Processing at the syntax-discourse interface in second language acquisition

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Declaration

I hereby declare that this thesis is of my own composition, and that it contains no material previously submitted for the award of any other degree. The work reported in this thesis has been executed by myself, except where due acknowledgement is made in the text.

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Abstract

The Interface Hypothesis (Sorace and Filiaci, 2006) conjectures that adult second language learners (L2 learners) who have reached near-native levels of proficiency in their second language exhibit difficulties at the interface between syntax and other cognitive domains, most notably at the syntax-discourse interface. However, research in this area was limited, in that the data were off-line, and thus unable to provide evidence for the nature of the deficit shown by L2 learners. This thesis presents online data which address the question of the underlying nature of the difficulties observed in L2 learners at the syntax-discourse interface.

This thesis has extended work on the syntax-discourse interface in L2 learners by investigating the acquisition of two phenomena at the syntax-discourse interface in German: the role of word order and pronominalization with respect to information structure (Experiments 1-3), and the antecedent preferences of anaphoric demonstrative (the der, die, das series homophonous with the definite article) and personal pronouns (the er, sie, es series) (Experiments 4-8). Crucially, this work has used an on-line methodology, the visual-world paradigm, which allows an insight into the incremental interpretation of interface phenomena in real-time processing. The data from these experiments show that L2 learners have difficulty integrating different sources of information in real-time comprehension efficiently, supporting the Interface Hypothesis.

However, the nature of the processing difficulties which L2 learners demonstrate in on-line processing was not determined by these studies, resulting in the question: are L2 learners' difficulties a result of a limitation of processing

resources, or the inability to deploy those resources effectively? A novel dual-task experiment (Experiment 9), in which native speakers of German were placed under processing load simulated the results previously obtained for L2 learners. It is concluded that syntactic dependencies were constrained by resource limitation, whereas discourse based dependencies were constrained by processing resource allocation.

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CHAPTER 1

Introduction

1.1 Introduction

In this thesis I investigate processing at the syntax-discourse interface by adult second language (L2) learners of German. Syntax-discourse interface phenomena are typically described as those phenomena where there are two syntactic options which are truth conditionally equivalent, however are considered felicitous in different conditions. Cowles (2003) argues that the availability of different syntactic options to encode the discourse status of entities in a discourse aids processing in adult native speakers by allowing better prediction and integration of upcoming words.

The Interface Hypothesis (Sorace & Filiaci 2006) proposes that L2 learners show difficulty at the interface of syntax with other cognitive domains. Processing syntax-discourse interface phenomena requires the processor to integrate syntactic information with information about the discourse status of different entities, adding an extra layer of computation to syntactic processing. Hopp (2007) proposes that the extra computation required to process the discourse implications of different syntactic options could make processing harder for L2 learners. However, Clahsen & Felser (2006*a*), (2006*b*) propose that L2 learners have a representational deficit which prevents syntactic representations in an L2 from being accessed in online processing, and argue that there is little evidence to suggest that L2 learners have a processing limitation. I propose an alternative framework to describe the nature of the difficulties

which L2 learners (among other populations) show at the syntax-discourse interface, and suggest that as well as a limitation of processing resources, L2 learners may not be able to allocate processing resources effectively, leading to non-targetlike behaviour.

To investigate L2 learners behaviour at the syntax-discourse interface, I follow the Form Specific Multiple Constraints Approach (Kaiser & Trueswell 2008), which emphasizes that different forms, or syntactic options (e.g. pronouns, demonstrative pronouns) are subject to different types of constraint (e.g. syntactic dependencies, discourse based dependencies). This approach allows a detailed consideration of which aspects of the interface are problematic for L2 learners. Using this approach as a starting point, I examine two different aspects of the interface: information structure and anaphor resolution, so that the relative difficulty of these phenomena can be compared. I then examine the nature of the difficulties faced in anaphor resolution in more detail.

The Form Specific Multiple Constraints Approach to syntax-discourse processing is relatively recent, and as a consequence, underexplored. In this thesis I present data which supports this approach as a valid way of describing the syntax-discourse interface for both native and non-native speaker processing.

1.2 Research Questions

The major research questions addressed this thesis with respect to each phenomenon investigated therefore are:

- To what extent is L2 learner processing at the syntax-discourse interface convergent on native speaker processing?
- If L2 learners do not show the same behaviour as native speakers at the syntax-discourse interface, what can account for these difficulties?
- To what extent is the Form Specific Multiple Constraint Approach to discourse processing a valid way of considering the syntax-discourse interface?

1.3 Experiments

In this thesis I test L2 learners of German who have English as a native language and compare them to adult native speakers of German. The acquisition of syntax-discourse interface phenomena in German by native speakers of English was chosen because German has a more flexible word order than English, and uses a wider range of pronominal forms than English. Since both these phenomena are strongly linked to discourse processing, they allowed the investigation of a range of aspects of the interface not seen in the native language of the participants. Thus far, much of the work exploring L2 learners' difficulties at the syntax-discourse interface has used offline measures, or online measures which do not allow an analysis of the incremental interpretation of these phenomena. Although measures such as reading times and reaction times can be informative, it is possible that L2 learners would not show difficulty despite the fact that their interpretation of a syntactic structure is not targetlike. Since the *interpretation* of syntax-discourse interface phenomena is central to the question of whether L2 learners are able to acquire and use the appropriate constraints in real-time processing, this thesis uses an online methodology which provides insight into this issue. The data are analysed using mixed modelling. This technique is suitable for dealing with categorical data, allows a more sophisticated treatment of unwanted variance in the data and is able to account for the fact that the data are longitudinal which previous statistical methods were unable to do.

In the thesis I use the visual-world paradigm to investigate the phenomena under investigation. The visual-world paradigm is a particularly suitable tool for investigating processing at the syntax-discourse interface, because it provides an insight into the interpretation of the stimuli over time, and does not place additional processing demands on participants; this is particularly useful for L2 participants.

I present three experimental strands to investigate the questions described above:

- Information Structure and Pronominalisation
- Antecedent Preferences of Anaphoric Demonstratives and Pronouns

- Simulating L2 Learners Difficulties in Native Speakers

The first two strands explore the difficulties which L2 learners show when processing syntax-discourse interface phenomena, and the third investigates the nature of these difficulties. The first strand, presented in Chapter 4 explores the information structure implications of word order variation and pronominalisation in German. The second strand (Chapter 5) explores the antecedent preferences of anaphoric demonstratives and personal pronouns in German. Both these strands contribute to the literature on the syntax-discourse interface in native German speakers; in particular, there had previously been little experimental work on anaphoric demonstratives in German. The lack of prior research on the antecedent preferences of anaphoric demonstratives and pronouns has proved particularly useful for research into L2 processing because it was unlikely that the L2 participants would have any explicit knowledge of the phenomenon, so their results could not be attributed to explicit knowledge. The third experimental strand (Chapter 6) aimed to investigate the nature of the difficulties shown at the syntax-discourse interface. L2 learners' antecedent preferences for anaphoric demonstratives and pronouns were simulated in native speakers of German experiencing attrition.

1.4 The Findings

Overall, there is evidence that L2 learners have a processing difficulty at the syntax-discourse interface. L2 learners seem to find resolving pronominal anaphors more difficult than lexical NP anaphors, which is further exacerbated by difficulties processing non-canonical word order (OVS). Furthermore, although L2 learners distinguish between personal pronouns and demonstratives in terms of the salience of their antecedents, they do not use native-like constraints, in that they rely on grammatical role information for both personal pronouns and demonstrative pronouns. This preference seems to interact with a Topic preference as antecedent for both types of anaphor. The final experimental strand simulated L2 learners' antecedent preferences for personal pronouns and demonstratives in native speakers under processing load who were affected by attrition. These data showed that a resource limitation affects the processing of personal pronouns (a syntactic dependency) in

L2 learners and native speakers of German under attrition, whereas a resource allocation deficit caused by competition from a competing English constraint accounts for the antecedent preferences for demonstratives in L2 learners and native speakers under attrition.

1.5 Broader Implications

The Interface Hypothesis proposes that L2 learners show difficulty at the interface of syntax with other cognitive domains. However, it does not make predictions about the extent to which these difficulties are apparent in all aspects of the interface, nor about what the underlying cause of these difficulties might be. This thesis contributes to the understanding of L2 learners difficulties in different aspects of the syntax-discourse interface, and presents an analysis of the possible causes of the behavioural patterns shown by L2 learners at the interface with other cognitive domains. Previous research has categorized difficulties at the syntax-discourse interface in terms of a representational or processing deficit, in which the processing deficit is typically defined as a limitation of processing resources. In the thesis I show that the processing deficits observed in L2 learners at the interface can be categorized differently, as either due to difficulties in resource allocation or a resource limitation. A resource allocation deficit occurs when the processor is unable to use processing resources appropriately, such as when there are two competing discourse constraints, possibly from the L2 and the native language. This approach to deficits at the syntax-discourse interface explains variation in performance observed in different interface phenomena, not only in L2 acquisition, but other populations, such as early bilinguals and native speakers experiencing attrition.

