analysis was run for each level of proximity and neither the far nor medium levels of proximity interacted significantly with the located object, whereas the near condition and located object resulted in a significant interaction $F(2,42)=4.85$; $p<.05$. This indicates that the accuracy levels between the different located object scenes varied significantly at only the near proximity conditions.

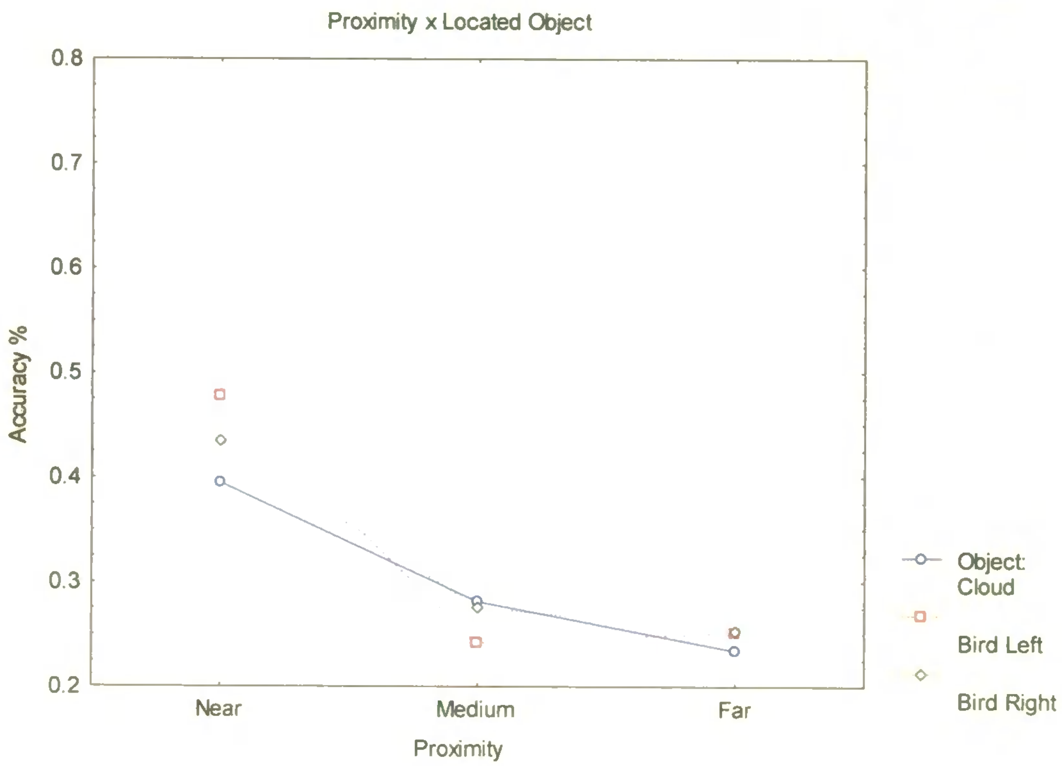


Figure 5.8 *Significant two-way interaction between Proximity x Located Object in Experiment Nine (all factors- on the diagonals – different trials).*

There was also a significant two-way interaction between <u>Proximity x Condition</u> (different left versus different right trials) $F(2,42)=4.17$; $p<.05$ (see Figure 5.9). The highest accuracy level was found at the near proximity condition with similar levels of judgment accuracy in the Different Right ($M = 0.45$) condition rather than the Different Left ($M = 0.43$) condition. Both the medium and far proximity levels had generally lower accuracy rates in which the medium scenes had slightly elevated rates for the Different Right ($M =0.29$) scenes rather than the Different Left ($M = 0.25$) scenes, whereas the far condition displayed an opposite pattern with slight favour of Different Left (M = 0.26) over Different Right (M = 0.23) scenes. A separate analysis of variance was run as a follow-up for each level of proximity and only the *medium* proximity condition, $F(1,21)=5.70; p<.05$, produced accuracy judgments that differed significantly between the different left and different right conditions.

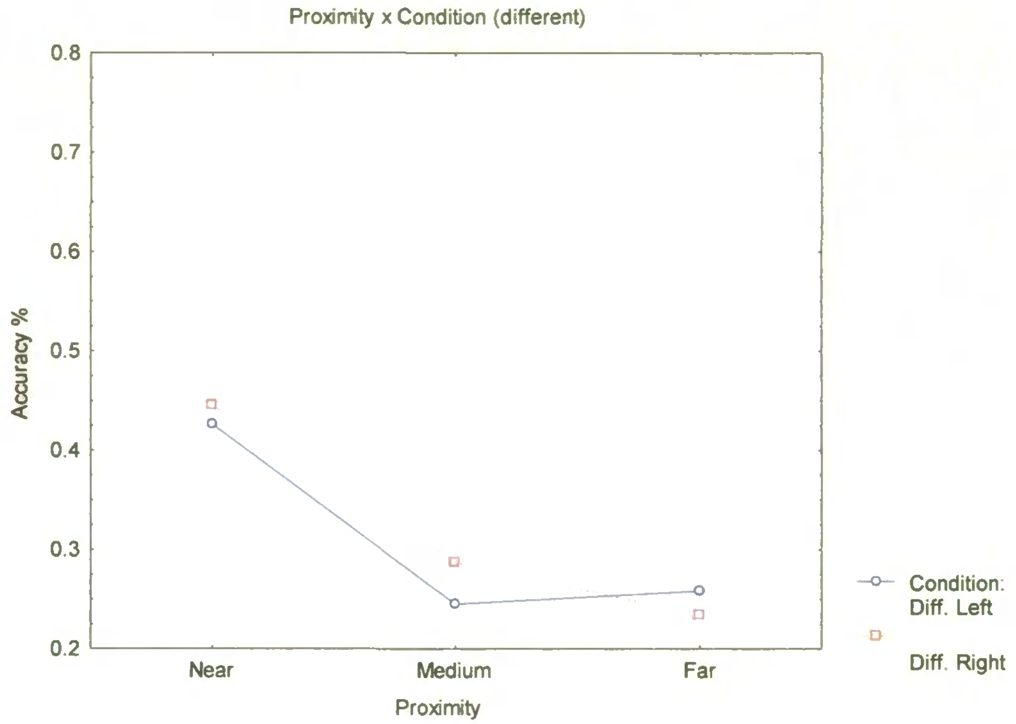


Figure 5.9 *Significant two-way interaction between Proximity x Condition in Experiment Nine (all factors- on the diagonals – different trials).*

There was a significant three-way interaction between <u>Condition (different movement left versus right) x Proximity x Horizontal location</u>; $F(2,42)=8.66$; $p<.001$ (Figure 5.10). The Near proximity location again had the highest accuracy rates in general, in which when the located object was positioned on the Left side of the screen different shifts to the Right (M = 0.49) were detected correctly more often than shifts to the Left (M = 0.40). By contrast, the scenes in which the located object was positioned on the Right side of the screen different shifts to the Left (M =0.46) were more easily detected than shifts to the Right (M = 0.40) although to a slightly lesser degree.

At the Medium proximity level when the located object was situated on the Left side of the screen both Different Left (M = 0.27) and Different Right (M = 0.24) had similarly low detection rates. However, when the located object was placed on the right side of the screen shifts in location towards the Right (M = 0.33) were more detectable than to the Left (M = 0.23).

For the Far proximity condition, the scenes involving a located object situated on the Right side of the screen showed no discrimination between accuracy rates of Different Left (M = 0.25) or Different Right (M = 0.25) scenes. In contrast, there were slightly higher accuracy rates for the scenes in which the located object was positioned on the Left side of the screen and shifted towards the Left (M = 0.27) rather than the Right (M = 0.22).

A follow-up analysis was conducted separately for each proximity level and neither the far or medium levels of proximity were found to significantly interact with the horizontal axis or different conditions. However, there was a nearly significant interaction between horizontal axis and different condition, $F(1,21)=4.03$; $p<.058$. Ultimately when the located object was at a *near* proximity to the reference object the more accurate the participants were in detecting a locational shift when the located object was moving away from the side of the screen on which it was positioned, in other words towards the axis extending vertically from the reference object.

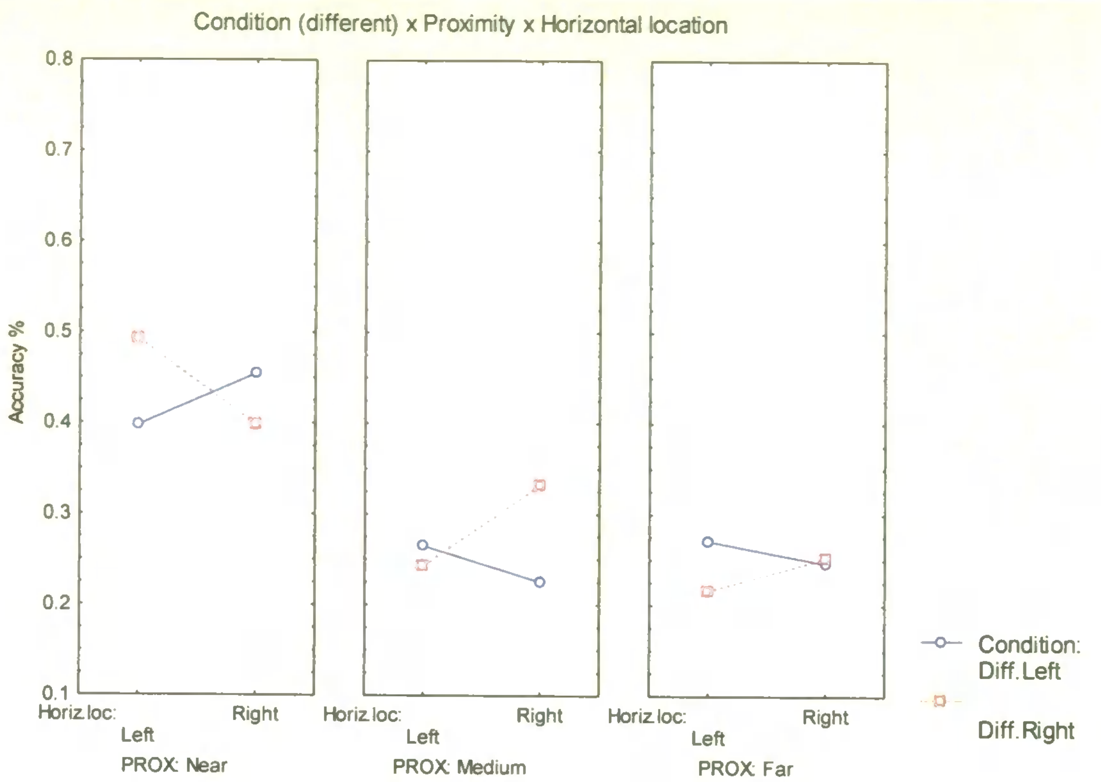


Figure 5.10 *Significant three-way interaction between Condition x Proximity x Horizontal location in Experiment Nine (all factors- on the diagonals – different trials).*

Furthermore, there was a significant three-way interaction between Proximity x Condition (different) x Located Object $F(4,84)=2.54$; $p<.05$ (Figure 5.11). At the Far proximity and Different Left trials the accuracy rates were generally low but both the bird left (M = 0.27) and blue cloud (M = 0.27) had similar accuracy levels, whereas bird right (M = 0.24) has slightly lower accuracy rates. Furthermore, for the Different Right trials the scenes with bird right (M = 0.26) as the located object had the highest accuracy ratings, whereas bird left (M = 0.24) and blue cloud (M = 0.20) had ratings declining in accuracy.

At the Medium proximity level again the rates of accurate detection were relatively low; both bird right (Different Left M = 0.25, Different Right M = 0.30) and blue cloud (Different Left M = 0.26, Different Right M = 0.30) had higher accuracy rates than bird left (Different Left M = 0.22, Different Right M = 0.26) for both different conditions . All conditions, however, showed a discrepancy in accuracy levels in slight favour of Different Right rather than Different Left. This may suggest that there is a general tendency for people to be more perceptive of rightwards motion, due to the reading habits of the western world leading the eyes naturally from the left towards the right.

Finally at the near proximity level the accuracy rates were highest, however bird left had higher rates in the Different Right ($M = 0.51$) condition rather than the Different Left ($M = 0.45$) condition. In contrast, bird right had higher accuracy levels for the scenes in which the different shift was to the left ($M = 0.46$) rather than the right ($M = 0.41$). This is in line with the experimental predictions that object knowledge would have an effect on accuracy. However, the scenes displaying a blue cloud as the located object had lower ratings than the trials with other located objects, showing higher accuracy for the Different Right ($M = 0.42$) rather than the Different Left ($M = 0.37$) condition. Which is again in accord with the prediction, that an object known to be relatively stationary, would not be as likely for people to accurately perceive as making locational shift.

Follow-up analyses of variance were done separately on each level of proximity from which it was apparent that only the *near* proximity level was interacting at a nearly significant level ($F(2,42)=3.10; p<.055$) with the located object and different condition.

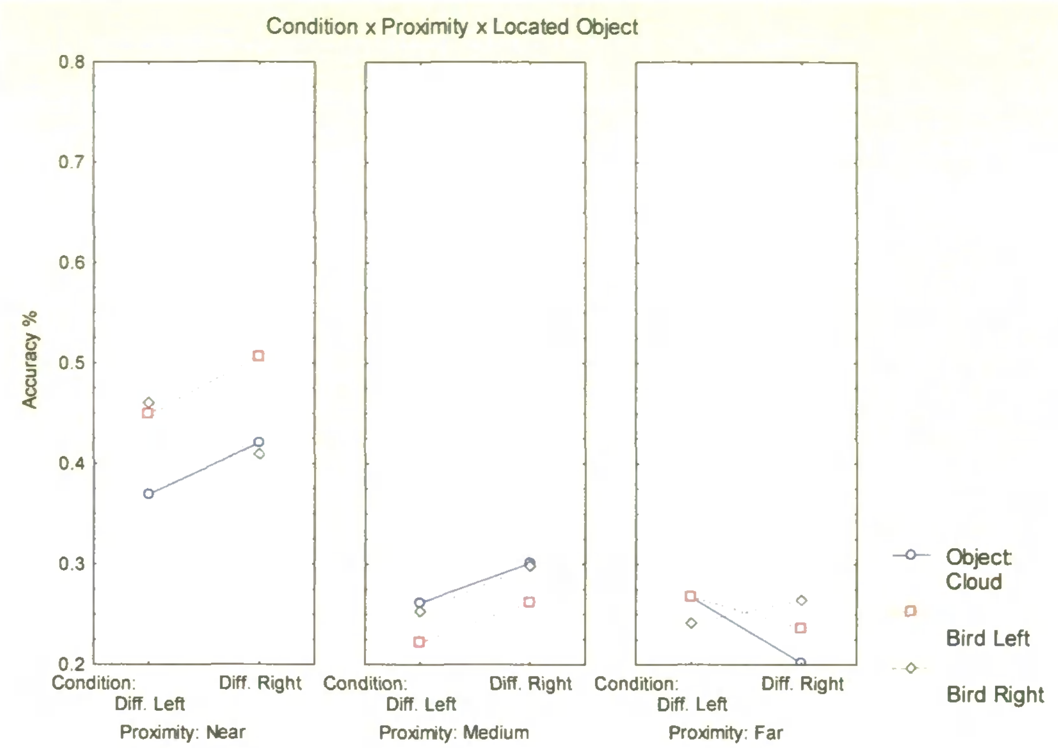


Figure 5.11 *Significant three-way between Condition x Proximity x Located Object interaction in Experiment Nine (all factors- on the diagonals – different trials).*

5.1.2.2 Diagonal axes –Same trials

The results of the five-way ANOVA (located object x condition x vertical location x horizontal location x proximity) of the diagonal grid locations for the *same* conditions is reported and followed by the table of means (see Table 5.3) and full ANOVA table (see Table 5.4).

There was only one significant effect in this analysis and that was the main-effect of Proximity, $F(2,42)=4.40$; $p<.05$. The scenes involving the Far proximity (M = 0.76) level had lower accuracy of judgement than the scenes in which the located object was positioned in the Medium (M = 0.84) or Near (M = 0.83) proximity conditions. From the elevated accuracy percentage it is clear that in this experiment people were more likely to judge scenes as the *same* rather than *different,* however separate analyses of Different and Same trials has avoided inflating the overall accuracy of memory for location.

Table 5.3 *Means for each condition for the Diagonal axes – Same trials analysis for Experiment Nine*

Located Object	Vertical Location	Horizontal Location	Proximity	accuracy mean
Cloud	Lower	Left	far	0.75
			medium	0.86
			near	0.85
		Right	far	0.76
			medium	0.83
			near	0.83
	Upper	Left	far	0.80
			medium	0.83
			near	0.83
		Right	far	0.76
			medium	0.84
			near	0.84
Bird left	Lower	Left	far	0.70
			medium	0.76
			near	0.80
		Right	far	0.76
			medium	0.84
			near	0.81

	Upper	Left	far	0.74
			medium	0.82
			near	0.78
		Right	far	0.75
			medium	0.91
			near	0.83
Bird right	Lower	Left	far	0.76
			medium	0.85
			near	0.82
		Right	far	0.78
			medium	0.86
			near	0.85
	Upper	Left	far	0.74
			medium	0.81
			near	0.89
		Right	far	0.78
			medium	0.81
			near	0.83

Table 5.4 *The results of the 4-way Anova for the Diagonal axes – Same trials analysis in Experiment Nine*

	MS (error)	F	Significance
Object (O)	0.03	1.77	ns
Vertical (V)	0.04	0.12	ns
Horizontal (H)	0.03	1.92	ns
Proximity (P)	0.11	4.40	*
O x V	0.02	1.18	ns
O x H	0.03	1.82	ns
V x H	0.04	0.03	ns
O x P	0.02	0.49	ns
V x P	0.03	0.04	ns
H x P	0.04	0.24	ns
O x V x H	0.05	0.13	ns
O x V x P	0.03	1.09	ns
O x H x P	0.03	0.45	ns
V x H x P	0.03	0.18	ns
O x V x H x P	0.03	0.64	ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

5.1.2.3 Cardinal axes – Different trials

The results of the initial four-way ANOVA (located object x condition x axis x proximity) of the cardinal axis grid locations (see Figure 5.12) for the *different* conditions is reported below preceded by the table of means (see Table 5.5) and full ANOVA table (see Table 5.6).

Upper axis

	1	2	3	4 *(far)*	5	6	7	
	8	9	10	11 *(medium)*	12	13	14	
	15	16	17	18 *(near)*	19	20	21	
Left axis	22 *(far)*	23 *(medium)*	24 *(near)*	X	26 *(near)*	27 *(medium)*	28 *(far)*	Right Axis
	29	30	31	32 *(near)*	33	34	35	
	36	37	38	39 *(medium)*	40	41	42	
	43	44	45	46 *(far)*	47	48	49	

Lower axis

Figure 5.12 A diagram of the *cardinal* axes trials with proximity division illustrated.

Table 5.5 *Means for each condition for the Cardinal axes – Different trials analysis for Experiment Nine*

Located Object	Condition	Axis	Proximity	accuracy Mean
Cloud	Different Left	lower	Near	0.52
			Medium	0.49
			Far	0.43
		Left	Near	0.58
			Medium	0.41
			Far	0.26
		right	near	0.83
			medium	0.40
			far	0.39

		upper	near	0.49
			medium	0.42
			far	0.38
	Different Right	lower	near	0.50
			medium	0.45
			far	0.43
		Left	near	0.74
			medium	0.47
			far	0.34
		right	near	0.67
			medium	0.38
			far	0.40
		upper	near	0.55
			medium	0.57
			far	0.42
Bird left	Different Left	lower	near	0.49
			medium	0.50
			far	0.43
		Left	near	0.58
			medium	0.44
			far	0.33
		right	near	0.83
			medium	0.49
			far	0.33
		upper	near	0.59
			medium	0.50
			far	0.35
	Different Right	lower	near	0.49
			medium	0.52
			far	0.39
		Left	near	0.86
			medium	0.44
			far	0.36
		right	near	0.60
			medium	0.41
			far	0.34
		upper	near	0.48
			medium	0.51
			far	0.47
Bird Right	Different Left	lower	near	0.43
			medium	0.49
			far	0.33
		Left	near	0.67
			medium	0.41
			far	0.28

	right	near	0.86
		medium	0.52
		far	0.35
	upper	near	0.52
		medium	0.53
		far	0.41
Different Right	lower	near	0.47
		medium	0.38
		far	0.44
	Left	near	0.83
		medium	0.47
		far	0.38
	right	near	0.73
		medium	0.43
		far	0.32
	upper	near	0.57
		medium	0.43
		far	0.44

Table 5.6 *The results of the 4-way Anova for the Cardinal axes – Different trials analysis in Experiment Nine*

	MS (error)	F	Significance
Located Object (O)	0.05	0.32	ns
Condition-different (C)	0.04	1.01	ns
Axis (A)	0.84	0.30	ns
Proximity (P)	0.20	41.66	***
O x C	0.05	0.50	ns
O x A	0.03	2.02	ns
C x A	0.06	8.89	***
O x P	0.03	0.91	ns
C x P	0.03	2.48	ns
A x P	0.05	23.62	***
O x C x A	0.04	0.64	ns
O x C x P	0.03	1.74	ns
O x A x P	0.04	0.92	ns
C x A x P	0.05	2.97	*
O x C x A x P	0.04	1.42	ns

Note: p>0.05: ns, p<0.05: *, p<0.01: **, p<0.001: ***

There was a significant main-effect of Proximity $F(2,42)=41.66$; $p<.001$, in which the accuracy rates increased the nearer the located object was to the reference object (Near M = 0.62, Medium M = 0.46, Far M = 0.38).

There was also a significant Axis x Condition interaction , $F(3,63)=8.89$; $p<.0001$ (Figure 5.13). In the Lower axis (Diff. Left M = 0.46, Diff. Right M = 0.45) and Upper Axis (Diff. Left M = 0.47, Diff. Right M = 0.49) conditions there was little discrimination of judgment accuracy between the Different Left or Right conditions. When the located object was situated on the Left axis, the Different Right scenes (M = 0.48) were more often detected than the Different Left scenes (M = 0.44). Furthermore, when the located object was positioned on the Right Axis, the Different Left scenes (M = 0.56) displayed higher accuracy rates than the Different Right scenes (M = 0.48).

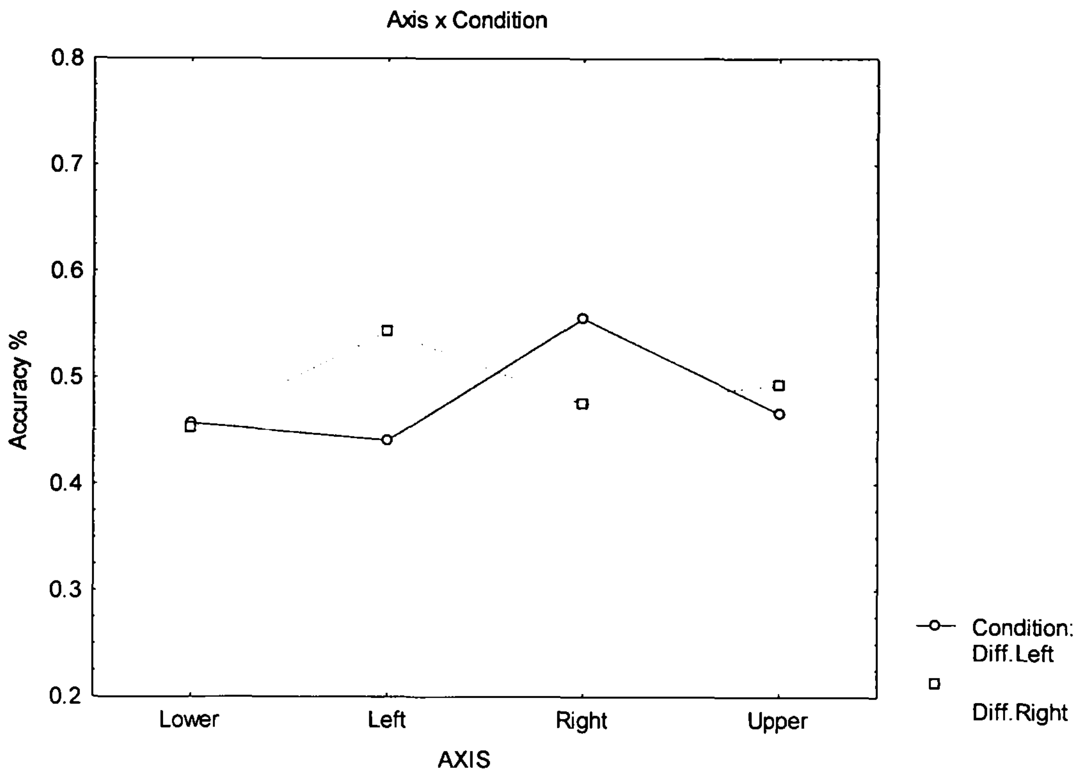


Figure 5.13 *Significant two-way interaction between Axis x Condition in Experiment Nine (ALL- cardinal axes – different trials).*

Furthermore, there was a significant two-way interaction between <u>Proximity x Axis</u>, $F(6,126)=23.62$; $p<.001$ (Figure 5.14). In the Far proximity condition both the Upper (M = 0.41) and Lower axes (M = 0.41) had higher detection rates than the Left (M = 0.33) and Right axes (M = 0.35). This pattern was also visible for the Medium proximity scenes although to a lesser extent (Upper M = 0.49, Lower M = 0.47, Left M = 0.44, Right M = 0.44 axes).

However, the pattern of judgment accuracy was very different in the Near condition in which the Right (M = 0.75) and Left (M = 0.71) axes have much higher levels of accuracy than the Upper (M = 0.53) and Lower (M = 0.48) axes. At the near proximity level the horizontal shifts in position were likely to be much more noticable since the located object was moving either directly towards or away from the reference object in a location that was right along side of it.

Two separate follow-up analyses of variance showed that neither the *far* or *medium* proximity levels interacted significantly with the different levels of axes. A separate anlaysis of variance of the *near* proximity level indicated a significant discrimination between the different levels of axes, $F(3,63)=6.99;p<.001$.

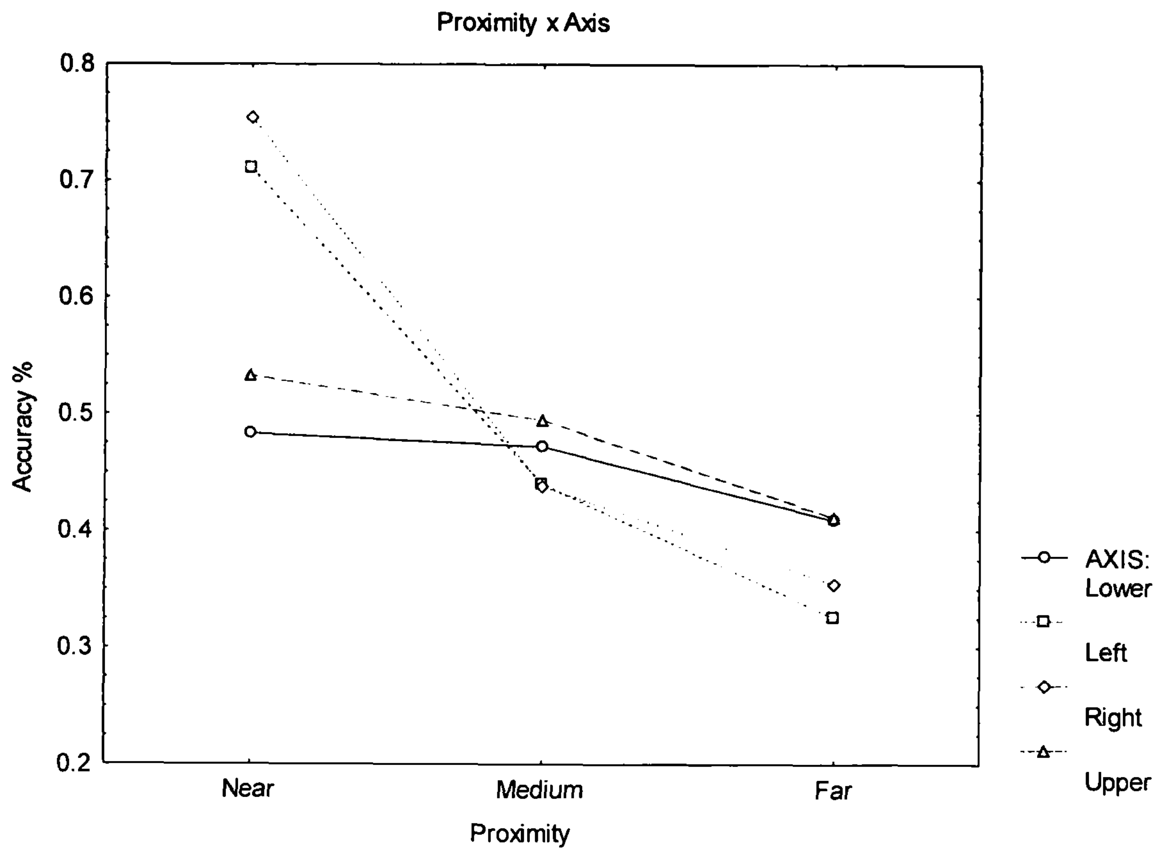


Figure 5.14 *Significant two-way interaction between Proximity x Axis in Experiment Nine (ALL- cardinal axes – different trials).*

Finally, there was a significant three-way interaction between Axis x Proximity x Condition (different), F(6,126)=2.97; p<.01 (Figure 5.15). The *Near* trials in this interaction throw more light on the previous two-way interaction, in that when the located object was on the Right axis Different Left trials (M = 0.84) had a higher detection rate than Different Right (M = 0.67) trials. However, when the located object is on the Left axis the Different Right scenes (M = 0.81) have higher accuracy rates than Different Left (M = 0.61). While the Lower (Different Left M = 0.48, Different Right M = 0.49) and Upper axes (Different Left M = 0.53, Different Right M = 0.53) have much poorer detection rates and no discrimination between Different Left and Right conditions.

The accuracy rates were generally lower for the *Medium* proximity scenes in which the scenes where the located object was positioned on the Left axis had slightly higher detection rates for Different Right (M = 0.46) scenes than Different Left (M = 0.42) scenes. However, the opposite was the case for the scenes in which the located object was on the Right axis (Diff. Left M = 0.47, Diff.Right M = 0.41). Furthermore although the accuracy rates were a little higher for the Upper axis trials there was no real discrimination between Different Right (M = 0.50) and Left (M = 0.49) scenes. Also, the Lower axis trials had slightly higher detection rates especially for the Different Left (M = 0.49) trials than Different Right (M = 0.46).

The accuracy rates were generally lower yet again in the *Far* proximity condition with the Lower axis scenes producing slightly higher accuracy rates than the rest of the scenes although indicating very little discrimination between Different Left (M = 0.40) and Right (M = 0.42) conditions. In contrast, the Upper axis scenes depicted a slight bias towards Different Right (M = 0.44) rather than Different Left (M = 0.39) scenes. The trials on the Right axis had low accuracy rates with no discrimination between Different Left (M = 0.36) and Right (M = 0.35) scenes, whereas, The Left axis trials had slightly higher accuracy rates for the Different Right (M = 0.36) rather than the Different Left (M = 0.30) scenes.

Follow-up analyses of variance were conducted separately for each level of proximity from which it was apparent that only the *near* proximity level was interacting at a significant level (F(3,63)=13.68;p<.001) with the axis and different condition.

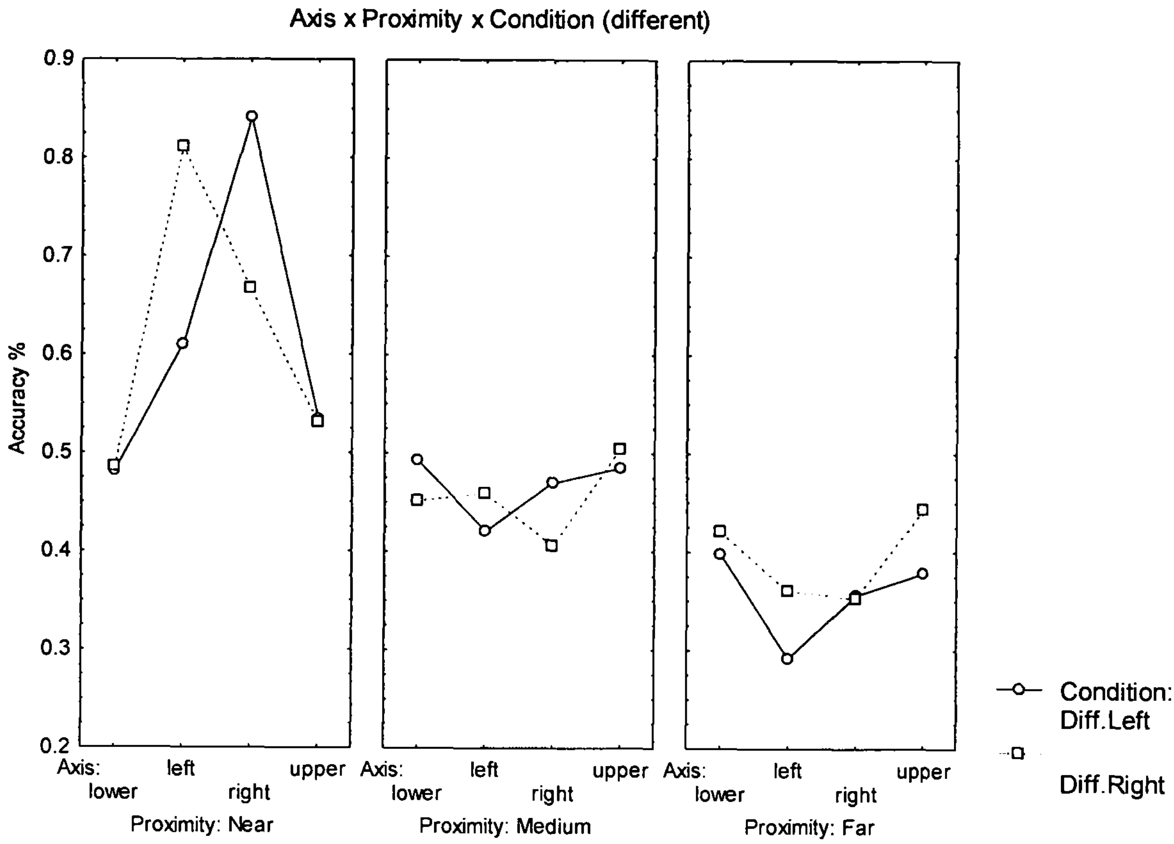


Figure 5.15 *Significant three-way interaction between Axis x Proximity x Condition in Experiment Nine (ALL- cardinal axes – different trials).*

5.1.2.4 Cardinal axes – Same trials

The results of the three-way ANOVA (located object x axis x proximity) of the cardinal axis grid locations for the *same* conditions found no significant interactions or main-effects. Below is reported the table of means (see Table 5.7) and full ANOVA table (see Table 5.8).

Table 5.7 *Means for each condition for the Cardinal axes – Same trials analysis for Experiment Nine*

Located Object	Axis	Proximity	accuracy mean
Cloud	Lower	Far	0.85
		Medium	0.81
		Near	0.86
	Left	Far	0.84
		Medium	0.89
		Near	0.84
	Right	Far	0.82
		Medium	0.85
		Near	0.81
	Upper	Far	0.77
		Medium	0.85
		Near	0.84
Bird left	Lower	Far	0.83
		Medium	0.83
		Near	0.81
	Left	Far	0.84
		Medium	0.84
		Near	0.84
	Right	Far	0.82
		Medium	0.85
		Near	0.90
	Upper	Far	0.90
		Medium	0.90
		Near	0.88
Bird right	Lower	Far	0.77
		Medium	0.83
		Near	0.84
	Left	Far	0.81
		Medium	0.82
		Near	0.82

Right	Far	0.83
	Medium	0.82
	Near	0.84
Upper	Far	0.86
	Medium	0.84
	Near	0.86

Table 5.8 *The results of the 3-way Anova for the Cardinal axes – Different trials analysis in Experiment Nine*

	MS (error)	F	Significance
Object (O)	0.03	1.41	ns
Axis (A)	0.03	1.18	ns
Proximity (P)	0.05	0.43	ns
O x A	0.03	1.15	ns
O x P	0.02	0.22	ns
A x P	0.03	0.11	ns
O x A x P	0.03	0.80	ns

Note: p>0.05: ns, p<0.05: *, p<0.01: **, p<0.001: ***

5.1.2.5 **Additional analysis of Results** for Experiment Nine

The second prediction for the current series of experiments is that when the located objects are positioned off the axes of the reference object then there would be higher detection accuracy of different trials in which the shift is towards the diagonal axis rather than away from it (Crawford et al., 2000). Therefore, another analysis of variance was carried out with the chosen alpha level at .05, however a different strategy was used for the selection of analysed data points. This time the *different* trial scenes containing only the locations on either side of the diagonal axes, and furthest away from the cardinal axes were only included for inspection (see Figure 5.16). The locations were also further collapsed resulting in only three factors: Located Object (cloud/bird left/bird right) x Horizontal movement (different left/different right) x Diagonal movement (away/towards diagonal). Horizontal movement in this instance means shifts of position either to the right or left, whereas diagonal movement distinguishes between movement which is either towards or away from the diagonal axes (see Figure 5.16). This analysis aimed to investigate whether Crawford and colleagues' (2000) claims that the cardinal axes were non-verbal spatial category boundaries and instead the category prototypical region might be along the diagonal axes instead.

1	**2** **←LT** **→RA**	**3**	**4**	**5**	**6** **←LA** **→RT**	**7**
8 **←LA** **→RT**	**9**	**10**	**11**	**12**	**13**	**14** **←LT** **→RA**
15	**16**	**17**	**18**	**19**	**20**	**21**
22	**23**	**24**		**26**	**27**	**28**
29	**30**	**31**	**32**	**33**	**34**	**35**
36 **←LA** **→RT**	**37**	**38**	**39**	**40**	**41**	**42** **←LT** **→RA**
43	**44** **←LT** **→RA**	**45**	**46**	**47**	**48** **←LA** **→RT**	**49**

Key: LA = left away (from diagonal axis); LT = left towards (diagonal axis);
RA = right away (from diagonal axis); RT = right towards (diagonal axis)

Figure 5.16. A diagram of the data points (depicted in red) on either side of the diagonal axes (depicted in green) that were analysed for the current investigation.