From a methodological perspective I show that the visual-world paradigm can be successfully adapted for use as a dual task experiment, allowing investigation of the effect of processing load on language processing. Furthermore, I demonstrate that this methodology is particularly suitable for use in L2 acquisition research. Additionally I develop a method for using mixed modelling for analysing visual-world paradigm data; this method allows for

a more sophisticated treatment of longitudinal data and unwanted variance in the data than traditional statistical methods.

The thesis additionally provides support for the Form Specific Multiple Constraint (Kaiser & Trueswell 2008) approach to the syntax-discourse interface. This approach proposes that different forms (e.g. pronouns, demonstratives, etc) are subject to different types of constraint. For example, in German, demonstrative pronouns determine their antecedent using topichood, preferring non-Topics as antecedents, whereas pronouns are more sensitive to grammatical role. In the thesis I provide further evidence of cross-linguistic variation with respect to antecedent preferences for anaphors.

1.6 Organisation of the Thesis

The thesis is organised as follows:

- Chapter 2: I discuss theoretical approaches to the syntax-discourse interface, review previous work on the syntax-discourse interface in L2 learners, and comparing L2 acquisition to other developmental population discuss the predictions which can be made for L2 learners at the syntax-discourse interface.
- Chapter 3: I outline the methodology used in the thesis and outline a method for using mixed modelling to analyse visual-world paradigm data.
- Chapter 4: I present three experiments examining the role of word order and pronominalisation on the processing of information structure.
- Chapter 5: I present five experiments investigating the antecedent preferences of anaphoric demonstratives and personal pronouns in German.
- Chapter 6: I describe the resource allocation/limitation approach in detail, and present a dual task experiment which simulates the antecedent preferences of anaphoric demonstratives and pronouns by L2 learners in native speakers experiencing attrition.
- Chapter 7: I summarize the findings and discuss future work.

CHAPTER 2

The Syntax-Discourse Interface

2.1 Introduction

There are many different theoretical approaches to the syntax-discourse interface. Ultimately, however, they all seek to determine the factors which contribute to signalling and promoting an entity's salience in discourse. These factors can be extra-linguistic (e.g. being a global discourse Topic, or what the discourse is 'about' (see e.g. Lambrecht (1994) for further discussion) or linguistic (e.g. grammatical role). Here I focus on the syntactic factors which contribute to salience. In this chapter I discuss different theories of discourse comprehension relevant to the syntax-discourse interface and set out the approach to the interface taken in this thesis: the Form Specific Multiple Constraint Approach.

Although research on the syntax-discourse interface in developmental populations is limited, the data currently available suggest that this interface is problematic for several populations. In this chapter I consider the syntax-discourse interface from a developmental perspective, examining performance at the interface in different populations: child bilinguals, child monolinguals, adult native speakers affected by attrition due to either a lack of exposure to the native language or a pathological cause (Alzheimer's disease), with a focus on L2 learners. I consider the similarities and differences between these populations with respect to language processing, and use these comparisons

to formulate hypotheses as to the underlying nature of difficulties which L2 learners may face at the syntax-discourse interface.

2.2 The Syntax-Discourse Interface in Native Speaker Processing

In natural language, frequently more than one syntactic option is used to express the same propositional content. This can be two different syntactic structures, as in Example (2.1), where there is an alternation between active and passive, or the choice of different referring expressions, as in Example (2.2), where a full NP or a pronoun can be used to refer to the man.

(2.1) a. The man bought a bicycle.
b. A bicycle was bought by the man

(2.2) a. The man bought a bicycle. He was very happy.
b. The man bought a bicycle. The man was very happy.

Are these different alternatives in free variation, or are they constrained in some manner? (Bolinger (1972, p72) quoted in Prince (1978) states that:

> "There are situations where the speaker is constrained by a grammatical rule, and there are situations where he chooses according to his meaning ...; but there are no situations in the system where "it makes no difference" which way you go."

In other words, when there appears to be a choice of syntactic structure, that structure is constrained by additional factors. Following Slioussar (2007), in this thesis I define the syntax-discourse interface as those phenomena where the choice of a syntactic option is guided by discourse constraints.

How should we define discourse constraints? In a discourse, which could be either a text or a dialogue, the speaker (or writer) introduces entities, and continues to refer to them in subsequent sentences or utterances. The speaker must take the knowledge of the listener into account, as some entities will

be familiar to the listener, either because they have already been introduced to the discourse or are salient due to extra-linguistic factors. The status of different entities in a discourse is often discussed in terms of cognitive status (Gundel, Hedberg & Zacharski 1993). Some entities are more prominent, or salient than other entities to the speaker and listener (or writer and reader). For example, in this extract from the children's story *The very hungry caterpillar* (Carle 1969), a story about the lifecycle of a caterpillar, the caterpillar is highly salient. In (2.3a), the caterpillar is first introduced as *a tiny and very hungry caterpillar* in (2.3a) using the indefinite article *a*, and in the post-verbal position. In subsequent mentions, however, the caterpillar is already salient, having previously been introduced, and a different form, a pronoun *he*, (Example (2.3b))is used to refer to the caterpillar.

(2.3) a. One Sunday morning, the warm sun came up and POP! Out of the egg came a tiny and very hungry caterpillar.
b. He started to look for some food.
c. On Monday he ate through one apple, but he was still hungry.
d. On Tuesday he ate through two pears, but he was still hungry.

Carle (1969, p4-7)

Although it is difficult to define salience precisely, it can be thought in terms of prominence: the caterpillar is salient because it is referred to repeatedly, and easy to identify. In the story, on each day a new foodstuff (Examples (2.3c), (2.3d)) is introduced, which becomes salient briefly but is not mentioned subsequently, and so the level of salience for each foodstuff decreases. Salience within a discourse can therefore be said to be dynamic: with each utterance or sentence the relative salience of different entities may increase or decrease. The use of different syntactic options can either track salience levels which have developed either in the discourse or due to extra-linguistic factors, or can be used to influence the salience of an entity.

Different syntactic options can signal that an entity is prominent, and likely to be referred to again later in the discourse, or that a given entity is new to the discourse. For example, in (2.3a), *a tiny and very hungry caterpillar* in the post-verbal position, is a signal that this is new information (Lozano &

Mendikoetxea 2008). Alternatively, the choice of anaphor (null pronoun, overt pronoun, etc.) can indicate how prominent in the previous discourse its antecedent is, and thus enable the comprehender to identify the correct referent more easily. For example, subsequent references to the caterpillar use the pronoun *he* rather than repeating the NP. Cowles (2003) argues that the ability to encode these distinctions of salience linguistically facilitates processing in native speakers, in that it helps the processor to anticipate upcoming words and integrate these into the discourse. For example, if an entity is encoded as a Topic, then the comprehender will try to interpret the following utterance as containing information about that entity. In short, encoding distinctions of salience linguistically allows the processor to predict upcoming information. It should be noted, though, that although there are linguistic options for encoding notions such as prominence, these are part of the wider extra-linguistic conceptual structure of a given context. For example, although an entity hasn't been explicitly mentioned in the discourse, if it is known to be prominent to both the speaker and listener, it is not necessary to use a linguistic means of signalling this. The physical presence of an entity, or even the fact that it can be inferred from a context (e.g. the presence of a waiter in a restaurant can be inferred) can contribute to salience. However, such entities only become salient to the extent that they form part of the mental model of the discourse, since not every entity which is physically present is salient.

It has been proposed that discourse features are syntax internal; Rizzi (1997) proposes a structural Topic and Focus position. Under a Minimalist analysis, movement must be triggered by a feature, and is not optional. However, word order alternations are typically optional; the felicity of an utterance being dependent not just on the choice of word order, but also on extra-linguistic factors. It is therefore not fully clear how syntactic features causing obligatory movement are compatible with discourse determined word order variation. Fanselow (2007) points out that certain marked word order are ambiguous between different information structure readings. Although it could be argued that certain information structure functions can be expressed and disambiguated using prosody, it seems clear that encoding discourse features within the syntax is problematic. Fanselow also notes that in some languages linear position and not hierarchical position are crucial for discourse features,

suggesting that discourse is external to the syntax. Fanselow (2007, p209) proposes that:

> "Results of syntactic processes can be exploited by distinctions of information structure, but this does not show that these processes are triggered by them"

In other words, in representations of the syntax-discourse interface, there is a link between certain syntactic constructions and discourse features, but that link is not internal to the syntax.

Theories of the syntax-discourse interface need to account for the way in which different syntactic options are used to encode different levels of salience. This can be considered from two different perspectives. Firstly, the way in which entities are introduced into a discourse; these are entities which have no prior mention, and since they are typically not easily identifiable, of low salience. Secondly, theories should explain which referring expressions are used to refer to which entities previously mentioned in the discourse (anaphor resolution). A further issue is cross-linguistic variation. Not all syntactic options are available in every language: Italian, for example, allows null pronouns, whereas English does not, as shown in Examples (2.4) and (2.5). It is currently not clear the extent to which different languages use the same linguistic structures to encode different discourse factors. The following sections will examine current approaches to the syntax-discourse interface, and lay out a framework which will form the basis of my assumptions about the syntax-discourse interface in this thesis.

(2.4) *Il portiere*$_i$ *saluta il postino*$_k$ *mentre Ø*$_i$*/lui*$_k$ *apre la porta.*
the doorman greets the postman while null/he opens the door
The doorman greets the postman while he opens the door.

(Sorace & Filiaci 2006, p342)

(2.5) *The doorman greets the postman while Ø opens the door.