5.1.2.5.1 Results

The results of the three-way ANOVA Located Object (cloud/bird left/bird right) x Horizontal movement (different left/different right) x Diagonal movement (away/towards diagonal) of the additional diagonal analysis is reported below preceded by the table of means (see Table 5.9) and full ANOVA table (see Table 5.10).

Table 5.9 *Means for each condition for the Additional analysis for Experiment Nine*

Located Object	Horizontal Movement	Diagonal Movement	Accuracy Mean
Cloud	Diff. left	away from diag.	0.28
		towards diag.	0.22
	Diff. right	away from diag.	0.26
		towards diag.	0.30
Bird left	Diff. left	away from diag.	0.26
		towards diag.	0.28
	Diff. right	away from diag.	0.26
		towards diag.	0.29
Bird right	Diff. left	away from diag.	0.26
		towards diag.	0.23
	Diff. right	away from diag.	0.25
		towards diag.	0.28

Table 5.10 *The results of the 3-way Anova for the additional analysis in Experiment Nine*

	MS (error)	F Value	Significance
Located Object (O)	0.01	0.55	ns
Horizontal movement (H)	0.01	1.14	ns
Diagonal movement (D)	0.02	0.13	ns
O x H	0.01	0.31	ns
O x D	0.01	0.94	ns
H x D	0.01	4.80	*
O x H x D	0.01	0.58	ns

Note: p>0.05: ns, p<0.05: *, p<0.01: **, p<0.001: ***

There were no significant main-effects or interactions apart from a two-way interaction between Horizontal movement x Diagonal movement, $F(1,21)=4.80$; $p<.05$ (Figure 5.17). The scenes which involved located object relative movement Away from the diagonal axes had similar levels of accuracy regardless of whether this was also towards the Left ($M = 0.27$) or Right ($M = 0.26$) of the screen, whereas, when the located object moved Towards the diagonal and also to the Right (M = 0.29) of the screen accuracy of judgement was higher than when movement was to the Left (M = 0.25) of the screen.

In conclusion, Experiment Nine produced no support for Crawford et al. (2000) claims that the non-verbal prototypical region might be along the diagonal axes.

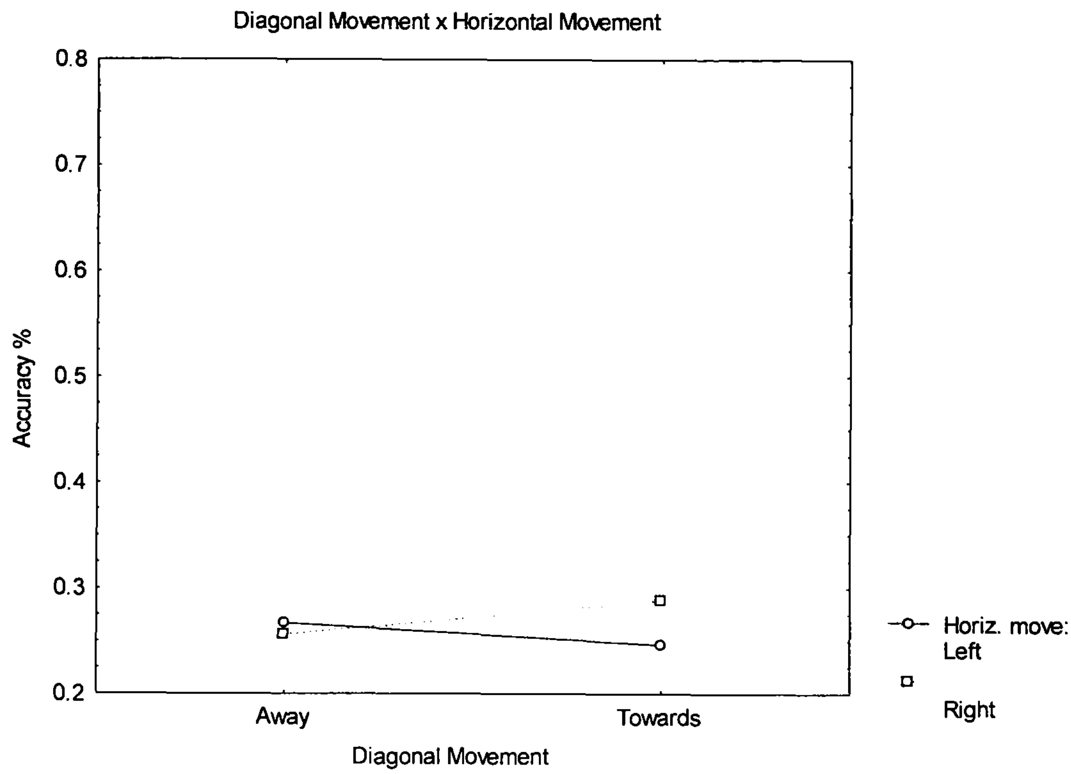


Figure 5.17. The significant interaction between Diagonal movement x Horizontal movement.

5.1.3 Experiment Nine Conclusion

The experimental hypotheses gained only marginal support in specific circumstances. The diagonal axes – different trials analyses provided some support for the prediction that detection would be higher when the direction of the locational shift is against the direction of expected motion of the object. The three-way interaction between Proximity x Condition-different x Located Object suggests that when the located object was positioned near to the reference object, shifts in position were easier to perceive when the bird with its beak pointing to the left was displaced towards the right, and when the bird with its beak pointing to the right was displaced towards the left. Also, in this interaction and at the near proximity level, detection of movement was generally lower when the scenes depicted a relatively static located object such as the cloud, which was also in accord with the prediction that object expectations in this case would make it more unlikely to notice motion.

It should, however be noted that these experimental hypotheses were only supported at the *near* proximity level of the Proximity x Condition-different x Located Object interaction, but not at the *medium* or *far* levels of proximity. More specifically, this support was gained only from the diagonal axis location analyses not the cardinal axis analyses. Furthermore, the additional analyses of strategic data points on either side of the diagonal axes did not produce any support for the second prediction that when the located object was positioned off the axes of the reference object, there would be higher detection accuracy of different trials in which the shift is towards the diagonal axis rather than away from it.

Experiment Ten

5.1.4 Method

This experiment was similar to Experiment 9, apart from the changes that were made to the design and which are outlined below.

5.1.4.1 Participants

The twenty-nine native (monolingual) English speaking participants were undergraduate or postgraduate students from The University of Plymouth and they received course credit or payment for their participation.

5.1.4.2 Design and Materials

The design, materials and lay-out used for this experiment were generally identical to those used in Experiment Nine. However, the located objects were partly different because the focus of interest for this experiment was accuracy judgments of objects potentially vertically mobile, in contrast to the potentially horizontally mobile object in Experiment Nine. Therefore, while the reference object was again always a white cloud, the located object was either a blue cloud, a rocket, or a bomb. This allowed for investigations to determine whether the potential (vertical) direction of located object movement had an effect on accuracy of memory. Moreover, higher detection rates were expected when the direction of the shift for the 'different' trials was against the direction of expected motion of the object.

5.1.4.3 Procedure

The format of the procedure was the same as that used in Experiment Nine in most parts. However, this time to avoid visual persistence, within each trial the *whole* second scene was displaced *horizontally* by 1.44 cm (a half of a grid cell) from the position of the first scene. Also, this time the 'different' scenes were created by moving the located object by half a grid space (1.44 cm) either upwards (1/3 of trials) or down (1/3 of trials) from its initial position in relation to the 'static' reference object.

5.1.4.4 Design

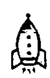
A 48 (location) x 3 (located object) x 3 (condition) within-participants design was used for the investigation. The location factor was strategically divided in various different ways for analyses by also excluding and including certain grid locations. These criteria will be discussed further in relation to the Results section analyses.

5.1.4.4.1 Main Manipulations

Factor 1: Location

Forty-eight levels of location were viewed (see Figure 5.5).

Factor 2: Located object

Three levels of located object potential animacy were manipulated (see Figure 2.X). The located object that was displayed was either a rocket:  (potential movement upwards), or a bomb:  (potential movement downwards), or a cloud:  (static control) (see Figure 5.5).

Factor 3: Condition

Three levels of condition were used: Same (both scenes of the trial were the same), Different Down (located object shift is downwards in the second scene), Different Up (located object shift is upwards in the second scene).

5.1.5 Results

In Experiment Ten a repeated measures analysis of variance was carried out with the chosen alpha level at .05 throughout all the statistical analyses. The data has been divided for more strategic analyses according to various criteria. First of all, the positions on the location grid were investigated separately according to whether the figure was situated either on the horizontal or vertical axes (depicted in blue) or on the diagonal axes (depicted in green) situated between these (see Figure 5.18). Also, a further split of data was made according to whether the scenes included a displacement in terms of relative position of the located object in relation to the reference object (Different Up/ Different Down), or whether the scenes maintained the same relative positions between both objects. In the current thesis the other conditions (depicted in black) were not included in the report.

Vertical axis

Diagonal axis	1 *(far)*	2	3	4 *(far)*	5	6	7 *(far)*
	8	9 *(medium)*	10	11 *(medium)*	12	13 *(medium)*	14
	15	16	17 *(near)*	18 *(near)*	19 *(near)*	20	21
Horizontal axis	22 *(far)*	23 *(medium)*	24 *(near)*	**X**	26 *(near)*	27 *(medium)*	28 *(far)*
	29	30	31 *(near)*	32 *(near)*	33 *(near)*	34	35
	36	37 *(medium)*	38	39 *(medium)*	40	41 *(medium)*	42
Diagonal axis	43 *(far)*	44	45	46 *(far)*	47	48	49 *(far)*

Figure 5.18. A diagram of the *diagonal* and *cardinal* (vertical and horizontal) axes that were analysed separately for the current investigation. Also, the proximity division is illustrated.

5.1.5.1 **Diagonal axes – Different trials**

The results of the initial five-way ANOVA (located object x condition x vertical location x horizontal location x proximity) of the diagonal grid locations (see Figure 5.19) for the different conditions is reported below preceded by the table of means (see Table 5.11) and full ANOVA table (see Table 5.12). including full ANOVA tables.

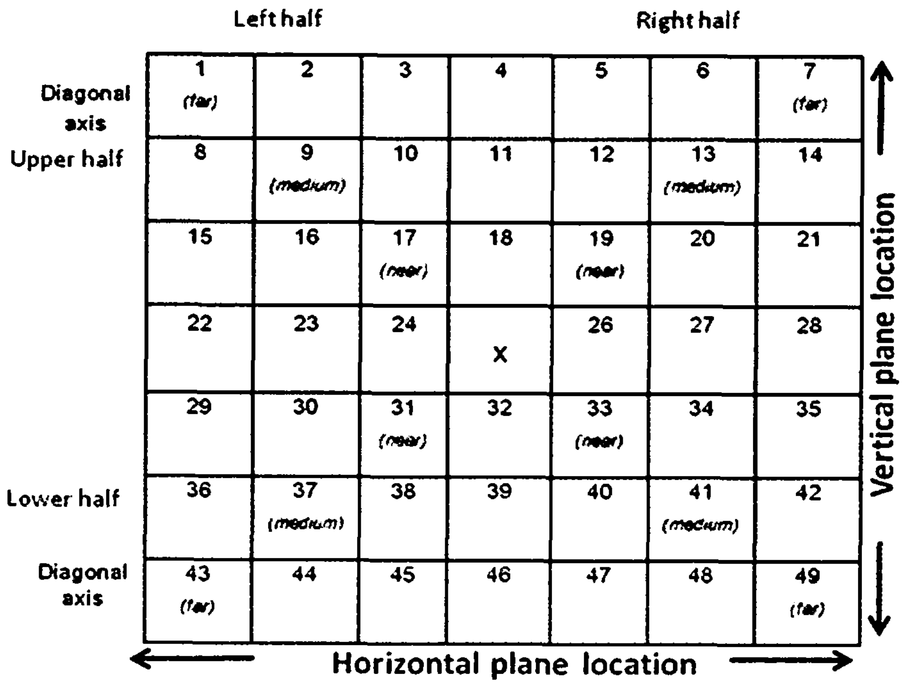


Figure 5.19. A diagram of the *diagonal* axes trials with proximity division illustrated. Also, the vertical and horizontal location division is outlined.

Table 5.11 *Means for each condition for the Diagonal axes – Different trials analysis for Experiment Ten*

Located Object	Condition	Vertical Location	Horizontal Location	Proximity	accuracy mean
Bomb	Different down	Lower	Left	Near	0.68
				Medium	0.29
				Far	0.34
			Right	Near	0.67
				Medium	0.43
				Far	0.35
		Upper	Left	Near	0.63
				Medium	0.40
				Far	0.26
			Right	Near	0.59
				Medium	0.37
				Far	0.33
	Different up	Lower	Left	Near	0.65
				Medium	0.44
				Far	0.37
			Right	Near	0.61
				Medium	0.45
				Far	0.37
		Upper	Left	Near	0.64
				Medium	0.43
				Far	0.33
			Right	Near	0.70
				Medium	0.41
				Far	0.37
Cloud	Different down	Lower	Left	Near	0.57
				Medium	0.35
				Far	0.35
			Right	Near	0.65
				Medium	0.39
				Far	0.27
		Upper	Left	Near	0.75
				Medium	0.33
				Far	0.32
			Right	Near	0.61
				Medium	0.29
				Far	0.32

	Different up	Lower	Left	Near	0.61
				Medium	0.34
				Far	0.27
			Right	Near	0.58
				Medium	0.34
				Far	0.25
		Upper	Left	Near	0.64
				Medium	0.37
				Far	0.35
			Right	Near	0.60
				Medium	0.39
				Far	0.34
Rocket	Different down	Lower	Left	Near	0.68
				Medium	0.45
				Far	0.31
			Right	Near	0.71
				Medium	0.40
				Far	0.35
		Upper	Left	Near	0.68
				Medium	0.36
				Far	0.28
			Right	Near	0.63
				Medium	0.32
				Far	0.37
	Different up	Lower	Left	Near	0.63
				Medium	0.42
				Far	0.44
			Right	Near	0.57
				Medium	0.41
				Far	0.34
		Upper	Left	Near	0.72
				Medium	0.47
				Far	0.34
			Right	Near	0.66
				Medium	0.56
				Far	0.35

Table 5.12 *The results of the 5-way Anova for the Diagonal axes – Different trials analysis for Experiment Ten*

	MS (error)	F	Significance
Located Object (O)	0.06	7.03	***
Condition-different (C)	0.07	2.90	ns
Vertical location(V)	0.04	0.37	ns
Horizontal location (H)	0.04	0.17	ns
Proximity (P)	0.17	108.55	***
O x C	0.05	2.25	ns
O x V	0.06	1.63	ns
C x V	0.35	1.16	ns
O x H	0.05	1.10	ns
C x H	0.07	0.15	ns
V x H	0.04	0.01	ns
O x P	0.04	0.67	ns
C x P	0.05	4.66	*
V x P	0.04	0.69	ns
H x P	0.04	1.35	ns
O x C x V	0.05	0.90	ns
O x C x H	0.06	0.25	ns
O x V x H	0.05	0.87	ns
C x V x H	0.04	4.63	*
O x C x P	0.04	0.47	ns
O x V x P	0.06	0.78	ns
C x V x P	0.14	0.25	ns
O x H x P	0.05	0.27	ns
C x H x P	0.05	0.46	ns
V x H x P	0.05	2.32	ns
O x C x V x H	0.06	0.01	ns
O x C x V x P	0.04	4.22	***
O x C x H x P	0.04	2.10	ns
O x V x H x P	0.04	1.38	ns
C x V x H x P	0.06	1.19	ns
O x C x V x H x P	0.06	0.31	ns

Note: p>0.05: ns, p<0.05: *, p<0.01: **, p<0.001: ***

The significant main effect of Located Object $F(2,56) = 7.03$, $p<0.001$, MSE = 0.06 was present, in which the rocket (M = 0.48) and the bomb (M = 0.46) were more accurately judged than the cloud (M = 0.43) collapsed across all conditions (significant difference (p<0.05). Although this effect is collapsed across all other conditions it generally supports the notion that accurate detection of movement would be lowest for an object which participants might expect to be relatively immobile.

There was also a significant main effect of Proximity $F(2,56) = 108.56$, $p<0.001$, $MSE = 0.18$, where the near ($M = 0.64$) proximity level had higher accuracy rates across all conditions than either the medium ($M = 0.39$) or far ($M = 0.33$) levels.

There was also a significant two-way interaction between Condition-different x Proximity $F(2,56) = 4.67$, $p<0.05$, $MSE = 0.05$ (Figure 5.20). The near level of proximity (Different Down $M = 0.65$, Different Up $M = 0.63$) had the highest level of accuracy regardless of different condition. Whereas, the medium level of proximity displayed lower levels of accuracy in general showing only a little discrimination between the two different conditions in the favour of Different Up ($M = 0.42$) rather than Different Down ($M = 0.36$). The lowest levels of accuracy were displayed for the far proximity level (Different Down $M = 0.32$, Different Up $M = 0.34$) regardless of different condition. A separate analysis of variance for each level of proximity was conducted as a follow-up and only the medium level of proximity was revealed to interact significantly with different up and different down conditions $F(1,28)=7.19, p<0.05, MSE=0.07$.

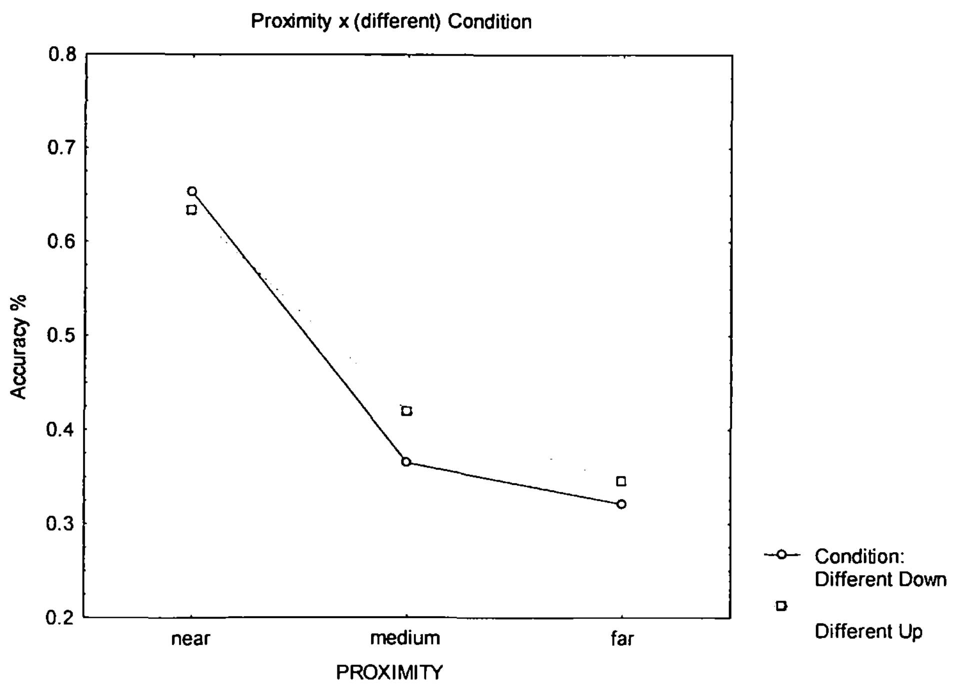


Figure 5.20 *Significant two-way interaction between Proximity x Condition in Experiment Ten (all factors- on the diagonals – different trials).*

Additionally, a significant three-way interaction between Vertical location x Horizontal location x Condition-different $F(1,28) = 4.63$, $p<0.05$, MSE = 0.04 was present (Figure 5.21). When the located object was on the Left side of the screen, regardless of whether that was on the Lower (Different Down M = 0.45, Different Up M = 0.46) or Upper (Different Down M = 0.45, Different Up M = 0.48) regions of the screen, the accuracy levels were very similar for Different shifts in both directions.

Furthermore, when the object was on the right side of the screen the Different Down condition produced higher accuracy ratings when the object was placed in the lower half (M = 0.47) of the screen than when it was in the upper half (M = 0.43). However, the interaction displayed an opposite pattern when the Different Up condition was present in that when the object appeared on the upper half (M = 0.49) of the screen the accuracy levels were higher than when the object was on the lower half (M = 0.44) of the screen.

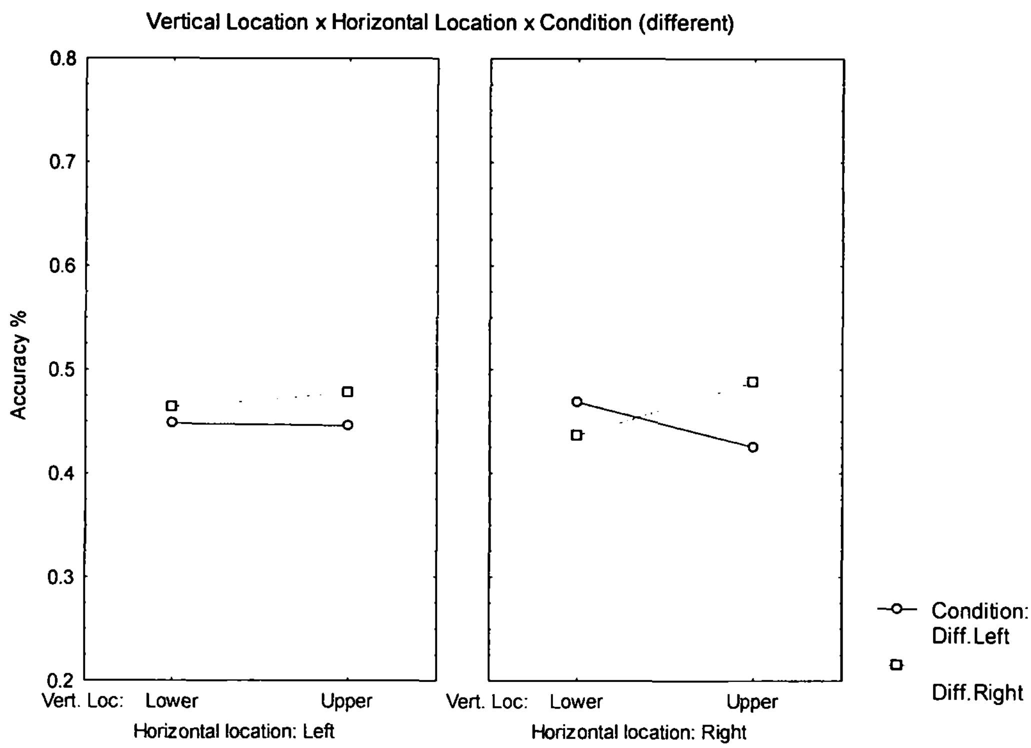


Figure 5.21 *Significant three-way interaction between Vertical location x Horizontal location x Condition in Experiment Ten (all factors- on the diagonals – different trials).*

Finally there was a significant four-way interaction between Located Object x Condition-different x Vertical location x Proximity $F(4,112) = 4.22$, $p<0.001$, MSE = 0.04 (Figure 5.22). This higher level interaction was investigated by further data splitting and pos-hoc analyses (reported further below) which determined that no support was gained for the experimental hypothesis

Located object situated on the lower half of screen:

When the located object was a bomb (Different Down M = 0.68, Different Up M =0.63), a rocket (Different Down M = 0.69, Different Up M = 0.60) or a cloud (Different Down M = 0.61, Different Up M = 0.59) and placed in the lower half of the screen at the *Near* proximity level, judgement accuracy was slightly higher for the Different Down condition than the Different Up condition.

When the located object was placed in the lower half of the screen at the *Medium* proximity level, there was very little discrepancy in the judgement accuracy between the Different Up and Down conditions (bomb: Different Down M = 0.36, Different Up M = 0.44; cloud: Different Down M = 0.37, Different Up M = 0.34; rocket: Different Down M = 0.42, Different Up M = 0.41).

Finally, when the located object was placed in the lower half of the screen at the *Far* proximity level, there was again only mild discrepancy in judgement accuracy between the Different Down and Different Up conditions (rocket: Different Down M = 0.33, Different Up M = 0.39; cloud: Different Down M = 0.31, Different Up M = 0.26; bomb: Different Down M = 0.34, Different Up M = 0.37) conditions.

Located object situated on the upper half of screen:

When the located object was placed in the upper half of the screen at the *Near* proximity level, there was mild discrepancy in the judgement accuracy between the Different

Down and Different Up conditions (bomb: Different Down M = 0.61, Different Up M =0.67; rocket: Different Down M = 0.66, Different Up M = 0.69; cloud: Different Down M = 0.68, Different Up M = 0.62).

When the located object was placed in the upper half of the screen at the *Medium* proximity level, there was a mild discrepancy in the judgement accuracy between the Different Down and different up conditions slightly in favour of up (bomb: Different Down M = 0.38, Different Up M = 0.42; cloud: Different Down M = 0.31, Different Up M = 0.38). The higher accuracy ratings favouring Different Up were even most visible when the located object was a rocket (Different Down M = 0.34, Different Up M = 0.52).

When the located object was placed in the upper half of the screen at the *Far* proximity level the overall accuracy levels were quite low. When the located object was either a Cloud (Different Down M = 0.32, Different Up M = 0.35), a Rocket (Different Down M = 0.33, Different Up M = 0.35) or bomb (Different Down M = 0.29, Different Up M = 0.35) there was again only mild differences between accuracy rates between the Different conditions.

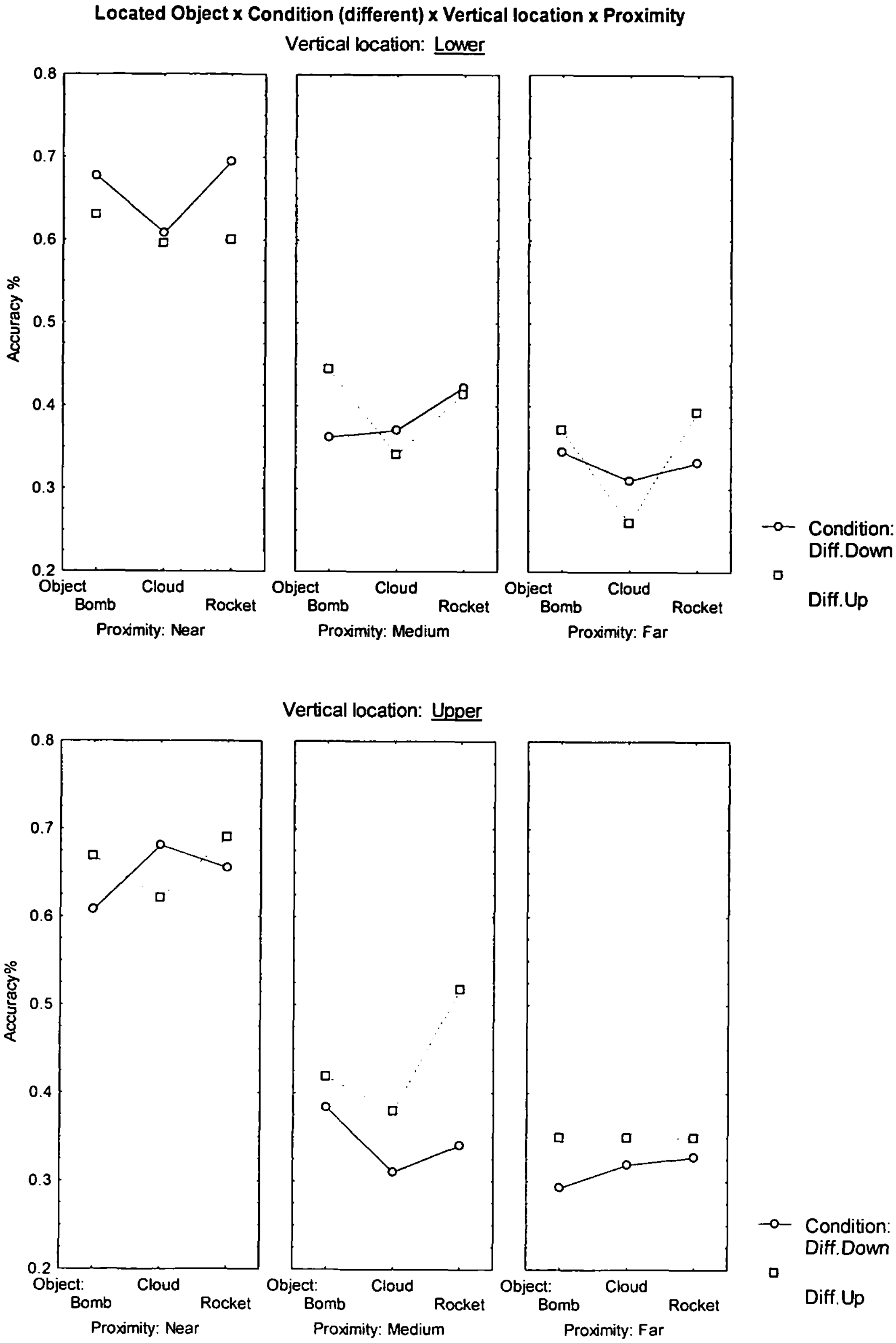


Figure 5.22 *Significant four-way interaction between Located Object x Condition-different x Vertical location x Proximity in Experiment Ten (all factors- on the diagonals – different trials).*

Follow-up analyses for proximity x located object x vertical location x condition:

Separate analyses of variance were conducted for each level of proximity as a follow-up investigation and only the *medium* level of proximity had a significant interaction between located object, different condition and vertical location, $F(2,56) = 3.78$, $p<0.05$, $MSE = 0.05$ (Figure 5.23). Whereas, the analyses of the *near* and *far* levels of proximity did not result in any significant interactions involving condition or located object.

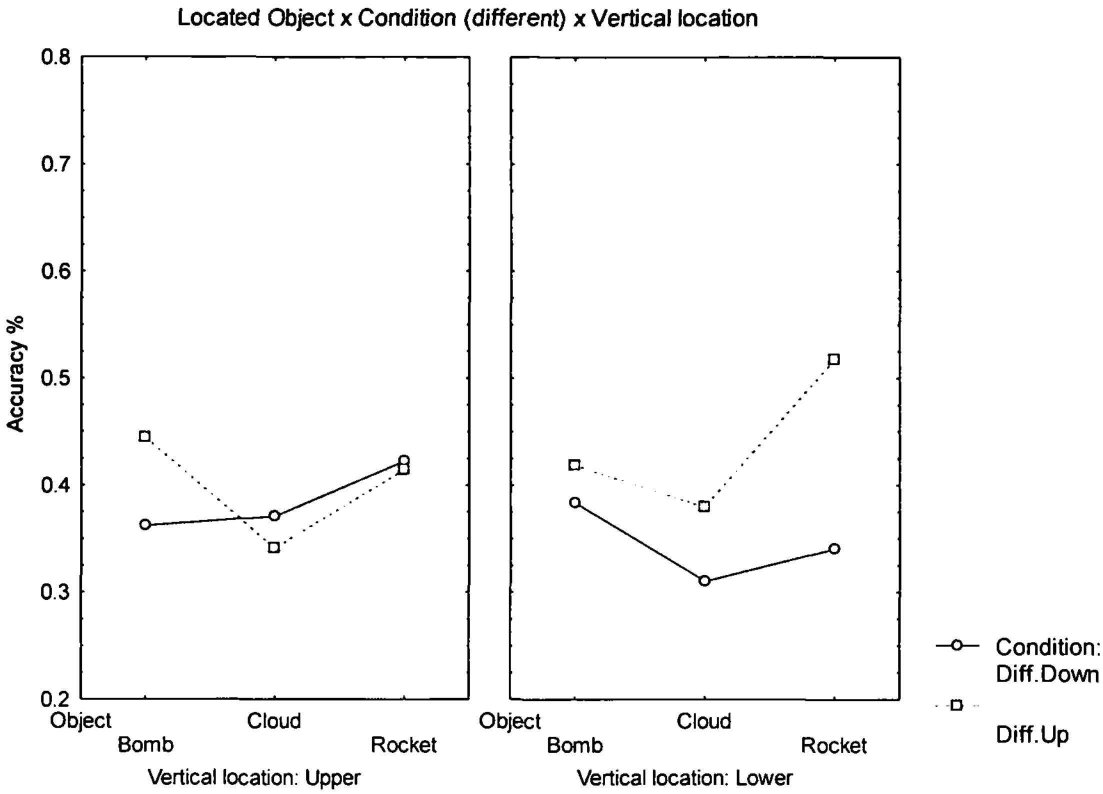


Figure 5.23 *Significant three-way interaction for a follow-up analysis between Located Object x Condition-different x Vertical location in Experiment Ten (Medium Proximity - on the diagonals – different trials).*

The data was split further by the vertical location condition and the scenes which involved the located object positioned on the lower part of the screen produced no significant effects whatsoever. Whereas, when the located object was positioned on the upper part of the screen there was a significant interaction between located object and condition, $F(2,56) = 3.79$, $p<0.05$, $MSE = 0.04$ (Figure 5.24). When the located object was either a bomb (diff.down M = 0.38; diff.up M = 0.42) or a cloud (diff.down M = 0.31; diff.up M = 0.38) both different conditions showed very similar levels of accuracy. Whereas, when the located object was a rocket the different down condition (M = 0.34) had significantly ($p<0.001$) lower accuracy levels than different up (M = 0.52). This goes completely against the hypothesis.

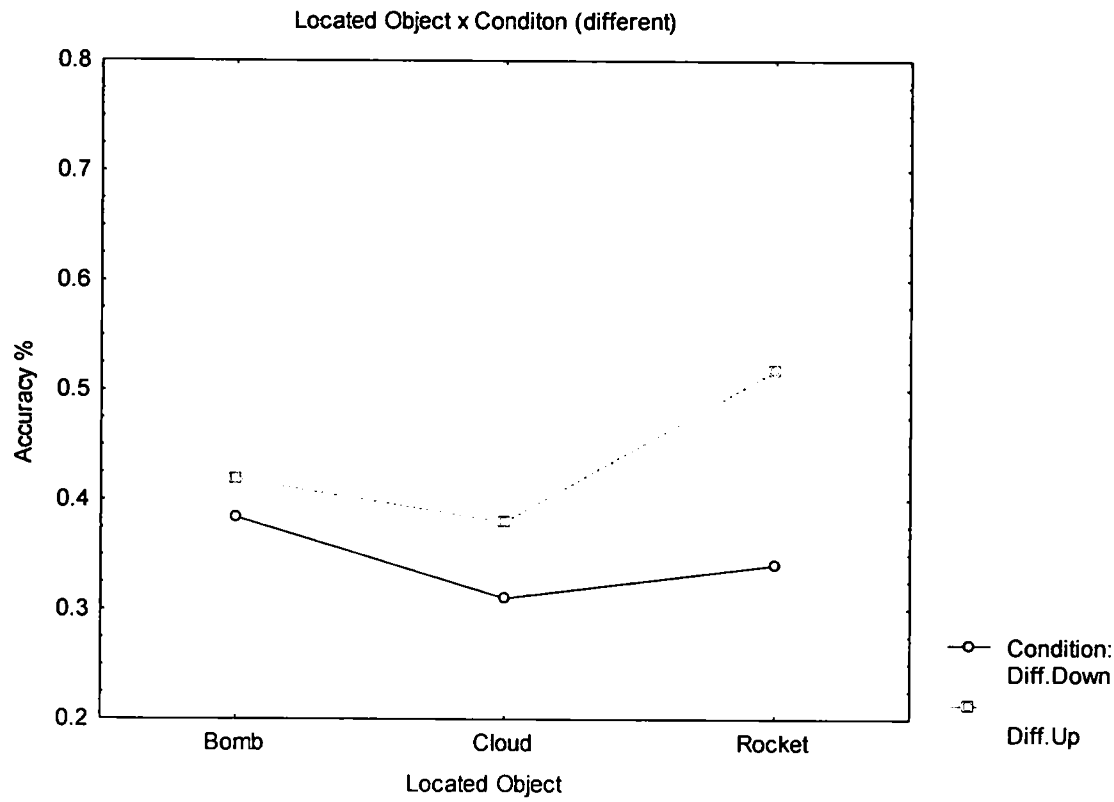


Figure 5.24 *Significant two-way interaction for a follow-up analysis between Located Object x Condition-different in Experiment Ten (Upper Vertical location - Medium Proximity - on the diagonals – different trials).*

5.1.5.2 <u>Diagonal axes – Same trials</u>

The results of the initial four-way ANOVA (located object x vertical location x horizontal location x proximity) of the diagonal grid locations for the same conditions is reported below preceded by the table of means (see Table 5.13) and full ANOVA table (see Table 5.14).