The terminology used to define aspects of the interface is frequently inconsistent across different theories, with the same term being used with very different meanings by different theories in different disciplines. For example the term *Focus* is used to mean information which is discourse-new in linguistic theories (see e.g. Lozano (2006)), whereas psycholinguistic theories (see e.g. Almor (1999)) typically use *Focus* to mean discourse-old and salient information, which is more similar to the linguistic notion of *Topic*. A further distinction should also be made regarding whether a term refers to a structural notion or a psychological notion. For example, *Topic* is used to mean both a structural position and salient, discourse-old information. In the following discussion it will be specified which of these meanings is intended with respect to each theory.

2.2.1 Choice of referring expressions

Gundel et al. (1993), as part of their Givenness Hierarchy, propose an implicational hierarchy of cognitive statuses which an entity in a discourse may have, as shown in Example (2.6). Their hierarchy ranges from the least salient cognitive status *type identifiable*, such that the type of entity is identifiable, e.g. an entity which can be described as a caterpillar, but which cannot be identified as a particular caterpillar. Gundel et al use *in Focus* to refer to the most salient, or given, entity.

(2.6) in Focus > activated > familiar > uniquely identifiable > referential > type identifiable

Gundel et al. (1993) link this hierarchy of cognitive status to linguistic forms, as shown in Table 2.1 for English.

in Focus	activated	familiar	uniquely identifiable	referential	type identifiable
pronoun (it)	this N	that N	definite article (the N)	indefinite (this N)	indefinite article (a N)

Table 2.1: Gundel et al's (1993) Givenness Hierarchy

For example, in (2.7a), *a cocoon* is mentioned for the first time. In this mention it is type identifiable, and so an indefinite article is used, but in (2.7b), on the second mention, it is uniquely identifiable, and so *the cocoon*, a definite article is the form used. The caterpillar, being *in Focus* in Gundel et al's terms, or highly salient, is referred to by the pronoun *he*.

(2.7) a. He built a small house around himself, called a cocoon, and he stayed inside for more than two weeks.
b. Then he nibbled a hole in the cocoon, pushed his way out, and he was a beautiful butterfly.

Carle (1969, p13)

Importantly, the Givenness Hierarchy is an implicational hierarchy: if an entity has the cognitive status, of, for example, *familiar*, it also has all the statuses lower on the hierarchy, i.e. it is also uniquely identifiable, referential and type identifiable. Gundel et al propose that the Givenness Hierarchy interacts with Grice's (1975) Maxim of Quantity. At the lower end of the hierarchy, using a type identifiable marker when the entity is uniquely identifiable is less informative than using a uniquely identifiable marker, violating Grice's Maxim. However, at the higher end of the hierarchy, using a pronoun (showing an entity is in Focus) rather than a full lexical NP is less informative, as the pronoun is less informative, as a pronoun typically only contains number and gender information. Gundel (1998) however suggests that using an anaphor which is less informative than necessary is less problematic than providing too much information. She gives the example of using a full definite NP, which signals identifiability, rather than an NP with a demonstrative pronoun, which is higher on the hierarchy. Gundel proposes that since showing that an NP is identifiable is sufficient to identify the referent, it is unnecessary to give the higher cognitive status. Gordon & Hendrick (1998) present experimental evidence to support this claim: repeating a lexical NP (rather than using a pronoun for the second mention) causes processing difficulty. This would be expected by the Givenness Hierarchy, as the second mention of an entity would use a form higher on the hierarchy. However, more recent research (Engelhardt, Bailey & Ferreira 2006) suggests that in production at

least, speakers are more likely to give surplus information, violating Grice's Maxim of Quantity in the opposite direction.

Ariel's (2001) Accessibility Theory takes a similar approach, albeit with different terminology. She states the level of salience in terms of accessibility with respect to the mental representation of the discourse, rather than the highly related notion of cognitive status. Ariel (2001, p30) argues that "context retrievals of pieces of information from memory are guided by signalling to the addressee the degree of accessibility with which the mental representation to be retrieved is held". That is, the addressee is able to decide which entities are prominent, and should retain high levels of activation, or accessibility by the way in which these entities are encoded. She proposes that referring expressions code a specific degree of mental accessibility, furthermore, that the choice of referring expression serves as a marker of accessibility. Rather than forming an implicational hierarchy, she notes the following factors which contribute to accessibility:

- Global discourse Topics > local discourse Topics > non-Topics
- 1st and 2nd person > 3rd person
- Frame induced entities (e.g. waiter in restaurant) > Inferred entities
- Fewer potential antecedents > more potential antecedents
- Recent mention > distant mention
- Use of Subject position

Clearly, these factors interact with Gundel et al.'s (1993) Givenness Hierarchy. In a conversation, the 1st and 2nd person are at least identifiable, even if not in Focus, whereas 3rd person mentions could be at any point on the Givenness Hierarchy. Similarly, frame induced entities could be considered to be more identifiable than inferable entities prior to their first mention. However, one clear advantage of Ariel's approach is that the factors which contribute to higher accessibility, or cognitive status are made explicit. These factors include both factors from within the discourse, such as recency of mention and use of Subject position, and extra-linguistic factors, such as the distinction between inferred and frame induced entities. However, both types of factor contribute to the accessibility of an entity within the mental representation of the discourse, although physical salience only indirectly influences the mental

representation of the discourse. Ariel assumes that all these factors contribute to a global notion of salience, which is linked to the choice of referring expression. It is not clear whether all of these factors have the same importance when determining salience, or whether some contribute more to salience.

Ariel's linking of different levels of accessibility to different forms follows the same pattern as those given in the Givenness Hierarchy, as shown in 2.8, where the form used for the most accessible entities precedes the form used for the less accessible entities.

(2.8) zero >verbal person inflections > cliticized pronoun > unstressed pronoun > stressed pronoun > stressed pronoun + gesture > proximate demonstrative (-NP) > distal demonstrative (-NP)> proximate demonstrative +NP > distal demonstrative +NP > proximate demonstrative + modifier > distal demonstrative + modifier > first name > last name > short definite description > long definite description > full name > Full name + modifier

(Adapted from Ariel (2001, p31)).

Ariel proposes that three criteria dictate the link between accessibility and form:

(2.9) a. Informativity (amount of lexical information)
b. Rigidity (ability to pick a unique referent based on the form)
c. Attenuation (phonological size)

Ariel (2001, p32)

Of these three criteria (2.9a) and (2.9b) are relevant for the syntax-discourse interface; these two criteria overlap substantially. For example, 3rd person personal pronouns have low informativity, in that they typically only give number and gender information, and low in rigidity, as, based on the form alone, potential antecedents include any entity which shares number and gender with the pronoun. Almor (1999), (2000) develops the hypothesis that informativity is central to the choice of referring expression. His Informational

Load Hypothesis proposes that there is a processing cost associated with using an informative anaphor with a salient (using Almor's terminology, *focussed*) antecedent, caused by the need to activate the full semantic representation of the anaphor. However, Almor's data are based on anaphors from the low accessibility or low cognitive status range of the scale, in that he compares different NP anaphors, rather than the full range of referring expression. In Almor (2000) he claims that the Informational Load Hypothesis would also apply to pronouns, but does not present data which contrast different types of pronominal.

Givón (1983) presents an alternative scale, which includes the structural position of an NP as a factor in topichood (topichood being here equivalent to Gundel et al.'s (1993) in *Focus*).

(2.10) zero anaphora > unstressed bound pronouns or grammatical agreement > stressed or independent pronouns > right dislocated definite NPs > neutral ordered definite NPs > left dislocated NPs > dislocated NPs > cleft/Focus constructions > referential indefinite NPs

Givón's hierarchy integrates the form of the referring expression with the structural position of the referring expression, suggesting that the form of the referring expression alone is insufficient to determine the cognitive status or accessibility of its antecedent. However, together with both Ariel and Gundel et al's frameworks, this raises the important issue of cross-linguistic variation. Not all types of referring expression, nor syntactic structure listed above are available in every language, and some languages may have additional options (such as Topic marking in Japanese, where Topics are marked morphologically). As can be seen in Table 2.2, Chinese, for example does not make a distinction between definite and indefinite NPs, however, null pronouns are licensed (N.B though null pronouns are licensed differently from null pronouns in Spanish). English, on the other hand, does not licence null pronouns. However, since all languages are able to encode all levels of *givenness* or prominence, the givenness space must be assigned differently across languages, with one type of anaphor potentially having different functions in different languages.

	Indefinite NPs	Definite NPs	Full Names	First names	Pronouns	Null Pronouns
Chinese						
Spanish						
English						

Table 2.2: Use of different anaphors in Chinese, Spanish and English

While Table 2.2 might suggest that there are discrete levels of givenness, this is of course not the case: it is a continuum. Therefore, within the *givenness* space, it seems likely that languages will stretch the available syntactic options to cover all degrees of givenness. English speakers, therefore, would use pronouns where Spanish speakers would use a null pronoun because at this end of the hierarchy Spanish has a distinction which English does not.

To summarize, there are several different theories of the syntax-discourse interface which address the choice of different referring expressions. Each theory emphasizes different factors which can influence what type of referring expression is chosen. However, overall, there is agreement about the ordering of referring expressions from those referring to salient antecedents to unsalient antecedents. The challenge which remains is to determine how to link these different forms to the relevant factors.