Table 5.13 *Means for each condition for the Diagonal axes – Same trials analysis for Experiment Ten*

Located Object	**Vertical Location**	**Horizontal Location**	**Proximity**	**accuracy Mean**
Bomb	Lower	Left	Near	0.78
			Medium	0.82
			Far	0.82
		Right	Near	0.80
			Medium	0.82
			Far	0.77
	Upper	Left	Near	0.84
			Medium	0.81
			Far	0.80
		Right	Near	0.82
			Medium	0.84
			Far	0.76
Cloud	Lower	Left	Near	0.85
			Medium	0.79
			Far	0.76
		Right	Near	0.85
			Medium	0.88
			Far	0.78
	Upper	Left	Near	0.79
			Medium	0.78
			Far	0.77
		Right	Near	0.81
			Medium	0.82
			Far	0.80
Rocket	Lower	Left	Near	0.72
			Medium	0.82
			Far	0.80
		Right	Near	0.84
			Medium	0.75
			Far	0.80
	Upper	Left	Near	0.76
			Medium	0.82
			Far	0.77
		Right	Near	0.82
			Medium	0.78
			Far	0.73

Table 5.14 *The results of the 4-way Anova for the Diagonal axes – Same trials analysis for Experiment Ten*

	MS (error)	F	Significance
Located Object (O)	0.04	1.52	ns
Vertical location (V)	0.04	0.61	ns
Horizontal location (H)	0.04	0.56	ns
Proximity (P)	0.05	1.88	ns
O x V	0.03	1.03	ns
O x H	0.02	2.76	ns
V x H	0.01	0.42	ns
O x P	0.02	0.56	ns
V x P	0.02	0.20	ns
H x P	0.02	1.84	ns
O x V x H	0.02	0.14	ns
O x V x P	0.03	1.25	ns
O x H x P	0.03	3.53	*
V x H x P	0.02	0.22	ns
O x V x H x P	0.03	0.42	ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

There were no significant main effects in the present analysis. However, there was a significant interaction between Horizontal location x Located Object x Proximity $F(4,112) = 3.54$, $p<0.05$, MSE = 0.03 (Figure 5.25). When the located object was situated on the left side of the screen the bomb scenes (near M = 0.81, medium M = 0.81, far M = 0.81) had the same accuracy levels regardless of the proximity. However, the cloud was judged only slightly more accurately when it was in the near (M = 0.82) rather than the medium (M = 0.78) or far (M = 0.76) conditions. Also, a slight variance of accuracy levels was visible for the rocket scenes in slight favour of the medium (M = 0.82) condition rather than the far (M =0.78) or near (M = 0.74) proximity.

When the located object was viewed on the right side of the screen the accuracy of judgement for the bomb scenes was very similar for the medium (M = 0.83) and near (M = 0.81) proximities and a little lower for the far (M = 0.76) condition. Also, the cloud scenes had similarly high levels of accuracy for the medium (M = 0.85) and near (M = 0.83) proximities and again slightly lower for the far (M = 0.79) condition. Finally, the rocket scenes displayed the highest level of judgement accuracy for the near (M = 0.83) scenes rather than the medium (M = 0.76) and far (M = 0.76) scenes which were at a similar lower level.

A follow-up separate analysis of variance was carried out on the different levels of proximity. The indications were that the interactions were only significant between the horizontal location and located object at the *near* ($\underline{F}(2,56) = 4.18$, $p<0.05$, MSE = 0.02) and *medium* ($\underline{F}(2,56) = 5.41$, $p<0.05$, MSE = 0.02) proximity levels.

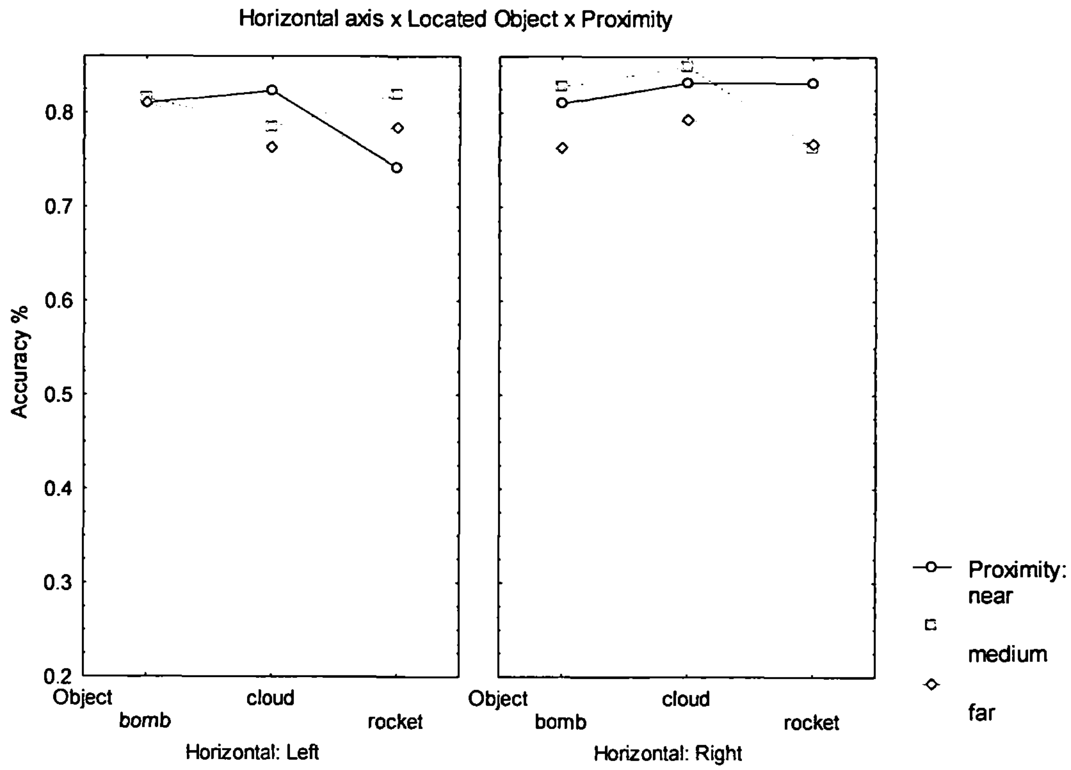


Figure 5.25 *Significant three-way interaction between Horizontal location x Located Object x Proximity in Experiment Ten (all factors – on the diagonals – same trials).*

5.1.5.3 <u>Cardinal axes – Different trials</u>

The results of the initial four-way ANOVA (located object x condition (different) x axis x proximity) of 'on the axes' (see Figure 5.26) grid locations for the 'different' conditions is reported below preceded by the table of means (see Table 5.15) and full ANOVA table (see Table 5.16).

Upper Axis

	1	2	3	4 *(far)*	5	6	7	
	8	9	10	11 *(medium)*	12	13	14	
	15	16	17	18 *(near)*	19	20	21	
Left axis	22 *(far)*	23 *(medium)*	24 *(near)*	X	26 *(near)*	27 *(medium)*	28 *(far)*	Right Axis
	29	30	31	32 *(near)*	33	34	35	
	36	37	38	39 *(medium)*	40	41	42	
	43	44	45	46 *(far)*	47	48	49	

Lower Axis

Figure 5.26 A diagram of the *cardinal* axes trials with proximity division illustrated.

Table 5.15 *Means for each condition for the Cardinal axes – Different trials analysis for Experiment Ten*

Located Object	Condition	Axis	Proximity	accuracy mean
Bomb	Different down	Lower	Far	0.46
			Medium	0.60
			Near	0.78
		Left	Far	0.43
			Medium	0.38
			Near	0.47
		Right	Far	0.41
			Medium	0.46

			Near	0.47
		Upper	Far	0.50
			Medium	0.68
			Near	0.91
	Different up	Lower	Far	0.52
			Medium	0.72
			Near	0.83
		Left	Far	0.43
			Medium	0.36
			Near	0.36
		Right	Far	0.42
			Medium	0.40
			Near	0.41
		Upper	Far	0.47
			Medium	0.55
			Near	0.80
Cloud	Different down	Lower	Far	0.36
			Medium	0.59
			Near	0.75
		Left	Far	0.38
			Medium	0.40
			Near	0.40
		Right	Far	0.42
			Medium	0.37
			Near	0.44
		Upper	Far	0.48
			Medium	0.60
			Near	0.86
	Different up	Lower	Far	0.52
			Medium	0.59
			Near	0.89
		Left	Far	0.42
			Medium	0.41
			Near	0.42
		Right	Far	0.36
			Medium	0.43
			Near	0.43
		Upper	Far	0.48
			Medium	0.63
			Near	0.80
Rocket	Different down	Lower	Far	0.41
			Medium	0.57
			Near	0.77
		Left	Far	0.47
			Medium	0.41

		Near	0.51
	Right	Far	0.39
		Medium	0.34
		Near	0.43
	Upper	Far	0.53
		Medium	0.66
		Near	0.84
Different up	Lower	Far	0.57
		Medium	0.78
		Near	0.90
	Left	Far	0.48
		Medium	0.41
		Near	0.39
	Right	Far	0.35
		Medium	0.47
		Near	0.44
	Upper	Far	0.47
		Medium	0.63
		Near	0.86

Table 5.16 *The results of the 4-way Anova for the Cardinal axes – Different trials analysis for Experiment Ten*

	MS (error)	F	Significance
Located Object (O)	0.04	2.90	ns
Condition-different (C)	0.04	2.53	ns
Axis (A)	0.71	13.50	***
Proximity (P)	0.11	52.28	***
O x C	0.03	4.86	*
O x A	0.04	1.00	ns
C x A	0.07	8.64	***
O x P	0.05	0.21	ns
C x P	0.03	1.75	ns
A x P	0.05	31.62	***
O x C x A	0.04	1.10	ns
O x C x P	0.04	1.18	ns
O x A x P	0.04	0.49	ns
C x A x P	0.05	0.61	ns
O x C x A x P	0.04	1.41	ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

The significant main effect of Axis was present $F(2,56) = 4.18$, $p<0.05$, MSE = 0.02, in which the upper (M = 0.66) and lower (M = 0.65)axes were higher in accuracy levels than the left (M = 0.42) and right (M = 0.41) axes. There was also a main effect of Proximity F(2,56) = 4.18, p<0.05, MSE = 0.02, in which the closer the proximity (near M = 0.63, medium M = 0.52, far M = 0.45) the higher the accuracy levels became.

A two-way interaction between Located Object x Condition (different), F(2,56)=4.86; p<.05, was also present (Figure 5.27). When the located object was a Bomb there was a small bias for higher accuracy in the Different Down (M = 0.54) rather than the Different Up (M = 0.52) scenes. However, this subtle pattern was the opposite for the trials displaying either a Cloud (Diff. Up M = 0.53, Diff. Down M = 0.51) or a rocket (Diff. Up M = 0.56, Diff. Down M = 0.53) in that both had slightly higher accuracy for the Different Up rather than Different down scenes.

In other words, detectability rates were affected by the actual expected motion, rather than going against the expected motion which is directly in conflict with the experimental hypothesis. However, after conducting a Tukey (HSD) follow-up analysis it was discovered that none of these contrasts were significant.

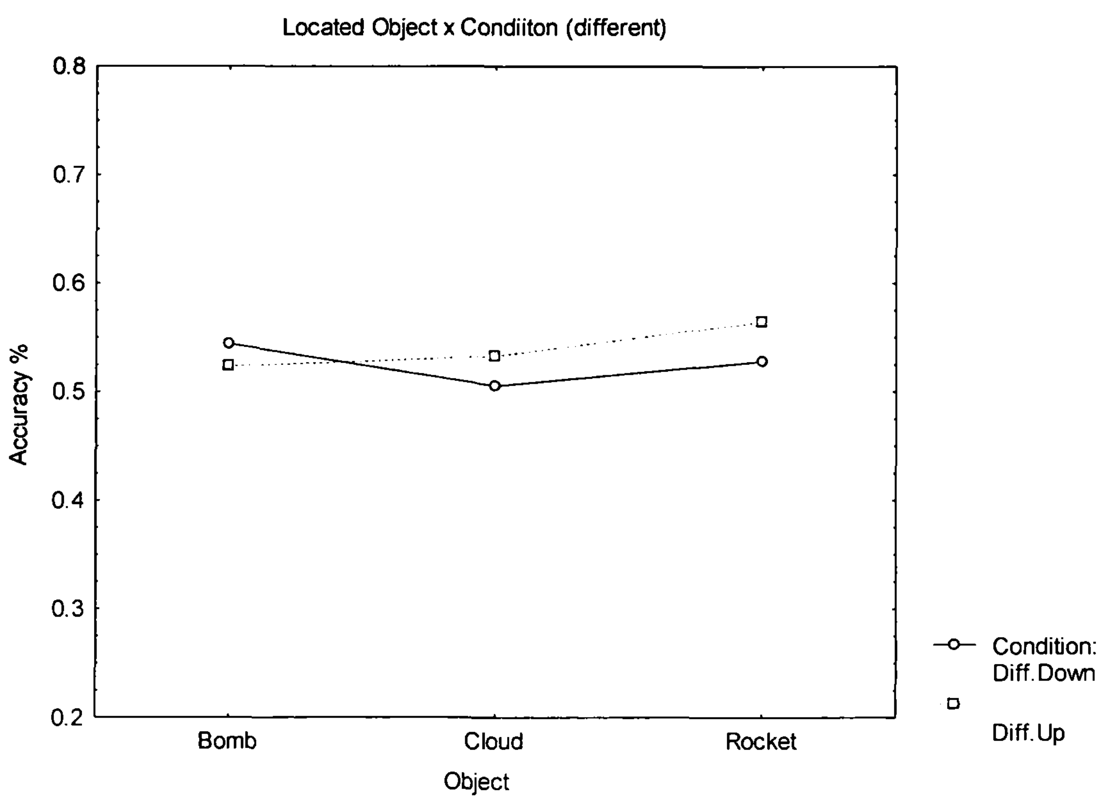


Figure 5.27 *Significant two-way interaction between Located Object x Condition in Experiment Ten (All proximity – on the cardinal axes – different trials).*

There was also a significant two-way interaction between Conditon (different) x Axis, $F(3,84)=8.64$; $p<.001$ (Figure 5.28). When the Located object was situated on either the Left (Diff. Down M = 0.43, Diff. Up M = 0.41) or Right (Diff. Down M = 0.41, Diff. Up M = 0.41) axis the accuracy levels were at similarly low rates for both Different Down and Different Up conditions. However, for the scenes in which the located object was positioned on the Upper Axis, Different Down (M = 0.68) scenes were detected more accurately than Different Up (M = 0.63) scenes. This pattern was the opposite when the located object was situated on the Lower axis, in that Different Up (M = 0.70) scenes had higher detection rates than Different Down (M = 0.59) scenes.

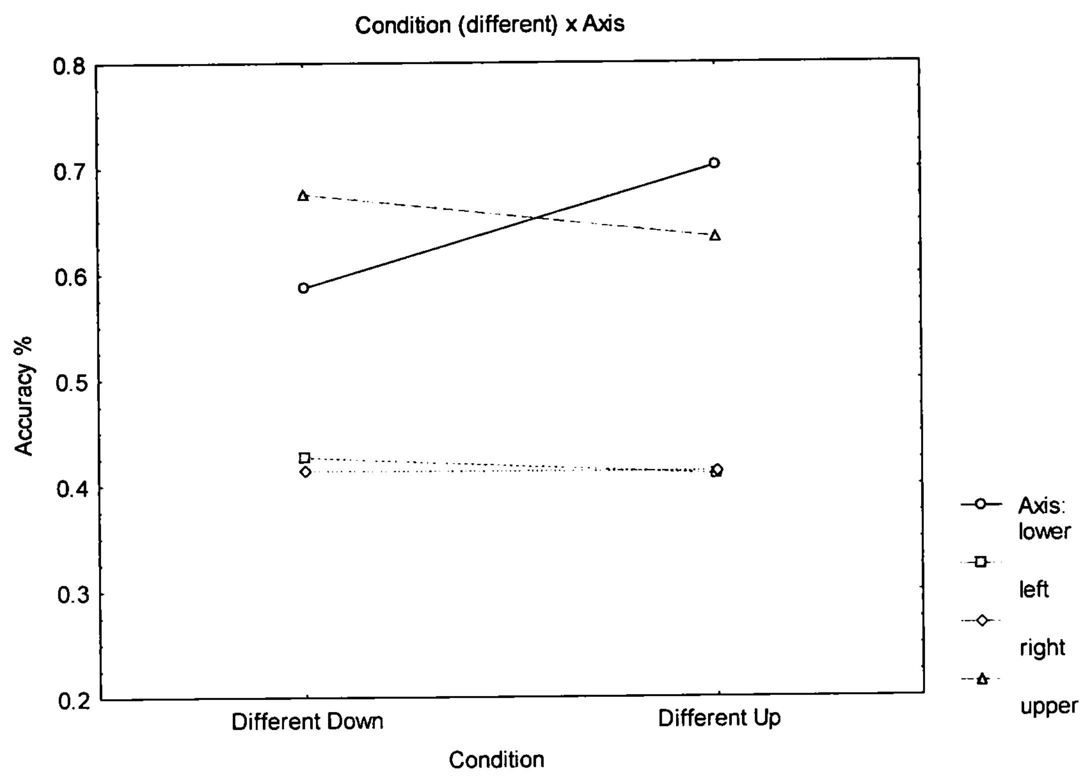


Figure 5.28 *Significant two-way interaction between Conditon x Axis in Experiment Ten (All proximity – on the cardinal axes – different trials).*

Finally, there was a significant two-way interaction between Proximity x Axis, $F(6,168)=31.62$; $p<.001$ (Figure 5.29). The trials in which the located object was situated on either the Left (Far M = 0.44, Medium M = 0.40, Near M = 0.42) or Right (Far M = 0.39, Medium M = 0.41, Near M = 0.43) axes produced very little discrimination of accuracy at any of the Proximity levels, whereas, when the located object was positioned on either the Lower (Far M = 0.47, Medium M = 0.65, Near M = 0.82) or Upper (Far M = 0.49, Medium M = 0.63, Near M = 0.85) axes detection rates increased as Proximity did. A separate analysis of variance was carried out for each proximity level, and it was indeed found that the difference in detection accuracy differed significantly ($p<.01$) between the different axis locations only for the *medium* and *near* proximity levels.

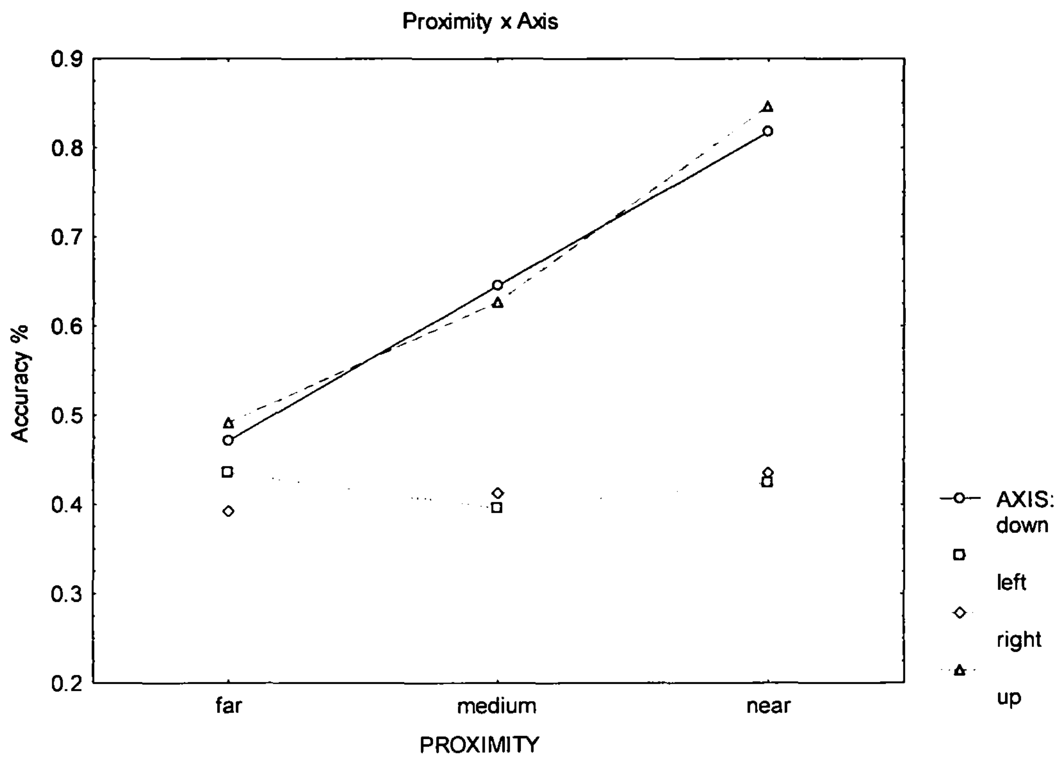


Figure 5.29 *Significant two-way interaction between Proximity x Axis in Experiment Ten (All proximity – on the cardinal axes – different trials).*

5.1.5.4 Cardinal axes – Same trials

The results of the three-way ANOVA (located object x axis x proximity) of the cardinal axis grid locations for the *same* conditions found no significant interactions or main-effects. The table of means (see Table 5.17) and full ANOVA table (see Table 5.18) are reported below.

Table 5.17 *Means for each condition for the Cardinal axes – Same trials analysis for Experiment Ten*

Located Object	Axis	Proximity	accuracy Mean
Bomb	Lower	Near	0.78
		Medium	0.74
		Far	0.78
	Left	Near	0.75
		Medium	0.80
		Far	0.84
	Right	Near	0.79
		Medium	0.87
		Far	0.79
	Upper	Near	0.80
		Medium	0.81
		Far	0.79
Cloud	Lower	Near	0.79
		Medium	0.81
		Far	0.75
	Left	Near	0.80
		Medium	0.78
		Far	0.85
	Right	Near	0.85
		Medium	0.83
		Far	0.86
	Upper	Near	0.78
		Medium	0.79
		Far	0.81
Rocket	Lower	Near	0.84
		Medium	0.81
		Far	0.80
	Left	Near	0.78
		Medium	0.87
		Far	0.77
	Right	Near	0.82
		Medium	0.83

	Far	0.78
Upper	Near	0.84
	Medium	0.81
	Far	0.81

Table 5.18 *The results of the 3-way Anova for the Cardinal axes –Same trials analysis for Experiment Ten*

	MS (error)	F	Significance
Object (O)	0.04	0.85	ns
Axis (A)	0.03	1.79	ns
Proximity (P)	0.05	0.21	ns
O x A	0.03	1.18	ns
O x P	0.04	0.99	ns
A x P	0.03	0.81	ns
O x A x P	0.03	1.16	ns

Note: p>0.05: ns, p<0.05: *, p<0.01: **, p<0.001: ***

5.1.5.5 **Additional analysis of Results** for Experiment Ten

Again, the second prediction for the current series of experiments was looked further into with an additional analysis. The hypothesis stated that when the located objects are positioned off the axes of the reference object then there would be higher detection accuracy of different trials in which the shift is towards the diagonal axis rather than away from it (Crawford et al., 2000). Therefore, another analysis of variance was carried out with the chosen alpha level at 0.05, however a different strategy was used for the selection of analysed data points. This time the *different* trial scenes containing only the locations on either side of the diagonal axes, and furthest away from the cardinal axes were only included for inspection (see Figure 5.30). The locations were also further collapsed resulting in only three factors: Object (cloud/bomb/rocket) x Vertical movement (different down/different up) x Diagonal movement (away/towards diagonal). Vertical movement in this instance means shifts of position either upwards or downwards, whereas diagonal movement distinguishes between movement which is either towards or away from the diagonal axes (Figure 5.30). This analysis aimed to investigate whether Crawford and colleagues' (2000) claims that the cardinal axes were non-verbal spatial category boundaries, and the category prototypical region might be along the diagonal axes instead.

1	2 ↓DT ↑UA	3	4	5	6 ↓DT ↑UA	7
8 ↓DA ↑UT	9	10	11	12	13	14 ↓DA ↑UT
15	16	17	18	19	20	21
22	23	24		26	27	28
29	30	31	32	33	34	35
36 ↓DT ↑UA	37	38	39	40	41	42 ↓DT ↑UA
43	44 ↓DA ↑UT	45	46	47	48 ↓DA ↑UT	49

Key: DA = left away (from diagonal axis); DT = left towards (diagonal axis); UA = right away (from diagonal axis); UT = right towards (diagonal axis)

Figure 5.30 A diagram of the data points (depicted in red) on either side of the diagonal axes (depicted in green) that were analysed for the current investigation.

Results

The results of the initial three-way ANOVA Object (cloud/bomb/rocket) x Vertical movement (different down/different up) x Diagonal movement (away/towards diagonal) of the additional diagonal analysis are reported below preceded by the table of means (see Table 5.19) and full ANOVA table (see Table 5.20).

Table 5.19 *Means for each condition for the Additional analysis for Experiment Ten*

Located Object	Vertical Movement	Diagonal Movement	accuracy mean
Bomb	Diff. down	away from diag.	0.32
		towards diag.	0.36
	Diff. up	away from diag.	0.36
		towards diag.	0.40
Cloud	Diff. down	away from diag.	0.27
		towards diag.	0.34
	Diff. up	away from diag.	0.36
		towards diag.	0.34
Rocket	Diff. down	away from diag.	0.33
		towards diag.	0.40
	Diff. up	away from diag.	0.38
		towards diag.	0.39

Table 5.20 *The results of the 3-way Anova for the Additional analysis for Experiment Ten*

	MS (error)	F Value	Significance
Object (O)	0.02	3.92	*
Vertical Movement (V)	0.02	7.24	*
Diagonal Movement (D)	0.01	9.71	**
O x V	0.01	0.42	0.66
O x D	0.01	0.42	0.66
V x D	0.01	6.00	*
O x V x D	0.01	1.34	0.27

Note: p>0.05: ns, p<0.05: *, p<0.01: **, p<0.001: ***

A significant main-effect of Object was present, $F(2,56)=3.92$; $p<.05$. Both scenes with a Bomb (M = 0.36) or a Rocket (M = 0.38) had highest judgment accuracy rates. Whereas, the Cloud (M = 0.33) scenes involving a shift of relative position seemed not to be as easy to perceive accurately. This lends support to the hypothesis that a cloud would have lowest rates of detection for movement because people may expect it to be relatively stable.

There was also a significant main-effect of Vertical movement, $F(1,28)=7.24$; $p<.05$. Higher accuracy of judgment for the vertical Upwards movement (M = 0.37) than the Downwards movement (M = 0.34) suggests that people were more likely to perceive a relative shift of position when it was against gravity.

Additionally, there was a significant effect of Diagonal movement, $F(1,28)=9.71$; $p<.01$. Higher accuracy of judgment for the Towards the Diagonal movement (M = 0.37) than the Away from the Diagonal movement (M = 0.34) suggests that people were more likely to perceive a relative shift of position when it involved migrating towards the diagonal axes.

Finally, There was one significant interaction between Vertical movement x Diagonal movement, $F(1,28)=6.00$; $p<.05$ (Figure 5.31). The scenes depicting Upwards movement of the located object in relation to the reference, produced similar accuracy rates regardless of whether that movement was also Away from (M = 0.37) or Towards (M = 0.38) the Diagonal axes. However, when the movement of the scenes involved Downward relative movement of the located object and Towards the Diagonal axes (M = 0.37), detection accuracy was higher than when the movement was Downwards and Away from the Diagonal axes (M = 0.31).

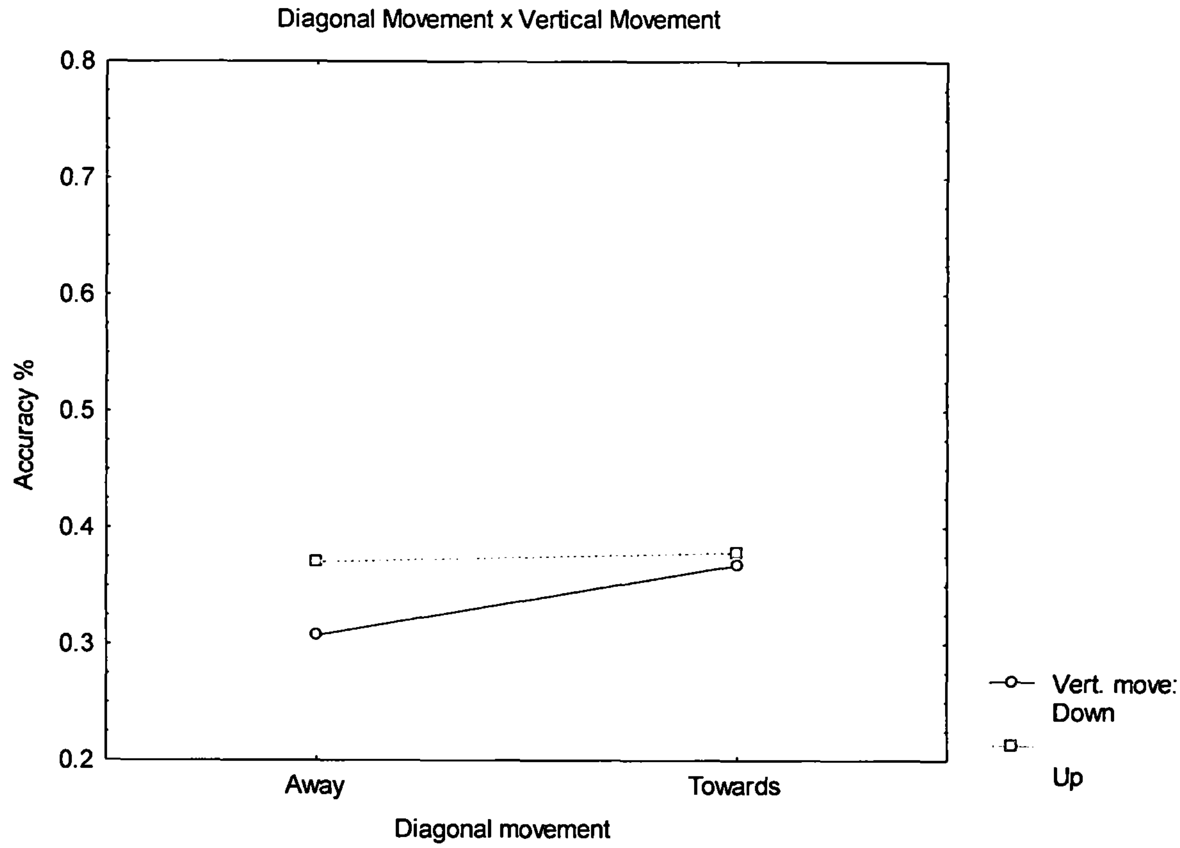


Figure 5.31 The significant interaction between Diagonal movement x Vertical movement for Experiment Ten.

5.1.6 Experiment Ten Conclusion

This series of analyses offer only little support for the experimental hypotheses. Neither the diagonal axes different trial analyses nor the cardinal axes different trial analyses resulted in producing data to support the prediction that higher detection rates would prevail when the scenes involved displacement of objects against the direction of expected motion. However, the cardinal axes different trial analyses produced a two-way interaction between Located Object x Condition-different in which detectability rates were slightly higher when the located object was displaced *in the direction* of expected motion instead of against it. This would suggest effects directly against the predictions of this study, however the results were not found to be significant after a post-hoc analysis.

The additional analyses of the strategic data points on either side of the diagonal axes and also the initial diagonal axes analysis did show general support for the prediction that people would be less likely to perceive movement in scenes involving a cloud because it is a relatively static object in contrast to the bomb and rocket. The additional data point analyses also indicated that there was also a main effect of vertical movement, which suggests that there was a general tendency for people to detect upwards movement rather than downwards movement. This may relate that when a shift of position is directly against gravity, people are likely to detect this regardless of what the object is. Also a main effect of diagonal movement revealed that when the object is located off of the cardinal axes people were more likely to perceive a shift in position when the direction was towards the diagonal axis rather than away from it. This provides support for Crawford and colleagues' (2000) claims that the non-verbal prototypical region might be along the diagonal axes instead of the cardinal axes.

5.1.7 General discussion for non-verbal experiments

This section of the thesis investigated whether extra-geometric factors influence memory for spatial object relationships as well as spatial language comprehension. Therefore, the type of object manipulated in Experiment Nine of this section included potentially horizontally mobile located objects (bird with beak pointing to the left or right), whereas Experiment Ten included potentially vertically mobile located objects (bomb or rocket), and both types of objects were contrasted with a relatively static object (cloud). This enabled an inspection of whether knowledge about dynamic-kinematic routines might influence non-verbal spatial memory for object location. The prediction was that people would be more accurate in detecting shifts of relative object relations when that shift is against the direction of expected motion of the object.

The experimental hypothesis about the influence of knowledge of dynamic-kinematic routines, gained only tentative support from the data points that were analysed directly on the diagonal axes in Experiment Nine but not in Experiment Ten. This indicated that detection rates were indeed higher when the direction of location shift was against the direction of expected object movement. In other words, scenes in which a bird was viewed pointing to the left positioned relative to a central reference object (cloud), were more likely to result in accurate detection of a shift in position if that shift was against the potential direction of motion i.e. to the right. Furthermore, this was the opposite for the scenes displaying a bird pointing to the right i.e. higher detection rates were found when the shift in location was to the left. This effect was also only prevalent on the diagonal axes and at the near proximity level. However, neither of the analyses from either Experiment Nine or Ten of the cardinal axes produced any clear effects of object knowledge.

It should also be noted that this type of object knowledge effect was only found for scenes which displayed objects potentially mobile along the horizontal axis rather than the vertical axis. It may be that when the experiment involved potentially vertically mobile objects, knowledge people have about gravitational forces overrides the influence of the knowledge for objects to potentially move independently of this. For instance, in Experiment Ten there were indications from the additional strategic data-point analyses, that there was a general tendency for participants to be more accurate in detecting upwards movement rather than downwards movement regardless of the type of located object that was viewed. Hence, whether the scenes involved a rocket or a bomb, it was more likely for people to notice a shift of position when it was against gravity even though the rocket was displaying an object that was potentially upwardly mobile.

Furthermore, in support of the object knowledge hypothesis there were some indications in both Experiments Nine and Ten that when the located object was a cloud, which is relatively static in contrast to the birds, bomb or rocket, the detection rates for shifts in relative location were less accurate. This may result from people being less likely to notice motion or shifts in position, because they were not as likely to be expecting vertical or horizontal movement from a cloud.

The second prediction for this series of experiments was that when a located object is positioned off the axes of the reference object, people would be more likely to notice a shift in position when it is towards the diagonal axis rather than away from it. The only support for this hypothesis was gained from the additional analyses of strategic data points in Experiment Ten but not Nine. Therefore, it would seem that there is only some support gained for Crawford and colleague's suggestion (2000) that the prototypical region of non-linguistic space is along the diagonal axes rather than the cardinal axes of the reference object. Experiment Ten involving vertical movement, indicated that when the shifts in position were towards the diagonal axis AND involved vertical axis movement (upwards/downwards), detection accuracy was higher. This was not, however found to be the case when the shifts in position were towards the diagonal and involved horizontal movement (left/right).

In conclusion it is difficult to say whether the suggestion that the non-linguistic prototypical region is centred on the diagonal axes rather than the cardinal axes, is in fact the case. Also in line with this claim, the cardinal axes are instead supposedly prototypical boundaries (Crawford et al., 2000). People do seem to categorise non-verbal space along the diagonal axes but only in some circumstances i.e. when the located object is not positioned along the cardinal axes, and even then in restricted circumstances. Furthermore, it is important to notice that throughout this non-verbal section the accuracy levels for detection of motion have generally been highest when the objects were positioned along the cardinal axes rather than the diagonal axes (see means tables for cardinal axis and diagonal axis analyses in Experiments Nine and Ten). Finally, the indications for the influences of object knowledge (dynamic-kinematic routines) in the non-verbal spatial arena are only apparent in very specific circumstances where there is no conflict between the knowledge of potential object motion and the pull of gravity on that object. In other words, understanding of Newtonian forces may influence memory more than the knowledge for an object to potentially move against it (i.e. rocket flying upwards against gravity). Therefore, people are more likely to not generally expect upwards movement and therefore are more likely to perceive it. The only prediction relating to object knowledge that received support in both Experiments Nine and Ten was that the cloud, which is often considered more static than a bird, rocket or bomb, would have lower accuracy rates for detection of movement.

Chapter Six

6.0 General Discussion

This thesis endeavours to outline some of the factors which affect production and comprehension of spatial language across English, Finnish and Spanish, and also look into what influences non-verbal spatial categorisation. We set out to answer two research questions which were: 1) '*To what extent are the different factors influencing spatial language, the same cross-linguistically?*'; and 2) '*Do extra-geometric factors only influence spatial language, or do they also affect memory for spatial object relationships?*'. This chapter will return to each question in turn, reviewing the main findings across the thesis.

6.1 The First Question

The first question of this thesis was: 1) *To what extent are the different factors influencing spatial language, the same cross-linguistically?* To recap, Chapters Two - Five looked into the issue of whether variables in the FGF operate across a range of languages, and not just English. A limitation with the FGF to date is that almost all the empirical work has been based on a single language - English. This was addressed by conducting a series of cross-linguistic experiments which examined different geometric and extra-geometric factors effecting three different categories of spatial terms: a) Chapter Two addressed topological terms such as *in/on* (and the Finnish and Spanish counterparts); b) Chapter Three addressed vertical axis projective terms such as *above/below* and *over/under* (and the Finnish and Spanish counterparts); c) Chapter Four examined horizontal axis projective terms such as *in front of/behind* (and the Finnish and Spanish counterparts). The intention was to identify differences and similarities in the geometric and extra-geometric factors that underlie our verbal conceptualisation of space across the chosen language groups. The results across languages are first overviewed below according to lexical category division, and similarities and differences in how extra-geometric variables effect spatial terms are discussed.

6.1.1 Topological terms

The Topological section of this thesis examined how object knowledge and how the dynamic-kinematic routine of location control contributed to the language people felt was appropriate for describing different spatial scenarios involving containment (English *in*, Finnish *–ssa*, Spanish *en*) and support (English *on*, Finnish *–lla*, Spanish *en*). The results indicated that the types of objects that were displayed in a scene affected how people chose to describe that spatial relationship. When an object was labelled a *plate* (and also looked like one) it prompted people to prefer the ad-position *on* and *–lla* its Finnish counterpart. In contrast, scenes which displayed an object called a *bowl* were considered to be most appropriately described by *in* and *–ssa* its Finnish counterpart. Furthermore, one study revealed that even when the reference object representing support/containment was labelled a dish which is a super-ordinate of both plate and bowl, or when it was indeed a hand, just manipulating the levels of concavity influenced the language used to describe the scenes. The results showed that when the reference object was least concave it was considered most appropriately described using the support term *on* and Finnish *–lla*, whereas when the reference object was most concave *in* and Finnish *-ssa*, the terms for containment, were the utterance of choice. Furthermore, while the direction of the effect of concavity was similar for both English and Finnish there was a cross-linguistic difference in lexical sensitivity as only the English group produced discrimination at a significant level. Spanish only has the ad-position *en* (*in/on*) to lexicalise support and containment relationships and therefore displayed equally high appropriateness ratings when describing scenes displaying the reference object at any of the three levels of concavity. Generally it would seem that object knowledge plays an important part influencing the language that is chosen for describing scenes and this is visible for both the Finnish and English languages.