2.2.2 Information structure

In the previous section I discussed the factors affecting the choice of referring expression. The theories reviewed generally converged on the relationship between form and salience, but differed regarding the factors which determine the salience of a potential antecedent. In this section I explore the different means of encoding an entity as salient, and a potential antecedent for a subsequent anaphor. This area is closely related to the traditional notion of Information Structure (see e.g. Lambrecht (1994)) which explains the way in which discourse-new and discourse-old information is encoded. However, although the terms discourse-new and discourse-old are convenient descriptive terms,

I would argue that these terms fall under the notion of salience: a discourse-new entity is not salient, because it has previously not been mentioned, while a discourse-old entity would typically be relatively salient.

Gernsbacher (1989) proposes several factors which are linked to the subsequent referential access, of which two are relate to the syntactic encoding of discourse notions[1]. She argues that the psychological Topic (as opposed to the structural Topic) is likely to be referred to subsequently by accessible anaphors. She proposes that this is because the psychological Topic is typically the first mentioned entity. First mentioned entities form the foundation of an utterance, and all subsequent entities must be added to this entity to form the discourse model. She argues that the first mention advantage is not due to grammatical role, as in Example (2.11a) *Ann* still retains an advantage, even though both *Ann* and *Pam* are both Subjects. Similarly, thematic role does not share the same importance; in Example (2.11b), the fact that the first mentioned entity *Ann*, is not an Agent does not alter the first mention preference. The first mention preference is argued to be a result of general cognitive factors, rather than processes specific to language comprehension.

(2.11) a. Ann and Pam argued with one another at the party.
b. Ann was beaten by Pam in the state tennis match.

Gernsbacher (1989, p141)

Grosz, Joshi & Weinstein (1995) however, within a Centering Theory framework, propose that for some languages at least, grammatical role does play an important role. Centering Theory (see also e.g. Walker, Joshi & Prince (1998)) is a theory of local discourse coherence. In an utterance, all the entities evoked by that utterance are termed forward-looking centers (Cf). Each utterance contains a backwards-looking Center (Cb) (one of the set of forward-looking Centers), which roughly corresponds to the psychological Topic of an utterance. The forward-looking Centers are ranked according to discourse salience, and the highest ranked Cf termed the Preferred Center (Cp). Centering Theory

[1]Referential distance, i.e. the distance between the anaphor and its antecedent, although an important factor, is a property of the discourse, rather than the syntactic encoding of discourse notions, so will not be discussed here

predicts that the Cp will be the Cb of the following utterance. Much of the work in Centering Theory has focussed on the relevant factors for determining the ranking of forward-looking Centers. Grosz et al. (1995), using English data, propose that grammatical role and pronominalisation affect the ranking of forward-looking Centers, with Subjects outranking Objects, which outrank other grammatical roles. However, Gordon, Grosz & Gillom (1993) found that for English, linear order was an significant factor for ranking Cf, and that the importance of grammatical role was unclear. However, since grammatical role is closely correlated with linear order in English, it is perhaps unremarkable that it is difficult to separate these two constraints. Grosz et al also proposed that pronominalised entities are high-ranking. However, since pronouns are typically used for highly accessible elements, which would, in a Centering Theory framework be the Cb, this is perhaps not surprising. Strube & Hahn (1999) take a different approach, and instead adopt Prince's (1981) familiarity terms, such that hearer-old discourse entities have a higher ranking than discourse-new entities. This approach, called *Functional Centering* by Strube and Hahn only makes indirect predictions about the linguistic encoding of the set of forward-looking Centers: from Strube and Hahn's approach it is difficult to make firm predictions about the linguistic realisation of high and low ranking forward looking Centers.

Work on the ranking of forward-looking Centers has been extended to other languages. Rambow (1993) proposes that for German, which has a much freer word order than English, linear order is the more important constraint. Hoffman (1998) found that in Turkish, grammatical role determines the ranking of forward-looking Centers. Kameyama (1985), cited in Cote (1998), found that for Japanese, Topic (indicated by -wa case-marking) and empathy markers play an important role in ranking the set of Cf. Clearly, there is a certain degree of cross-linguistic variation, which is at least partially determined by the syntactic options available in a given language.

Many studies discussed thus far have focussed on the role of one factor as being relevant for a given language, however, as Grosz et al. (1995) note, it is likely that more than one factor will contribute to the ranking of the set of Cf. Järvikivi, van Gompel, Hyönä & Bertram (2005) compared the first-mention and Subject preference accounts of discourse salience by examining whether

Subjects, or First mentioned entities were preferred as the antecedents of personal pronouns in Finnish using the visual-world paradigm. Finnish has a flexible word order, allowing Objects and Subjects to occur pre-verbally in sentence initial position so that it is possible to contrast the two accounts. They found that both grammatical role and order of mention affected the antecedent preferences: although Subjects were preferred overall for both SVO and OVS word order sentences, that this effect happened early. An effect of linear order emerged later, suggesting a slight preference for first mentioned entities. Furthermore Rose (2005), in a series of corpus and self-paced reading tasks found that both grammatical and thematic role did contribute to the salience of entities in discourse, and their availability for pronominal reference in subsequent utterances.

To summarize, it seems that more than one factor is relevant for determining how to encode potential antecedents. The studies discussed in this section suggest that it is necessary to consider more than one constraint when forming predictions, and that there is considerable cross-linguistic variation. Chapter 4, Section 4.2 provides further discussion of information structure processing in native speakers with respect to German.

2.2.3 Form Specific Multiple Constraint Approach

Recently a different approach to the syntax-discourse interface has emerged, which unites the issues discussed in the previous two sections: the Form Specific Multiple Constraint (FSMC) approach (Kaiser & Trueswell 2008). Under the FSMC approach, it is possible that within a language, one type of anaphor, such as a personal pronoun, would be sensitive to one type of constraint, such as grammatical role, whereas another type of anaphor, such a demonstrative pronoun, would be sensitive to a different type of constraint, such as linear order or topicality. Furthermore, as Kaiser and Trueswell note for Finnish demonstrative pronouns, a given anaphor may be sensitive to more than one type of constraint. For example, Accessibility Theory (see e.g. Ariel (2001)) would predict that in Italian, null pronouns would have a more salient antecedent than overt pronouns. Carminati (2002), however, has found that null pronouns, prefer antecedents in a particular syntactic position, spec IP, whereas overt pronouns are more flexible, preferring an Object antecedent or

a non-Topic antecedent. Although Carminati's 2002 findings do not contradict the Accessibility Hierarchy, since spec IP (typically grammatical Subjects) is a salient position, they add an additional dimension as we now know exactly which factors contribute to the antecedent preferences of these two anaphors (See Chapter 5, Section 5.2 for further discussion).

This type of approach may go some way towards resolving the discrepancies between studies discussed above. Theories of referring expression (e.g. Ariel's Accessibility Theory) try to match different types of referring expression along one salience scale. However, each different scale emphasizes different factors. If different types of anaphor are sensitive to different constraints, then we would anticipate that it would prove problematic to formulate one unifying scale, as seems to be the case. Conversely, in Centering Theory terms, there is little agreement concerning the ranking of forward-looking centers. If, however, different "types" of backward-looking centers (or anaphors) were sensitive to different factors, it would not be feasible to develop one scale which applied to the ranking of forward-looking Centers with respect to all backward-looking centers. The basic question which theories of the syntax-discourse interface address still remains the same: which factors are used to encode different levels of salience? However, under the FSMC approach, it is clear that the use of a monotonic scale is no longer appropriate.

This approach allows a more detailed examination of the syntax-discourse interface with respect to L2 processing. Previously there has been little attempt to separate which aspects of the interface are difficult for L2 learners, (with the exception of Sorace & Filiaci (2006)). By examining different types of constraint, it is possible to determine which means of encoding salience are problematic, or not, for L2 learners, which contributes to our understanding of the nature of L2 processing at the syntax-discourse interface. In the following sections I examine the acquisition problem faced by L2 learners, and discuss this issue in terms of different aspects of the interface.

2.3 The Syntax-Discourse Interface in L2 Acquisition

The Interface Hypothesis (Sorace & Filiaci 2006) proposes that although L2 learners are able to acquire narrow syntax, they have residual difficulties at the

interface of syntax with other domains. Sorace & Serratrice (2008) propose a distinction between internal interfaces, such as the syntax-semantics interface, and external interfaces such as the syntax-discourse interface, with the latter resulting in greater difficulties in bilingual first language acquisition. In this thesis I use the terms *difficulty* and *deficit* to describe the differences between L2 learners and native speakers. However, this relies on the traditional notion that L2 learners are considered to *fail* if their behaviour in the L2 does not converge on that of native speakers (Lardiere 2006), and *succeed* if they do converge. However, as will be discussed in more detail in Chapter 7, this notion of L2 *success* or *failure* is not necessarily appropriate. Where the terms *difficulty* or *difficulty* are used, they should be considered to be referring to a *difference* between L2 and monolingual native speaker behaviour. In this section I discuss the necessary and sufficient conditions which L2 learners must meet to converge with native speakers when processing syntax-discourse interface phenomena in terms of a representational and processing deficit, then examine the literature on L2 acquisition and the syntax-discourse interface. Finally, I compare the deficits observed in L2 learners with the behaviour of other populations with developing language systems, to form hypotheses about the nature of the difficulties which L2 learners might have at the syntax-discourse interface.

2.3.1 Acquiring representations at the syntax-discourse interface

What exactly is the acquisition task for the L2 learner? The L2 learner must link the appropriate syntactic feature with the appropriate discourse feature, i.e. know which level of salience should be linked to which syntactic form. I term knowledge of this link *representation*. One prerequisite is that L2 learners are able to acquire the appropriate syntactic representations: only if there is an appropriate syntactic representation is the L2 learner able to link this representation to discourse features. The extent to which L2 learners are able to acquire such syntactic representations is currently a matter for debate. The Shallow Structure Hypothesis (SSH) (Clahsen & Felser 2006*a*, Clahsen & Felser 2006*b*) states that L2 learners underuse syntactic information during parsing, relying more on lexical-semantic information. Clahsen and Felser propose

that the underuse of syntactic information during parsing is a result of a representational deficit: L2 learners are unable to store syntactic representations in a form which is accessible for parsing. However, the SSH is based on studies where there was a high processing load for the L2 participants. For example, Marinis, Roberts, Felser & Clahsen (2005) investigated the processing of long-distance filler gap dependencies. Following Gibson & Warren (2004), adult native speakers show evidence of intermediate gaps in sentences such as Example (2.12). Native speakers show longer reading times at the intermediate gaps e_2 and e_1 because they are integrating the moved wh-phrase *who*. However, Marinis et al. (2005) found that L2 learners did not show evidence for these intermediate gaps, and concluded that L2 learners linked the wh-phrase directly with its subcategoriser *angered*. Although this study demonstrates that L2 learners may use syntactic dependencies to a lesser extent than native speakers under certain circumstances, the syntactic structures used are difficult even for native speakers to process, so it is possible that L2 learners may not have behaved like native speakers due to the high processing load, rather than an inability to use (even inappropriate) syntactic representations in processing.

(2.12) [$_{DP}$The nurse][$_{CP}$[who$_i$ [the doctor] argued [[e$_2$] that [the rude patient] had angered] [e$_1$]]]]is refusing to work late.

Marinis et al. (2005, p61)

Even if it is assumed that L2 learners are able to acquire appropriate syntactic representations, it is a matter of debate about the initial syntactic representation (see e.g. Schwartz & Sprouse (1996); Vainikka & Young-Sholten (1996); Hawkins & Chan (1997)), and it is not clear at what level of proficiency L2 learners are able to link discourse features to syntactic representations. For example, an L2 learner of Italian with English L1 would need to acquire pro drop (evidence suggests that the acquisition of pro drop is possible, (see e.g. Hawkins (2001) for discussion) either before, or possibly at the same time as being able to acquire the discourse properties of null pronouns. Hopp (2007) points out that processing the discourse constraints of a syntactic structure as well as processing the syntactic structure itself adds an additional layer of

computational complexity. If the newly acquired syntactic construction were not processed using a high degree of automaticity, then this additional layer of complexity may prevent the link between the syntactic construction and the discourse features of that construction being acquired initially, at least. The issue of transfer is also unclear, as to the extent to which transfer from the native language can facilitate, or lead to inappropriate representations. As noted in Section 2.2.1, not all syntactic options are available in all languages, such that different syntactic options may have slightly different discourse implications. The extent to which L2 learners transfer the different discourse implications of different syntactic options has not been investigated in detail (though see Hopp (2007)).

2.3.2 Processing deficit

It is not necessarily the case, though, that representations are impaired in L2 learners. Although this cannot currently be ruled out, it is also plausible that L2 learners' difficulties at the syntax-discourse interface are caused by a processing deficit. When processing discourse, there are many sources of information to integrate: real world knowledge, knowledge of the speaker, the current discourse model (which entities have been mentioned, and are prominent, etc.), and syntactic knowledge. It is plausible, for example, that L2 learners have a deficit in resource allocation, described by Levy (2008) as the ability to allocate processing resources such as, but not limited to, memory during processing. This could lead to a failure to link the correct syntactic structures to the correct discourse features. Alternatively, there could be lack of availability of processing resources, such as memory, which causes differences from native speaker processing.

Processing is central to the acquisition of appropriate representations. Evidence for the correct representation may be found in the input, which the learner must process, by determining which syntactic features co-occur with which discourse features. To perform in a nativelike manner, the learner must not only acquire the correct syntactic representation, but also be able to maintain a model of the discourse, and be able to integrate both the linguistic input and extra-linguistic information to determine an interpretation of the utterance, and ultimately determine which syntactic structures signal which

discourse features. Even assuming that L2 learners are able to acquire appropriate syntactic representations, it is not clear how L2 learners would make the link between syntax and discourse. There are several theoretically possible options. Firstly, general cognitive principles, such as the fact that the first mentioned entity is most salient, can provide information to the learner. Secondly, the extra-linguistic context can provide information about the intentions of the speaker. A correlation of this extra-linguistic information with certain structures would enable the L2 learner to associate certain structures with certain discourse features. However, since the link between syntax and discourse is typically considered in terms of *preference*, or *felicity*, rather than acceptability, the input is likely to be noisy. For example, the extra-linguistic context may additionally provide discourse information which obscures the link between syntactic and discourse features. A failure to process the input appropriately could lead to several outcomes. It is possible that the input is misanalysed, and inappropriate representations are formed. This could be due to an over-reliance on general cognitive principles (e.g. first mentioned entity is most salient), or the failure to integrate information from the extra-linguistic context with the syntactic structures. It is further possible that processing is so impaired, that it is simply not possible to integrate different sources of information and form any links at all. The final possible option is that the L2 learner is left with a greater degree of optionality than native speakers - an inappropriate representation could co-exist with the appropriate representation due to the noisy nature of the input. In this thesis I focus on the extent to which L2 learners' online processing behaviour is affected by processing limitations; a more detailed investigation of the implications of a processing limitation for representations is beyond the scope of the current work.

There have been a limited number of offline studies of the syntax-discourse interface. In the following section I review and summarize the major findings of these studies, which fall broadly into the two categories described in Section 2.2: those which look at the interface from the perspective of the antecedent, and those which look at the interface from the perspective of the anaphor.

2.3.3 Anaphor resolution in L2

Much of the research conducted on the syntax-discourse interface from the perspective of the anaphor has been based on pro-drop languages such as Spanish and Italian. In a story translation task, Pérez-Leroux & Glass (1999) compared the use of null Subjects in Spanish in two contexts: where the antecedent of the pronoun is a quantifier and the distribution is claimed to be regulated by a principle of Universal Grammar, and where the distribution of the null pronoun is dependent on discourse constraints. They concluded that there was early mastery of null Subjects in the formal syntax condition, whereas mastery of the discourse condition was gradual for L2 learners. However, their definition of formal syntax versus discourse contexts could be disputed. In Spanish, overt Subject pronouns are used to encode Focus, for new or contrastive information, Null Subjects, on the other hand have been said to be used for discourse Topics. However, Pérez-Leroux and Glass argue that the behaviour of null and overt pronouns in quantifier binding is a formal syntactic constraint. In this situation, overt pronouns refer to particular individuals, whereas null pronouns are ambiguous between a variable interpretation and a referential interpretation. While it is clear that additional syntactic constraints apply in the quantifier context, it is not clear how the referential function of the null versus overt pronoun is not also a discourse constraint. This is particularly relevant in the light of Carminati's (2002) work on Italian, which suggests that specific syntactic positions are preferred as the antecedents for null pronouns, such that if null pronouns in Spanish are subject to the same constraints as Italian null pronouns, then the crucial distinction between these two conditions could be said to one of a narrow syntax versus and interface condition. Currently, however, the exact constraints determining the antecedent preferences of null and overt pronouns is not fully clear.

Polio (1995) investigated the acquisition of null anaphora in a Topic drop language, Chinese. Participants with English and Japanese L1, and native speakers of Chinese were asked to produce narratives based on the Pear Film (Chafe 1980). She found that L2 learners behaved in a nativelike manner where there was a semantic restriction on the use of null pronouns, but struggled where there was a discourse constraint. Both groups of L2 learners produced more overt pronouns than the native speakers, with the number of null

pronouns increasing with proficiency. As Japanese also has null pronouns, licensed and identified similarly to Chinese null pronouns, this seems to rule out the possibility that transfer from the L1 strongly affects the use of null pronouns. Polio argues that there are several possible explanations for the overuse of overt pronouns. Firstly, it is possible that using an overt pronoun allows the learner extra time to process the sentence. Secondly, it could be the case that the input that the learners received contained more overt pronouns, as native speakers may use more overt pronouns with non-native speakers of Chinese. Finally, Polio suggests that L2 learners overuse full NPs or overt pronouns to improve clarity, though she does not examine closely whether or how the under-use of null pronouns does improve clarity.