The dynamic-kinematic routine of location control which the reference object exerts over the located object has been identified as a factor not influencing topological term production and comprehension quite as expected across the three languages. We manipulated location control in four different ways across language groups. In one experiment the located object and the reference object animacy was controlled so that they could either be potentially mobile or not. The assumption was that the reference object would not be able to exert as much control over the potentially mobile located object (fly), than it would over an inanimate located object (coin) and this would lead to the reduction of perceived appropriateness of *in* and the Finnish (*-ssa*) and Spanish (*en*) counterparts. This effect pattern was indeed only found for the English language group and even then not at quite a significant level. This does not really support Feist's research findings. Additionally, this sensitivity to differentiate between potentially animate and static scenes was not found for the Finnish or Spanish containment terms. Furthermore, the manipulation of reference object animacy (hand/ dish) did not reveal effects of distinction between potentially animate or static scenes for the containment terms across any of the three languages. These results only found a suggestion of a pattern supporting Feist's (2000) findings, which indicates that the discrimination between potentially mobile and inanimate objects by the containment term *in* is rather fragile. Additionally, it would certainly seem that both the Finnish and Spanish languages do not portray this type of sensitivity at all in their topological lexicon.

The final two ways in which location control was manipulated were by adding a source of external control to the scenes, and also by tilting the container which held the located object. The idea was that an external source of control (a string) would create a conflict with the location control the reference object had over the located object and therefore reduce the appropriateness of the topological terms in English, Finnish and Spanish. The indications were that only the Finnish, English and Spanish containment terms *(-ssa, in* and *en)* were effected detrimentally by the addition of external control in the scenes, while support terms *(-lla* and *on)* did not show such sensitivity. However, even though the pattern for the effects of external control on the containment were as predicted, the discrepancies were not quite significant. The final way of compromising location control was by tilting the reference object (bowl or plate) in which the located object was positioned, and it was found that tilting a reference object only produced differentiation amongst spatial terms when the located object was additionally placed at the highest level above the rim of the reference object. Furthermore, once again the support terms did not show such sensitivity, and only the English and Finnish containment terms displayed the predicted pattern (although not at significant levels); this was not mirrored for Spanish. The different results across these two types of location control manipulation show a general tendency for containment terms to be slightly more sensitive to compromises of the control which is exerted over the located object by the reference object, whereas support terms are not as easily effected. However this does not provide even partial support for Garrod and colleague's (1999) findings as the patterns were not displaying significant levels of distinction. The lack of any expected effects for support terms was in conflict with findings from another study run by Garrod et al. (1999), which had revealed that when an alternative means of support such as a chain or string was attached to the located object, there was a reduction for the confidence in *on* descriptions given to spatial scenes regardless of maintaining the same geometric relationship.

6.1.2 Vertical axis projective terms

The Vertical projective (also called superior/inferior terms) section of this thesis examined how the interplay between function and geometry affected the language which people used for describing spatial relationships along the vertical axis. The terms that were of interest in this section were: *above/below* and *over/under* and their Finnish (*yläpuolella/ alapuolella* and *yllä/alla* respectively) and Spanish (*encima/ debajo* and *sobre/bajo* respectively) counterparts. Two of the experiments revealed that *above/below* and *yläpuolella/ alapuolella* (the Finnish equivalents) were more sensitive to geometric manipulation, whereas in line with expectations the Spanish terms *encima/ debajo* (the Spanish equivalents) did not show a distinction between different levels of geometry. These results provided cross-linguistic support for the claims of Coventry and colleagues (2001).

The functional relationship between two objects has also been shown to have an influence on how we describe a spatial scene. Indeed one of the experiments described in the Topological chapter indicated that *over/under* were the terms of choice when describing a scene in which an umbrella (located object) was fulfilling its functional purpose of protecting a man from rain. This result was not, however evident for the Spanish or Finnish analyses, which does not agree with the results of work carried out by Coventry and Guijarro-Fuentes for Spanish. This may suggest that these languages are not as prone to discriminating between functional and non-functional scenes. Another study which involved varying a functional relationship with a located object (toothpaste/paint) and toothbrush by manipulating object association did not result in any support for the hypothesis. These results were not in line with Carlson-Radvansky and colleagues' (1999) research. Another experiment comparing scenes in which a glass of wine was displayed either fulfilling its function of containing wine or not, did however reveal that not only *over/under* but also the Finnish equivalents *yllä/alla* showed the expected pattern of functional sensitivity, although this pattern was not quite significant. The Spanish section of the topological studies did not show any clear effect of functionality even though according to Coventry et al. (2001) this might have been expected. The uncovered similarities and differences which languages displayed in relation to functional sensitivity amongst vertical axis projective terms may suggest that different types of functional relationships may be more or less salient for each particular language, and therefore the degree to which the production and comprehension of spatial language is influenced by functional relations varies somewhat cross-linguistically.

6.1.3 Horizontal axis projective terms

The Horizontal projective section of this thesis included experiments in which the functional relationship between objects was manipulated by either facilitating or inhibiting functional interaction between the reference object and located object. This was achieved by examining how several factors such as orientation, object association, obstruction, and proximity influenced the functional relationship, and as a result the language that was used to describe a spatial scene. The horizontal projective terms of interest were *in front of, to the left of* and *at*, and the Spanish equivalents; *delante, izquierda,* and *en*. However, the Finnish study differed slightly as there were more lexical items available, including two in front of terms: *edessä /edellä* and *äärellä* (*at* equivalent). The general prediction was that when a functional relationship was enabled this would prompt the adoption of the intrinsic reference frame and therefore result in people rating *in front of* and the Spanish (*delante)* and Finnish (*edessä)* equivalents as the preferred descriptors. In contrast, it was hypothesised that when a functional relationship was disabled this would prompt the instantiation of the relative reference frame and therefore result in people rating *to the left of* and the Spanish equivalent (*izquierda*) as most appropriate to describe the spatial relationship.

The manipulation of orientation revealed that both the English and Spanish groups rated *in front of* and *delante* (instantiation of the intrinsic frame of reference) highest when the interaction between objects was enabled by orienting them facing one another, whereas the Finnish terms did not exhibit such a difference (this was for both the postman and artist experiments). Furthermore, the prediction that disabling functional interaction by facing the located object away from the reference object would result in the adoption of the relative frame of reference (*to the left of: izquierda*) more often, found only mild support from the Spanish analyses of the artist and postman experiments, although not statistically significant. The same pattern for the preferred adoption of the intrinsic frame of reference was also present for the English analysis of the postman experiment, but this was again not significant. However, as expected both the postman and artist experiments indicated that the other Finnish term *edellä* (in front of) was the preferred descriptor in scenes where the orientation was such that the objects might be following one another in order. These results provide some support for Richards' (2001) findings about the influence of orientation on reference frame selection, and indicates that Spanish behaves similarly to English, while Finnish does not seem to be affected in the same way by orientation and does indeed provide a different pattern for its in front of terms.

The manipulation of obstruction was not found to prompt the instantiation of the intrinsic frame of reference for any other language apart from English, in which *in front of* was the term of choice for scenes in which an obstruction was NOT positioned between the located object and reference object. Furthermore, when the scenes displayed an obstruction between the two objects, the relative frame of reference was not adopted for any of the language groups. This provides partial support for the findings revealed by Richards (2001) for effects of obstruction on reference frame selection, however this did not generalise across languages.

Additionally, the manipulation of object association (artist/easel or artist/stove; postman/post-box or postman/book/shelf) did not have an influence on whether an intrinsic or relative frame of reference was chosen for any of the language groups, which was not consistent with the findings of Richards (2001). Finally, the manipulation of proximity revealed that when the objects were located nearer to one another it was more likely for people to adopt an intrinsic frame of reference, thus the English *in front of* and Finnish *edessä* were the preferred descriptors for such scenes (Spanish did not produce clear results). However, the other *in front of* term for Finnish: *edellä* did not show much discrimination between levels of proximity, and certainly not the type of differentiation that was apparent when object orientation was manipulated. Additionally, when objects were positioned further away from one another it was not any more likely for the relative frame of reference to be enabled for any of the language groups (where the option was available).

Finally, one of the experiments that was included in the horizontal axis investigations endeavoured to examine whether the potential animacy of an object in combination with manipulations of orientation, would have an effect on the language that was used to describe spatial relations. As expected Finnish displayed a finer discrimination between scenes in which it was revealed that when either the static or potentially animate located objects were positioned with their fronts pointing in the same direction as the reference object's front, *edellä* was the preferred descriptor. In contrast, *edessä* showed very little difference in rating levels between levels of orientation. Furthermore, it was clear that *edessä* was appropriate in a broader variety of scenes than *edellä*.

Additionally, there was no real evidence from any of the language groups for the prediction that people's awareness of dynamic-kinematic routines would lead to higher ratings of the *in front of* terms (Finnish *edessä/edellä,* Spanish *delante*) when potentially dynamic objects were positioned with their fronts oriented in the same direction, or for the prediction that two static object would be considered more appropriately described by the *in front of* terms when positioned facing towards one another.

6.1.4 General Points on the Cross-linguistic work

As mentioned earlier, almost all the empirical work exploring the FGF has been based on a single language - English, whereas we have endeavored to examine these issues across three languages. For instance, the present work has uncovered some differences in the horizontal and vertical axis projective terms displayed between languages to functional sensitivity in relation to reference frame instantiation. This may be down to the fact that different types of functional relationships are more or less salient for each particular language, since acceptability ratings of spatial terms were affected to different degrees cross-linguistically by the manipulation of various factors influencing functional object relationships (i.e. object association, orientation, obstruction animacy, proximity etc.). Generally, some of Richards (2001) investigation results were supported in this thesis but often in a differing way across languages. Also, the present results find some generalisability for the Feist (2000),Garrod et al. (1999), Carlson-Radvansky et al. (1999) and Coventry et al. findings, but also some cross-linguistic differences. Furthermore, it is also clear that when a language offers more lexical items for a particular term, it is likely to result in a finer discrimination between extra-geometric factors and this was in line with previous work conducted by Frias-Lindqvist (Coventry & Frias-Lindqvist, 2005).

The fact that some of the previous research results were not fully replicated in the present investigations may be due to the fact that the present studies were limited in terms of the materials that were used for any one lexical topic area, whereas some of the previous research has incorporated many data sets. This may also have contributed to the fact that sometimes the predicted effect pattern was there, but was only at a marginally significant level. However, this was difficult to avoid, as the current aim was to examine a broad selection of spatial terms across three languages rather than concentrate on just one specific area. Also, some of the differences we have found, and some that we have not found, may be attributable to chance since often many factors were being manipulated across each individual experiment.

6.2 The Second Question

Chapter Four aimed to address the second core question of the thesis which was: 2) *Do extra-geometric factors only influence spatial language, or do they also affect memory for spatial object relationships?* From the cross-linguistic research conducted in this thesis it is clear that extra-geometric and geometric routines differ in the weightings that are given to specific spatial terms regardless of various underlying similarities across languages.

So naturally we set out to examine potential extra-geometric effects on spatial memory. Additionally, this thesis endeavoured to look further into issues about the similarities/differences between verbal and non-verbal categorisation uncovered by past work on spatial memory. For instance, Hayward and Tarr (1995) found similar effect patterns in non-verbal memory tasks and language tasks, in that those locations (vertical/horizontal axes of reference object) that were most consistently named by the English spatial terms were also most accurately remembered, suggesting that the same prototypical regions underlie both domains. In contrast, Crawford, Regier, &

Huttenlocher (2000) suggest that non-linguistic spatial categories do not map directly onto linguistic spatial categories. They claim that the prototypes for non-linguistic spatial categories are the diagonals, whereas the linguistic spatial categories are *on* the cardinal axes (Hayward & Tarr, 1995).

6.2.1 Nonverbal spatial conceptualisation

The first memory experiment focused on manipulating potential object animacy along the vertical axis and the other experiment manipulated potential object animacy along the horizontal axis. The participants were shown two scenes in sequence in which the relative spatial relationship between the located object and reference object either stayed the same or changed in the second scene. The only predicted effect of potential motion of the located object was found for the horizontal movement study, in which the results indicated that people were more likely to accurately detect a shift in position when that shift was against the direction of expected motion and at a near proximity level. In other words, when the located object was a bird pointing to the left a relative shift in position was more likely to be detected correctly when that shift was to the right, whereas if the located object was a bird with its beak pointing to the left it was more likely that participants would notice a relative shift in position to the right. Furthermore, detection accuracy displayed the opposite pattern for the scenes in which the bird was pointing to the left. This, however, was only found as a marginally significant effect for the analyses of the diagonal axes 'near' location in particular, but not for the cardinal axes in the horizontal study. It may be that because people were generally more accurate in detecting shifts of relative position when the located object was positioned centrally on the reference object axis, they were not as likely to be influenced by extra-geometric cues. In contrast, since detection of shifts was generally lower along the diagonal axes any additional cues such as that of expected direction of motion were more heavily relied upon by participants.

The fact that no effects of object were found for the experiment involving potentially vertically mobile objects, may have been a result of the knowledge people have about gravitational forces. For instance, there were indications from the additional strategic data-point analyses, that in some cases there was a tendency for participants to be more accurate in detecting upwards movement rather than downwards movement regardless of the type of located object that was viewed. This suggests that it may have been more likely for people to notice a shift of position when it was against gravity regardless of the presence of a potentially upwards mobile located object (a rocket). Finally, the memory experiments revealed in several instances that when the located object was a cloud, which is relatively static in contrast to the bird, bomb or rocket, the detection rates for shifts in relative location were less accurate. This may result from people being less likely to notice motion or shifts in position, because they were not as likely to be expecting them from a cloud.

In conclusion, it is safe to say that there are extra-geometric as well as geometric constraints influencing spatial memory and not just spatial language. However, the circumstances under which knowledge of dynamic-kinematic routines become visible are quite specific and other factors such as knowledge about gravitational forces may over-ride these influences. Finally, the analyses revealed some support for Crawford et al.'s (2000) view that the prototypical region of non-linguistic space is along the diagonal axes rather than the cardinal axes of the reference object. One of the additional data point analyses involving vertical movement, indicated that when the shifts in position were towards the diagonal axis and involved vertical axis movement (upwards/downwards), detection accuracy was higher. This was not, however found to be the case when the shifts in position were towards the diagonal and involved horizontal movement (left/right). Therefore, it would seem that people do categorise non-verbal space along the diagonal axes in some restricted circumstances. However, it is not possible to infer from this that the prototypical region of non-linguistic space is along the diagonal axes rather than the cardinal axes since it still remains that accuracy levels for detection of motion have generally been highest when the objects were positioned along the cardinal axes rather than the diagonal axes. Therefore, it appears that there is not sufficient enough evidence available to be able to make the claim that the verbal and non-verbal categorisation of space involves different prototypical regions as Crawford and colleagues (2000) claim.

6.3 Conclusions

The cross-linguistic research in this thesis clearly indicates the interplay between geometric and various extra-geometric constraints on spatial language is present for languages other than English although the degree to which each language is affected by different factors varies. Therefore, it would be interesting to conduct further investigation into topological, and vertical and horizontal projective terms by extending the types of materials used that might affect functional object relations or dynamic-kinematic routine. Also, including other language families in such research is a natural direction for progression in this field. For instance, adding languages such as Arabic or Cantonese would possibly reveal further differences underlying the way in which languages are affected by extra-geometric influences. This would allow for further mapping of influential factors for languages that are not only representatives of the Uralic or of the Indo-European language families, but also the Semitic and Sino-Tibetan language families. This may reveal interesting results since the cultural differences underlying each language environment would be diverse, which in turn may result in different weightings being assigned to different geometric and extra-geometric factors.

When conducting studies across further languages, it may also be useful to initially collect data from language production tasks, before moving onto collecting data from language rating tasks which can then be further examined and contrasted across languages. This would allow each language group to naturally produce the spatial language, rather than perhaps confine them to an awkward selection of predetermined terms.

Furthermore, it would be interesting to examine whether other extra-geometric factors than just dynamic-kinematic routines (i.e. object association), might have in combination with geometric factors in influencing spatial memory of English speakers. Additionally, these memory experiments could be twinned with corresponding linguistic tasks to allow for direct comparisons of the verbal and non-verbal domains across different language groups. Perhaps, also including languages such as Arandic (Pama-Nyungan, Australia) and Guugu Yimithirr (North Queensland, Australia), where terms like '*to the left/right of*' do not exist. Instead, they use terms which only locate directions or sides using an absolute frame of reference (like North, South, East and West). As these languages differ from Indo-European languages so radically, it would be interesting to examine whether the structure of the language also affects the encoding of nonlinguistic spatial relationships as was found by Pederson et al. (1998), however using the memory paradigms of this thesis paired with language tasks.

Another intriguing factor to investigate further, would be the actual movement of an object rather than just the potential animacy that has been incorporated in several of the above experiments. It may be that much stronger influences on spatial language and/or spatial memory would be revealed when the observer sees an object moving, and thus does not have to infer movement from a static scene. These are but a few of the potential future avenues that would be worth pursuing in research of the verbal and non-verbal spatial conceptualisation of space.

As for the *functional geometric framework* proposed by Coventry and Garrod (2004), this thesis has provided further evidence that while spatial language relates to the visual scenes being described, it is also influenced by acting in the real world, and that the salience of the functional interaction between objects has an important affect on how we describe object relations across different languages (although with different weightings), and even to some degree for the memory of object relations. This is clear from instances in which certain spatial terms are no longer considered appropriate descriptors regardless of geometric relations remaining the same, but in which it is apparent that the two objects are no longer functionally related (i.e. the umbrella is not protecting the man from rain, the wine glass is not successfully containing the wine). In other words, *where* objects are located combined with *what* the objects are, influence how we describe the spatial relationship.

To conclude, this thesis has provided support for the notion that extra-geometric influences, such as dynamic-kinematic routines and conceptual knowledge, combine with geometric influences to affect how we speak about space across English, Finnish and Spanish. Thus, we have delved a little further into understanding the factors underlying the cross-linguistic differences between the ways in which languages carve up space. Furthermore, the current research has helped to add to the existing data exploring the extent to which representations underlying spatial language determine our non-linguistic spatial conceptualisation, or indeed the other way around. Finally, better comprehension for the factors underlying spatial language may have implications for computerised translation software, computational modelling and second language education.

Appendix 1: Topological experiment ANOVA tables

Table 2.a *The Results of 4-way Anova in Experiment One for English*

	MS (error)	F value	Significance
Located Object (LO)	1.29	0.05	Ns
Reference Object (R)	2.85	3.41	Ns
Concavity (C)	1.35	0.21	Ns
Ad-position (Ad)	11.87	3.23	Ns
LO x R	0.83	0.00	Ns
LO x C	0.81	5.28	**
R x C	1.52	2.71	Ns
LO x Ad	5.27	11.47	**
R x Ad	10.08	12.98	**
C x Ad	3.27	11.11	***
LOx R x C	1.69	0.26	Ns
LO x R x Ad	3.45	0.60	Ns
LO x C x Ad	3.88	0.10	Ns
R x C x Ad	3.20	0.32	Ns
LO x R x C x Ad	2.48	1.44	Ns

Note: p>0.05 : ns, p<0.05 : *, p<0.01 : **, p<0.001 : ***

Table 2.b *The Results of 4-way Anova in Experiment One for Finnish*

	MS (error)	F value	Significance
Located Object (LO)	2.38	0.99	ns
Reference Object (R)	9.51	6.85	*
Concavity (C)	1.75	2.14	ns
Ad-position (Ad)	23.47	8.25	*
LO x R	3.21	0.34	ns
LO x C	1.35	0.09	ns
R x C	1.69	0.07	ns
LO x Ad	1.67	2.72	ns
LO x Ad	6.23	25.59	***
C x Ad	1.62	4.19	*
LO x R x C	2.22	0.21	ns
LO x R x Ad	2.80	0.04	ns
LO x C x Ad	0.96	0.17	ns
R x C x Ad	2.41	0.15	ns
LO x R x C x Ad	1.73	0.49	ns

Note: p>0.05 : ns, p<0.05 : *, p<0.01 : **, p<0.001 : ***

Table 2.c *The Results of 4-way Anova in Experiment One for Spanish*

	MS (error)	F value	Significance
Located Object (LO)	1.41	2.93	ns
Reference Object (R)	4.55	21.35	***
Concavity (C)	0.93	0.82	ns
Ad-position (Ad)	7.78	25.23	***
LO x R	1.55	1.33	ns
LO x C	0.93	1.06	ns
R x C	1.00	0.25	ns
LO x Ad	1.56	4.42	Nearly sig. 0.052
R x Ad	6.66	15.76	***
C x Ad	1.16	5.08	**
LO x R x C	0.95	0.16	ns
LO x R x Ad	1.60	3.09	ns
LO x C x Ad	0.73	0.55	ns
R x C x Ad	1.33	1.00	ns
LO x R x C x Ad	0.71	0.45	ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table 2.d Results of 5-way Anova in Experiment Two for English

Source	F value	MSe	Significance
Reference Object (RO)	0.14	6.53	ns
Height (H)	13.14	6.90	***
Angle (A)	5.18	7.94	*
Control (C)	3.61	2.25	ns
Ad-position (AP)	1.58	23.43	ns
(RO) x (H)	3.50	2.90	*
(RO) x (A)	0.08	3.19	ns
(RO) x (C)	0.90	2.21	ns
(RO) x (AP)	11.39	10.92	***
(H) x (A)	2.69	3.06	ns
(H) x (C)	0.08	1.44	ns
(H) x (AP)	27.63	8.56	***
(A) x (C)	1.26	1.57	ns
(A) x (AP)	3.79	2.04	*
(C) x (AP)	4.88	1.90	**
(RO) x (H) x (A)	0.35	2.69	ns
(RO) x (H) x (C)	1.84	1.59	ns
(RO) x (H) x (AP)	1.32	2.48	ns
(RO) x (A) x (AP)	0.14	1.67	ns
(RO) x (A) x (C)	0.38	2.99	ns
(RO) x (C) x (AP)	1.39	1.70	ns
(H) x (A) x (AP)	2.33	1.12	*
(H) x (A) x (C)	0.12	2.03	ns
(H) x (C) x (AP)	1.52	1.62	ns
(A) x (C) x (AP)	0.92	0.97	ns
(RO) x (H) x (A) x (C)	1.37	2.31	ns
(RO) x (H) x (A) x (AP)	2.57	1.28	*
(RO) x (H) x (C) x (AP)	2.47	1.70	*
(RO) x (A) x (C) x (AP)	1.27	1.78	ns
(H) x (A) x (C) x (AP)	0.30	1.65	ns
(RO) x (H) x (A) x (C) x (AP)	0.84	2.07	ns

Note p>0.05 : ns, p<0.05 : *, p<0.01 : **, p<0.001 : ***

***Table 2.e** Results of 5-way Anova in Experiment Two for Finnish*

Source	F value	MSe	Significance
Reference Object (RO)	1.56	2.21	ns
Height (H)	28.49	4.71	***
Angle (A)	2.45	2.65	ns
Control (C)	0.00	3.90	ns
Ad-position (AP)	15.35	27.23	***
(RO) x (H)	0.59	2.55	ns
(RO) x (A)	2.49	1.70	ns
(RO) x (C)	0.28	2.39	ns
(RO) x (AP)	12.67	17.80	***
(H) x (A)	1.21	4.31	ns
(H) x (C)	0.41	1.57	ns
(H) x (AP)	21.40	8.96	***
(A) x (C)	5.27	1.93	*
(A) x (AP)	0.78	2.32	ns
(C) x (AP)	4.28	1.90	**
(RO) x (H) x (A)	1.21	1.77	ns
(RO) x (H) x (C)	0.21	1.85	ns
(RO) x (H) x (AP)	0.26	3.32	ns
(RO) x (A) x (AP)	1.14	1.90	ns
(RO) x (A) x (C)	4.47	3.12	ns
(RO) x (C) x (AP)	1.40	1.19	ns
(H) x (A) x (AP)	2.41	2.10	*
(H) x (A) x (C)	2.15	1.54	ns
(H) x (C) x (AP)	2.19	1.52	(ns)
(A) x (C) x (AP)	1.19	0.95	ns
(RO) x (H) x (A) x (C)	0.87	2.09	ns
(RO) x (H) x (A) x (AP)	0.66	1.54	ns
(RO) x (H) x (C) x (AP)	0.88	1.41	ns
(RO) x (A) x (C) x (AP)	0.26	2.68	ns
(H) x (A) x (C) x (AP)	0.97	1.43	ns
(RO) x (H) x (A) x (C) x (AP)	0.70	1.63	ns

Note $p>0.05$: ns, $p\leq0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table 2.f. Results of 5-way Anova in Experiment Two for Spanish

Source	F value	MSe	Significance
Reference Object (RO)	0.02	2.88	ns
Height (H)	0.82	5.54	ns
Angle (A)	2.92	2.74	ns
Control (C)	0.45	3.04	ns
Ad-position (AP)	19.31	38.57	***
(RO) x (H)	1.37	2.75	ns
(RO) x (A)	0.01	2.79	ns
(RO) x (C)	0.80	2.66	ns
(RO) x (AP)	0.47	3.44	ns
(H) x (A)	9.30	1.13	***
(H) x (C)	1.49	1.76	ns
(H) x (AP)	5.25	6.46	**
(A) x (C)	0.70	1.27	ns
(A) x (AP)	1.24	1.85	ns
(C) x (AP)	3.21	10.08	(ns)
(RO) x (H) x (A)	1.28	1.54	ns
(RO) x (H) x (C)	0.63	1.58	ns
(RO) x (H) x (AP)	1.18	2.26	ns
(RO) x (A) x (AP)	0.54	1.17	ns
(RO) x (A) x (C)	1.55	1.07	ns
(RO) x (C) x (AP)	0.04	1.45	ns
(H) x (A) x (AP)	0.57	1.48	ns
(H) x (A) x (C)	2.38	1.97	ns
(H) x (C) x (AP)	0.30	1.83	ns
(A) x (C) x (AP)	0.87	2.06	ns
(RO) x (H) x (A) x (C)	0.15	2.51	ns
(RO) x (H) x (A) x (AP)	1.10	1.16	ns
(RO) x (H) x (C) x (AP)	0.43	1.82	ns
(RO) x (A) x (C) x (AP)	0.53	1.13	ns
(H) x (A) x (C) x (AP)	0.17	1.20	ns
(RO) x (H) x (A) x (C) x (AP)	0.15	1.50	ns

Note $p>0.05$: ns, $p\leq0.05$: *, $p<0.01$: **, $p<0.001$: ***

Appendix 2: Vertical Projective Experiment ANOVA tables

Table 3.a *The Results of 3-way Anova in Experiment Three (toothbrush) for English*

	MS (Error)	F Value	Significance
Figure (F)	10.27	0.11	ns
Location (L)	6.64	51.09	***
Ad-position (AP)	4.18	9.49	***
F x L	2.36	1.49	ns
F x AP	0.71	2.34	(ns)
L x AP	2.21	4.25	***
F x L x AP	0.80	2.05	*

Note: p>0.05 : ns, p<0.05 : *, p<0.01 : **, p<0.001 : ***

Table 3.b *The Results of 3-way Anova in Experiment Three (toothbrush) for Finnish*

	MS (Error)	F Value	Significance
Figure (F)	1.27	1.42	ns
Location (L)	8.24	17.36	***
Ad-position (AP)	10.10	17.93	***
F x L	2.14	0.63	ns
F x AP	1.61	0.82	ns
L x AP	1.47	8.35	***
F x L x AP	0.97	0.96	ns

Note: p>0.05 : ns, p<0.05 : *, p<0.01 : **, p<0.001 : ***

Table 3.c *The Results of 3-way Anova in Experiment Three (toothbrush) for Spanish*

	MS (Error)	F Value	Significance
Figure (F)	4.13	0.26	ns
Location (L)	10.64	12.91	***
Ad-position (AP)	11.54	5.65	**
F x L	2.79	0.78	ns
F x AP	1.55	0.45	ns
L x AP	1.90	2.03	*
F x L x AP	1.47	0.71	ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table 3.d *The Results of 3-way Anova in Experiment Four (umbrella) for English*

	MS (Error)	F Value	Significance
Function (F)	6.76	6.51	**
Angle (A)	7.62	8.06	**
Ad-position (AP)	5.73	13.72	***
F x A	4.16	3.47	*
F x AP	0.98	2.70	*
A x AP	2.75	11.45	***
F x A x AP	1.14	1.22	ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table3.e *The Results of 3-way Anova in Experiment Four (umbrella) for Finnish*

	MS (Error)	F Value	Significance
Function (F)	3.80	2.34	ns
Angle (A)	11.91	8.58	**
Ad-position (AP)	10.30	12.21	***
F x A	2.32	0.66	ns
F x AP	1.45	0.99	ns
A x AP	3.85	4.05	**
F x A x AP	1.57	1.06	ns

Note: p>0.05 : ns, p<0.05 : *, p<0.01 : **, p<0.001 : ***

Table 3.f *The Results of 3-way Anova in Experiment Four (umbrella) for Spanish*

	MS (Error)	F Value	Significance
Function (F)	1.60	1.16	ns
Angle (A)	3.62	1.76	ns
Ad-position (AP)	8.77	0.55	ns
F x A	1.69	2.06	ns
F x AP	1.41	1.48	ns
A x AP	0.82	1.21	ns
F x A x AP	0.75	1.84	Ns

Note: p>0.05 : ns, p<0.05 : *, p<0.01 : **, p<0.001 : ***

Table 3.g *The Results of 3-way Anova in Experiment Five (wine) for English*

	MS (Error)	F Value	Significance
Function (F)	6.112	16.332	***
Angle (A)	8.281	6.749	*
Ad-position (AP)	3.897	22.933	***
F x A	3.440	0.390	Ns
F x AP	1.719	2.013	(0.07)
A x AP	3.281	12.659	***
F x A x AP	0.838	1.562	Ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table 3.e *The Results of 3-way Anova in Experiment Five (wine) for Finnish*

	MS (Error)	F Value	Significance
Function (F)	5.13	13.46	***
Angle (A)	9.82	7.56	*
Ad-position (AP)	7.80	12.56	***
F x A	2.42	4.38	*
F x AP	1.98	1.98	(0.08)
A x AP	3.24	5.50	**
F x A x AP	1.40	0.61	Ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table 3.f *The Results of 3-way Anova in Experiment Five (wine) for Spanish*

	MS (Error)	F Value	Significance
Function (F)	9.15	2.85	(ns)0.077
Angle (A)	5.29	0.06	Ns
Ad-position (AP)	5.16	1.19	Ns
F x A	7.97	0.21	Ns
F x AP	1.20	0.49	Ns
A x AP	0.99	1.44	Ns
F x A x AP	1.46	0.62	Ns

Note: p>0.05 : ns, p<0.05 : *, p<0.01 : **, p<0.001 : ***

Appendix 3: Horizontal axis experiment ANOVA tables

Table 4.a *The Results of 4-way Anova in Experiment Six (Artist) for English*

	MS (Error)	F Value	Significance
Object Association (OA)	2.30	1.80	Ns
Obstruction (Ob)	1.56	12.02	**
Orientation (OR)	2.47	25.55	***
Ad-position (AP)	14.68	28.08	***
OA x Ob	1.20	0.10	Ns
OA x OR	1.63	0.33	Ns
Ob x OR	1.44	0.01	Ns
OA x AP	1.02	0.36	Ns
Ob x AP	1.94	5.24	**
OR x AP	1.78	9.04	***
OA x Ob x OR	0.60	11.70	**
OA x Ob x AP	1.08	0.63	Ns
OA x OR x AP	0.96	0.43	Ns
Ob x OR x AP	1.55	2.16	Ns
OA x Ob x OR x AP	0.89	0.29	ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table 4.b *The Results of 4-way Anova in Experiment Six (Artist) for Finnish*

	MS (Error)	F Value	Significance
Object Association (OA)	2.81	2.27	ns
Obstruction (O)	2.06	7.85	*
Orientation (OR)	3.08	7.47	*
Ad-position (AP)	12.01	46.95	***
OA x O	3.46	0.08	ns
OA x OR	1.65	1.02	ns
O x OR	1.35	5.24	*
OA x AP	1.53	1.58	ns
O x AP	1.51	0.77	ns
OR x AP	2.92	6.64	***
OA x O x OR	1.30	0.26	ns
OA x O x AP	1.27	1.53	ns
OA x OR x AP	1.01	0.96	ns
O x OR x AP	1.35	1.65	ns
OA x O x OR x AP	1.15	0.85	ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table 4.c *The Results of 4-way Anova in Experiment Six (Artist) for Spanish*

	MS (Error)	F Value	Significance
Object Association (OA)	2.28	4.33	0.054
Obstruction (O)	1.76	0.27	ns
Orientation (OR)	1.66	0.00	ns
Ad-position (AP)	17.14	22.65	***
R x O	1.36	0.16	ns
R x OR	1.04	4.42	0.052
O x OR	1.11	2.12	ns
R x AP	3.44	7.07	***
O x AP	2.04	0.77	ns
OR x AP	1.87	4.43	**
R x O x OR	0.97	0.05	ns
R x O x AP	1.64	0.63	ns
R x OR x AP	1.22	0.85	ns
O x OR x AP	1.44	1.68	ns
R x O x OR x AP	1.14	1.34	ns

Note: p>0.05 : ns, p<0.05 : *, p<0.01 : **, p<0.001 : ***

Table 4.d *The Results of 4-way Anova in Experiment Seven (Postman) for English*

	MS (Error)	F Value	Significance
Object Association (OA)	0.96	0.26	ns
Proximity (P)	2.24	46.87	***
Orientation (O)	3.95	8.72	**
Ad-position (AP)	13.14	32.42	***
OA x P	1.38	1.31	ns
OA x O	0.95	1.68	ns
P x O	1.46	0.73	ns
OA x AP	1.19	1.14	ns
P x AP	2.09	13.99	***
O x AP	2.27	9.79	***
OA x P x O	0.88	9.35	**
OA x P x AP	0.65	0.20	ns
OA x O x AP	0.50	2.65	*
P x O x AP	0.96	3.22	*
OA x P x O x AP	0.75	1.35	ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table 4.e *The Results of 4-way Anova in Experiment Seven (Postman) for Finnish*

	MS (Error)	F Value	Significance
Object Association (OA)	1.37	0.15	ns
Proximity (P)	3.13	28.63	***
Orientation (O)	2.54	0.24	ns
Ad-position (AP)	9.72	51.61	***
OA x P	3.57	0.00	ns
OA x O	1.14	3.33	0.087
P x O	1.28	0.27	ns
OA x AP	1.36	0.46	ns
P x AP	2.39	11.46	***
O x AP	1.97	8.38	***
OA x P x O	1.42	2.15	ns
OA x P x AP	1.97	0.46	ns
OA x O AP	1.18	1.25	ns
P x O x AP	0.99	1.69	ns
OA x P x O x AP	1.17	2.69	*

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

4.f ***The Results of 4-way Anova in Experiment Seven (Postman) for Spanish***

	MS (Error)	F Value	Significance
Object Association (OA)	2.98	0.54	ns
Proximity (P)	1.45	12.52	**
Orientation (O)	2.78	0.15	ns
Ad-position (AP)	20.19	22.13	***
OA x P	0.50	0.03	ns
OA x O	1.81	0.00	ns
P x O	0.39	2.72	ns
OA x AP	1.65	0.49	ns
P x AP	2.81	0.82	ns
O x AP	2.96	3.09	*
OA x P x O	0.47	1.38	ns
OA x P x AP	1.01	0.10	ns
OA x O AP	1.63	1.59	ns
P x O x AP	0.98	0.83	ns
OA x P x O x AP	1.00	2.42	0.058

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table 4.g *The Results of 4-way Anova in Experiment Eight (Cars) for English*

	MS (Error)	F Value	Significance
Reference Object (R)	2.01	7.48	*
Figure Object (F)	2.44	3.39	0.086
Orientation (O)	0.85	0.07	ns
Ad-position (AP)	11.56	100.01	***
R x F	1.67	16.50	**
R x O	0.97	0.02	ns
F x O	0.61	2.08	ns
R x AP	1.34	11.20	**
F x AP	1.92	6.86	*
O x AP	1.27	4.90	*
R x F x O	1.26	0.20	ns
R x F x AP	1.56	4.01	0.064
R x O x AP	0.62	3.07	ns
F x O x AP	1.19	0.01	ns
R x F x O x AP	1.04	0.96	ns

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table 4.h *The Results of 4-way Anova in Experiment Eight (Cars) for Finnish*

	MS (Error)	F Value	Significance
Reference Object (R)	2.61	2.17	ns
Figure Object (F)	4.86	1.40	ns
Orientation (O)	2.69	5.04	*
Ad-position (AP)	10.26	34.17	***
R x F	2.69	0.37	ns
R x O	1.73	1.79	ns
F x O	2.33	2.92	ns
R x AP	3.24	0.33	ns
F x AP	2.92	1.76	ns
O x AP	2.67	14.83	***
R x F x O	3.09	0.69	ns
R x F x AP	2.14	0.18	ns
R x O x AP	1.85	1.01	ns
F x O x AP	1.42	4.61	**
R x F x O x AP	1.13	9.21	***

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

Table 4.i *The Results of 4-way Anova in Experiment Eight (Cars) for Spanish*

	MS (Error)	F Value	Significance
Reference Object (R)	1.34	1.72	ns
Figure Object (F)	0.91	1.16	ns
Orientation (O)	1.02	1.04	ns
Ad-position (AP)	26.23	41.33	***
R x F	0.98	1.09	ns
R x O	1.02	0.61	ns
F x O	0.72	2.71	ns
R x AP	2.10	0.02	ns
F x AP	1.12	2.06	ns
O x AP	4.48	0.18	ns
R x F x O	1.49	9.79	**
R x F x AP	2.04	1.96	ns
R x O x AP	1.74	0.93	ns
F x O x AP	0.59	0.06	ns
R x F x O x AP	1.28	3.53	0.079

Note: $p>0.05$: ns, $p<0.05$: *, $p<0.01$: **, $p<0.001$: ***

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