More recently, Sorace & Filiaci (2006) investigated the use and interpretation of null and overt pronouns in near-native speakers of Italian, a pro drop language using a picture verification task. They present data which suggest that even near-native speakers of Italian with English L1 over produce overt Subjects, and are more likely to misinterpret overt pronouns as being coreferential with a preceding Subject than native speakers (see Example 2.4). The near-native group behaved in a nativelike manner with respect to null pronouns, however. They suggest that processing overt pronouns is more difficult, as different sources of knowledge from different domains (discourse, syntax) must be integrated to compute an interpretation of overt pronouns, whereas processing the more closed system of a syntactic dependency requires fewer processing resources. Lozano (2009) presents data which supports this hypothesis. He explored the acquisition of the antecedent preferences of Spanish null and overt pronouns in a corpus study, comparing first, second and third person pronouns. He found that first and second person pronouns were used in a more targetlike way with respect to their antecedents compared to third person pronouns. It could be argued that first and second person pronouns typically have fewer potential antecedents than third person pronouns, and so first and second person pronouns would require fewer processing resources.

One of the few studies which examines L2 anaphor resolution in a non null-Subject language and uses an online methodology investigates the interpretation of Subject pronouns in Dutch by native speakers of German, also a non null-Subject language, and Turkish, which has null Subjects. Roberts,

Gullberg & Indefrey (2008) compared the results of an offline acceptability task and an eye-tracking during reading study. In Dutch, a Subject pronoun prefers to have a sentence internal referent, such that (2.13a) (local resolution) is preferred to (2.13b), where a disjoint referent is forced. In (2.13c) (optional resolution), it is possible to interpret the pronoun *hij* as either Peter or Hans, however, due to the preference for a local antecedent, Peter is the preferred referent.

(2.13) a. *De werknemers zitten in het kantoor. Terwijl Peter aan*
the workers are in the office. While Peter at
het werk is, eet hij een boterham. Het is een rustige
his work is, eat he a sandwich. it is a quiet
dag.
day.
The workers are in the office. While Peter is working, he is eating a sandwich. It is a quiet day.

b. *De werknemers zitten in het kantoor. Terwijl Peter aan*
the workers are in the office. while Peter at
het werk is, eten zij een boterham. Het is een rustige
his work is, eat they a sandwich. it is a quiet
dag.
day.
The workers are in the office. While Peter is working, they are eating a sandwich. It is a quiet day.

c. *Peter en Hans zitten in het kantoor. Terwijl Peter aan*
Peter and Hans are in the office. while Peter at
het werk is, eet hij een boterham. Het is een rustige
his work is, eats he a sandwich. it is a quiet
dag.
day.
Peter and Hans are in the office. While Peter is working, he is eating a sandwich. It is a quiet day.

Roberts et al. (2008, p341)

In the offline judgement task, Roberts et al. (2008) report that the Turkish learners interpreted Dutch Subject pronouns as they would overt pronouns in Turkish, in that they allowed the sentence external referent in the optional resolution condition, while the German group performed like the Dutch native

speakers. However, in the eye-tracking study, the two L2 groups patterned together, showing a processing difficulty in sentences such as (2.13c), where there were two potential antecedents for the pronoun. Roberts et al. (2008) characterize the processing limitations of L2 learners in terms of a difficulty integrating multiple sources of information in online processing. They conclude that L2 learners show a processing difficulty, regardless of their L1. However, the effect of the L1 remains unclear, as Roberts et al. (2008) assume that Turkish behaves like other null Subject languages with respect to the interpretation of null and overt pronouns. Recent work by Filiaci (2008) suggests that there is cross-linguistic variation even between two closely related languages, Spanish and Italian with respect to this phenomenon, so it is perhaps premature to draw strong conclusions about the effect of the L1 in the Turkish group. This study does highlight the need for more online measures of L2 processing of anaphor resolution, as different results were obtained across the acceptability and eye-tracking studies. One disadvantage of using an eye-tracking during reading study is that no online measure of interpretation is possible. It is possible that although the German group ultimately reach the same interpretation as native speakers, that this is slower than in the native group, but the eye-tracking during reading only records the initial difficulty. In Chapter 5, Section 5.5, more detailed predictions for L2 learners' behaviour with respect to the antecedent preferences for anaphoric demonstratives and pronouns in German are discussed; Experiments 7 and 8 investigate these hypotheses.

2.3.4 Information structure in L2

Research on the acquisition of information structure constraints has largely focussed on word order variation, with relatively few studies investigating other means of encoding discourse-new and old information. However, Carroll, Murcia-Serra, Watorek & Bendiscolli (2000) investigated the relevance of information organisation to second language acquisition, by examining the syntactic means which are used by learners of German with English and Spanish L1 for reference introduction, that is, how a new referent is introduced into the discourse. Participants described a scene and were asked to specify the location of particular objects.

Referents can be introduced using an existential *There is a...* or locational *Nearby there is a...* perspective. Additionally, it is possible to introduce entities in relation to previously mentioned entities *Near the museum there is a* . In German, referents are generally introduced using a locational perspective, whereas in English new referents are introduced using an existential perspective. In Spanish, entities are usually introduced in relation to other entities. Carroll, Murcia-Serra, Watorek and Bendisciolli found that while the English advanced learners of German were able to acquire the German locational perspective, the Spanish learners did not. They concluded that while their participants behaved in a nativelike manner in terms of their use of formal syntax, that the use of the appropriate syntactic form for reference maintenance was more difficult. It remains unclear why there was a difference between the Spanish and English learners of German, but suggests that different degrees of difference in the native language and target language with respect to the interface may facilitate or impair acquisition.

Turning to the study of word order variation with respect to information structure, Marefat (2005) investigated the acquisition of information structure by examining the acquisition of dative alternation by L2 learners of English with L1 Persian. In contrast to Carroll, Murcia-Serra, Watorek and Bendisciolli (2000), where learners were able to produce a wide range of structures, Marefat used an acceptability judgement task and controlled production task, facilitating classification and analysis of the data.

In English, dative structures are assumed to alternate freely between Prepositional Dative and Double Object, as in (2.14b) and (2.15b) However, rather than being in free variation, there is a discourse constraint whereby an NP carrying new information is dispreferred in the position immediately following the verb. Therefore, Example (2.14a) should elicit (2.14b), whereas (2.15a) should elicit (2.15b).

(2.14) a. What did you give to Mary?
b. I gave Mary a book

(2.15) a. Who did you give the book to?
b. I gave a book to Mary.

Marefat (2005, p72)

The production task indicated no effect of information structure in either the native speaker controls or the L2 groups. However, in an acceptability task, the high-intermediate and advanced L2 groups were similar to native speakers and showed a given-new preference. However, lower intermediate and elementary L2 learners did not show any information structure preference. The lack of effect of information structure in the production task is probably a result of priming - described by Marefat as *echoicity*; she found that native speakers and all levels of L2 learners, except for the elementary level, had a tendency to repeat the structure of the stimulus question. Interestingly, Marefat notes that while there were no overall differences between the higher level L2 groups and the native speaker groups, the native speakers seemed to differentiate between different verbs whereas the L2 learners did not. This suggests, contrary to Juffs (1998), that L2 learners have difficulty acquiring the appropriate representations for individual items.

Lozano (2006) and Hertel (2003) investigated the acquisition of word order alternations in L2 Spanish. In Spanish, word order is governed by both formal properties and discourse properties. Spanish native speakers demonstrate a preference for VS word order for unaccusative verbs, such as *venir* (come), while unergative verbs *gritar* (shout), have a SV order preference. However, this interacts with discourse conditions, so that Subjects which encode presentational Focus (or wide Focus) and introduce new information predicated about the Topic have a preference are post-verbal, whereas Subjects which are discourse Topics (typically old information) are pre-verbal. Therefore, SV word order is only preferred for unfocused sentences with unergative verbs. Using an acceptability judgement task, Lozano found that while learners with English and Greek L1s were sensitive to the formal lexical semantic constraints, they were not sensitive to the discourse constraints in a native-like manner. Hertel (2003), on the other hand found that her advanced and high intermediate learners were indistinguishable from native speakers in a production task. It is not clear why there is a difference between the results obtained by Hertel and Lozano, however, it is possible that the different demands of the tasks resulted in the difference.

In a subsequent corpus study, Lozano & Mendikoetxea (2008) examined a parallel phenomenon in Spanish learners of L2 English. In English he proposes that post-verbal Subjects are possible, but only when the verb is unaccusative, and the post-verbal Subject is focussed (new information) and phonologically heavy (i.e. long and complex). Lozano found that while L2 learners produce post-verbal Subjects under these conditions, that they overuse post-verbal Subjects to syntactic contexts which are not acceptable. He argues that these data suggest that L2 learners do not have a pragmatic deficit, but rather show difficulty encoding information structure correctly, however, it is not clear why difficulty encoding information structure correctly is not considered a pragmatic deficit.

Lozano proposes the issue is a grammatical problem, and concludes that "learners' deficits at the syntax-discourse interface are the result of their inability to encode Focus syntactically" (p178), and are insensitive to the uninterpretable strong feature of the functional Focus head. Asking the question as to why learners are unable to interpret a focused constituent (i.e. in VS order) as new information, he states that as it is universal that information is packaged into Topic and Focus, L2 learners must know from their L1 that presentational Focus in Subjects is used to encode new information. However, it is not clear how learners should automatically know this, as Topic and Focus are encoded syntactically differently in different languages: in short, it is not clear how the learner knows that VS word order in Spanish is used to encode presentational Focus, although in the participants in his studies, Spanish learners of L2 English, and English learners of L2 Spanish could in principle use L1 transfer. All the learner knows (initially, at least) is that presentational Focus must be encoded somehow in the syntax, and part of the acquisition task is to learn how Focus (and indeed other discourse factors) are encoded syntactically. Furthermore, he argues that the interfaces in adults are fully developed, and so the syntax-discourse interface in L2 learners must therefore be fully developed. However, this fails to take into account that the syntax-discourse interface functions differently in different languages - different structures are associated with different levels of the Givenness Hierarchy (Gundel et al. 1993).

Lozano's (2006) data indicates that L2 learners of Spanish do allow movement resulting in VS word order for unergatives; this suggests that the learners do

have a strong feature which triggers movement, but the fact that no preference for either SV or VS is shown in focussed conditions indicates that it is not clear which discourse condition prefers VS order. Additionally, the acceptance of VS order in the unfocussed condition differs between the native and non-native groups, suggesting that the strong feature is accepted more by the non-natives in the unfocused condition. Lozano ignores the role of processing in acquisition, in that all analyses of the data are described in terms of the underlying syntactic representations. Indeed, while he correctly points out that L2 learners should already understand notions of prominence, etc, it seems that they are unable to make the link between syntactic structures and items which are prominent. While it cannot be ruled out from these data that the underlying representations are non-nativelike, it is possible that the deficit is at the level of processing, leading to the development of non-nativelike representations.

Most studies of information structure in L2 processing have used offline measures of behaviour. Reichle (2008) investigated the processing of information structure violations in L2 French in an ERP study. Participants were shown photographs of objects followed by a written question and response about the item. In French, clefting is used to indicate Focus. In Examples (2.16) and (2.17), the question requires *marteau* (hammer) to be clefted. In (2.16), this is the case, whereas (2.17) is infelicitous. Reichle measured whether the N400 and P600 effects seen in native speakers for an information structure would be seen in L2 learners of French. While the low proficiency L2 learners showed a different response, a P3, the high proficiency L2 learners behaved in a nativelike fashion.

(2.16) a. *Cest quoi quon voit sur la table?*
it.is what that.one sees on the table
WHAT do we see on the table?

b. *Cest un marteau quon voit sur la table.*
it.is a hammer that.one sees on the table
We see a HAMMER on the table.

(2.17) a. *Cest quoi quon voit sur la table?*
it.is what that.one sees on the table
WHAT do we see on the table?

b. **Cest sur la table quon voit un marteau.*
it.is on the table that.one sees a hammer
We see a hammer on the TABLE.

Reichle (2008)

Hopp (2007) compared offline and online (self-paced) measures of the processing of scrambling in context in German by native speakers of English, Russian and Dutch, who were near-native speakers of German. He found an effect of native language, in that the Russian native speakers performed in a targetlike manner, showing sensitivity to context effects in Subject-Object and Object-Subject orders. The context was varied with a question which either required a Subject-Focus or Object-Focus answer, similar to the alternation shown for French in Examples (2.16) and (2.17). English native speakers showed a weaker effect of context, which did not emerge in the offline judgement task, while native Dutch speakers did not show context sensitivity. However, even near-native speakers showed morphological difficulty, which affected their ability to perform in a targetlike manner at the syntax-discourse interface.

To summarize, in this section it has been shown that although L2 learners do show difficulties with respect to information structure, at higher proficiency levels L2 learners can perform in a targetlike manner. However, this seems to occur in conjunction with facilitation from the native language (Hopp 2007), and in a context where the Focus is determined by nature of the question. Chapter 4, Section 4.4 presents a discussion of the predictions made with respect to the role of word order and pronominalisation in German L2 information structure.

2.3.5 Proficiency and L2 learners at the syntax-discourse interface

A further issue which needs to be raised in relation to these studies relates to the role of proficiency. Wilson (2005) found that processing at the lexical-semantic syntax interface correlated with time spent living in a native language environment (e.g. a German speaking area for learners of German), but did not correlate with proficiency scores on a standard placement test,

which measured formal syntactic knowledge. However, it is frequently the case that for reasons of practicality, studies which look at a range of proficiency levels use participants who are at various stages of a university course (see e.g. Hertel (2003), Pérez-Leroux & Glass (1999), Lozano (2006)). Those students in the most advanced group have frequently spent time abroad in an immersion environment. This means that this advanced group of students differ from the less advanced students not only in proficiency, but in the type and amount of exposure to the native language. It could therefore be the case, that rather than knowledge of the syntax-discourse interface being acquired later than formal syntactic representations, that different learning conditions are necessary, and only when the learner is exposed to the L2 in a naturalistic environment is it possible to develop competence at the syntax-discourse interface. The results obtained by Wilson suggest that it is advisable to control for both these factors, and, furthermore that this is an area of interest when studying the development of processing in second language acquisition. While it may be more problematic to find experimental participants who score highly on a proficiency test and yet have not spent extended periods of time in the target language environment, it is possible to find learners who have not yet developed their syntactic representations who are living in a target language environment.

2.3.6 Summary: L2 processing at the syntax-discourse interface

Most studies investigating the syntax-discourse interface in L2 acquisition have shown that L2 learners do not behave in a targetlike manner. However, in limited contexts, such as information structure processing in a question-answer context, higher proficiency L2 learners do behave in a targetlike manner. These results suggest that it is important to consider different aspects of the syntax-discourse interface to determine which aspects of the interface are problematic. It is possible, for example, that if there is a processing deficit, certain types of syntax-discourse interface phenomena have lesser computational demands, so that a targetlike performance is possible.

From a methodological perspective, it is clear that very few studies in this area have used online measures of behaviour, and of these studies there has been little attempt to understand incremental interpretation of syntax-discourse

phenomena. Since interpretation of these phenomena is crucial, there is a clear need for work to investigate whether L2 learners are computing the same interpretation of interface phenomena as native speakers.

2.3.7 *The underlying cause of L2 learners' difficulties at the syntax-discourse interface.*

The underlying cause of L2 learners' difficulties at the syntax-discourse interface has thus far received little attention. Although Sorace & Filiaci (2006) propose that the difficulties could be a result of computational limitations, and Clahsen & Felser (2006*b*) and Lozano (2006) propose that L2 learners have a representational deficit, at least with respect to syntax, very little work has explicitly investigated the issue. However, as Sorace (2005) suggests, by comparing processing at the syntax-discourse interface in other populations it is possible to form hypotheses about the possible causes. In the following sections I examine performance at the syntax-discourse interface in four populations where differences from adult monolingual processing have been observed: adults affected by attrition, both as a result of lack of exposure to the native language and language loss as a result of Alzheimer's disease, and child language acquisition, in monolingual and bilingual populations. The discussion will focus on anaphor resolution, as this area has been studied for all of these populations.

The syntax-discourse interface in child language acquisition

Early research on monolingual child acquisition of pronominals (Jakubowicz (1984), cited in Avrutin (1999)), demonstrated a difference between the interpretation of reflexive pronouns relative to personal pronouns. For example, children aged 4-6 years correctly accepted (2.18a) to describe a situation where Father Bear is washing himself, and correctly rejected it as description of a situation where Father Bear is washing somebody else. However, (2.18b) is sometimes incorrectly accepted by children of this age as describing a situation where Father Bear is washing himself.

(2.18) a. Father Bear washed himself.
b. Father Bear washed him.

c. Every bear washed him.

Avrutin (1999, p16)

Chien & Wexler (1990) showed that children are sensitive to the nature of the antecedent, as when the antecedent is quantified, as in Example (2.18c), children reject coreference between *Every bear* and *him*. Avrutin (1999) argues that this distinction is a result of a lack of processing resources: children perform better where there are only syntactic dependencies, as hypothesized for reflexive pronouns (Chomsky (1981), but c.f. Sturt (2003)), but are less targetlike for tasks which require the integration of syntax with discourse.

However, although children seem to show difficulties at the syntax-discourse interface, they do not behave in a random manner. For example, children acquiring Inuktitut used ellipsis less frequently for discourse-new entities than for those which were discourse-old, and recently mentioned (Allen 2000). Skarabela (2007) further shows that children acquiring Inuktitut aged 2 years to 3 years 6 months were sensitive to the role of joint attention, using ellipsis more frequently when the child and her interlocutor shared joint attention, indicating that even relatively young children are able to integrate extralinguistic information. Hickmann & Hendriks (1999) found that 4 year old children (acquiring Chinese, English, French or German) used pronouns (or null arguments) more frequently to refer to recently mentioned discourse-old entities, and that the Subject of a sentence was more likely to be the Subject of a following sentence, which was likely to be pronominalised rather than a lexical NP. These results are consistent with theories of adult native speaker discourse processing, such as Ariel (2001), Gundel et al. (1993).

Bittner (2007), Kühnast (2007) and Gagarina (2007) investigated the development of the use of different means of signalling discourse prominence in children acquiring German, Bulgarian and Russian. They found that younger children, aged approximately 2 years to 3 years 6 months used animacy (animate entities are more salient) more than grammatical role to determine salience,

however, after this age grammatical role increased in importance, until convergence with adult groups was reached aged at about 6 years. Since animacy and grammatical role are frequently correlated (DuBois 1987), with Subjects frequently being animate, this suggests that children are able to identify salient referents correctly, however, have misanalysed the input such that they use non-targetlike constraints. Song & Fisher (2005), (2007), also investigated the extent to which children aged 2 years 6 months and 3 years were sensitive to different means of signalling discourse prominence for subsequent pronominal reference. They showed that frequency of mention, first mention, grammatical role (Subjecthood) and pronominalisation were sufficient to bias the interpretation of an ambiguous pronoun, and that of these cues, first mention and Subjecthood were sufficient to cause an entity to be sufficiently prominent to be anticipated as the referent of a pronoun. However, the younger children were slower to resolve the ambiguity than the 3 year old group, who were also slower than adult native speakers. Song and Fisher argue that children may be slower or less efficient in processing, and, or instead, may have a smaller working memory capacity. Furthermore, Song and Fisher showed that high vocabulary children aged 2 years 6 months were faster than low vocabulary children of the same age. They argue that since vocabulary growth is related to language experience, that higher vocabulary or older children may have encountered more input, allowing them to determine the relevant discourse cues. An alternative explanation proposed by Song and Fisher, which is consistent with Avrutin's (1999) hypothesis, is that there is a strong link between the acquisition of vocabulary and processing efficiency. The ability to recognise and process lexical items could free up processing resources, and allow faster processing of discourse constraints. A large vocabulary could also be a symptom, or by-product of an efficient processing system which is better able to process different discourse constraints. Song and Fisher also point out that their materials allowed their participants a relatively long period of time to resolve the ambiguity (about 4s), and that although their participants were able to use several different constraints in the experimental environment, they might be too slow to do so in normal processing.

Serratrice (2005) found that children acquiring Italian, aged between 1;7 and 3;3 were less likely to omit null pronouns as age increases, but that by MLUW

(Mean Length of Utterance in Words) 2.0, they were able to use null and overt pronouns in a pragmatically appropriate way. Research on bilingual child acquisition with respect to the syntax-discourse interface is more limited. Several studies have found that bilingual children acquiring a pro drop language, such as Italian, Greek or Spanish, overuse overt pronouns relative to monolingual children (Paradis & Navarro (2003); Serratrice, Sorace & Paoli (2004)). Argyri (2006) found that in older Greek-English bilingual children, that overt Subjects were subject to cross-linguistic influence in interface contexts, from English to Greek, however, these effects were only evident in English-dominant children. She argues that cross-linguistic influence is particularly likely when there is surface overlap (see also Müller & Hulk (2001), Argyri & Sorace (2007)). Sorace, Serratrice, Filiaci & Baldo (2008) investigated the use of null and overt pronouns by English-Italian and Spanish-Italian bilingual children. They found that 6-7 year old English-Italian bilingual children resident in the UK chose more overt pronouns than older English-Italian bilinguals aged 8-10, and 6-7 bilinguals resident in Italy. However, the Spanish-Italian bilinguals showed more overuse of overt pronouns in the older age group. Although this could be evidence that cross-linguistic influence is not the only factor influencing the use of overt and null pronouns, Filiaci (2008) proposes that the discourse conditions licensing null and overt pronouns in Spanish and Italian are not identical, allowing scope for cross-linguistic influence. Currently there is need for further research to confirm this hypothesis.

To summarize, then, it seems that children are sensitive to very similar factors affecting anaphor resolution as monolingual adults. However, young children's lack of processing resources seem likely to account for some of the differences seen in young monolinguals, while the role of cross-linguistic influence appears to be an important factor when handling two languages. It is possible that the additional computational complexity of interface phenomenon leads to the differences seen in bilinguals relative to monolinguals, or it could be due to the competition between constraints across languages.

The syntax-discourse interface in language loss and attrition

In this section I discuss two different types of language change in adult native speakers: language loss resulting from Alzheimer's disease, and attri-

tion resulting from reduced exposure to the native language over a period of time, typically due to residence in a country where that language is not widely spoken. Alzheimer's disease is a form of dementia associated with a working memory deficit (see Baddeley, Bressi, Della Sala, Logie & Spinnler (1991) for a review), and with empty speech, containing many *empty words*, such as *thing, it, do*, including a high proportion of pronouns (in English), frequently used inappropriately (Almor, Kempler, MacDonald, Andersen & Tyler 1999). Almor et al find that the overuse of pronouns and the ability to comprehend pronouns both correlated with working memory performance. Furthermore, with respect to the comprehension of referring expressions, patients with Alzheimer's found lexical NPs easier to comprehend than pronouns. Almor et al argue that the observed impairment is a result of a memory impairment, rather than an impairment of discourse representations, since a working memory deficit would lead to the inability to store and reactivate the entities in a discourse effectively. March, Pattison & Wales (2009) obtained similar results: in a map task, the appropriate use of pronouns was predicted by visual working memory and semantic verbal fluency by patients with Alzheimer's. Crucially, these results contrast with Burkhardt, Avrutin, Piñango & Ruigendijk's (2008) data, which suggest that for patients with Broca's aphasia, reflexive pronouns are more difficult than pronouns, suggesting that these patients have a specific syntactic processing deficit, in contrast to a more global working memory limitation, as seen in both child language acquisition and patients with Alzheimer's (although it should be noted that it is often difficult to generalize from studies on aphasia due to the large inter-participant variation and small sample sizes).

Turning to native language attrition which is the result of reduced exposure to the native language, we would expect to see different patterns of behaviour compared to patients with Alzheimer's disease: people who have merely had less input in their native language do not have memory deficits of the type seen in patients with Alzheimer's disease. However, their native language faces competition from the additional language which provides the bulk of the linguistic input. Furthermore, although there is no memory deficit as such, it is possible that people experiencing reduced exposure in attrition process their native language less with less automaticity, slowing processing, which

could have similar effects to a memory deficit. Tsimpli, Sorace, Heycock & Filiaci (2004) found that native speakers of Italian and Greek who are highly proficient in English and undergoing L1 attrition, were more likely to interpret overt pronouns as the matrix Subject compared to monolingual native speakers, however, there were no differences with respect to the interpretation of null Subjects. Strikingly, these results are similar to those found in bilingual child acquisition and by Sorace & Filiaci (2006) in L2 learners, in that behaviour with respect to overt pronouns differed from monolingual native speakers, while behaviour with respect to null pronouns converged with monolingual native speaker behaviour.

Summary and predictions

In the preceding sections I have reviewed the findings from four different populations: monolingual child acquisition, bilingual child acquisition, patients with Alzheimers and people experiencing L1 attrition. What similarities do these populations share with adult L2 learners? Bilingual children, people experiencing reduced exposure attrition and L2 learners are all bilingual, at least to some extent, and so must manage the different discourse constraints from each language. Interestingly, these three groups show strong similarities with respect to the interpretation of null and overt pronouns in Italian: null pronouns are generally used (in both comprehension and production) in a manner similar to monolingual adults, while overt pronouns are typically overused. Null pronouns are hypothesized to be processed using a syntactic dependency which appears to be less sensitive to cross-linguistic influence. It seems likely then, that overt pronouns, processed using a discourse based dependency (Carminati 2002) are more vulnerable to cross-linguistic influence. It remains to be seen the extent to which this is a result of surface similarity or the fact that discourse based dependencies are more likely to be sensitive to cross-linguistic influence. What might be the underlying cause of cross-linguistic influence: does it lie at the level of representation or processing? This issue is discussed in more detail in Chapter 6. It could be hypothesized that handling two languages would cause a higher processing load, due to the additional complexity. However, since the bilingual children studied were typically older children, it seems unlikely that the effects observed in this

population were due to a lack of processing resources, as might be expected with younger children, especially since similar effects were seen in another bilingual population. It therefore seems that the effects of a lack of processing resources and of competition with another language can be separated.

Young children acquiring their first language and patients with Alzheimer's disease also show some similarities: both are hypothesized to have processing limitations. Although L2 learners are not hypothesized to have a working memory deficit as such (they are still able to process their native language without problems) morphosyntactic processing is slower (Wilson 2005). This would result in the need to store items in working memory for longer, effectively reducing capacity. Reduced working memory might affect the ability to integrate different sources of information to interpret an utterance by slowing down the integration to the extent that certain sources of information cannot be processed quickly enough to be used in real-time processing.

What might we predict for L2 learners? If L2 learners are suffering from a processing deficit of the same type as children and patients with Alzheimer's disease, i.e. a lack of processing resources, then we might expect that L2 learners would show difficulties with anaphor resolution, as observed by Polio (1995), Sorace & Filiaci (2006), among others. Even though the resulting effects may show similarities, the cause of a lack of processing resources in L2 learners, child acquisition and L1 attrition is as a result of different mechanisms: in L2 acquisition it is hypothesized that processing is less automatic, and slower, so more items must be stored for longer in working memory, reducing available capacity. In children, it is likely that working memory capacity has not yet reached maturity, and so is not as large as that of healthy adults. In patients with Alzheimer's, the reduction in working memory is a result of neurological degeneration (Baddeley et al. 1991). Anaphor resolution is hypothesized to be particularly vulnerable to a lack of processing resources due to the need to store a mental representation of the salience levels and features of entities in a discourse over time. Furthermore, L2 learners would not show evidence of the Repeated Name Penalty: Almor et al. (1999) found that patients with Alzheimer's disease were able to process repeated lexical NPs better than pronouns.

L2 learners are similar to early bilinguals and native speakers experiencing attrition due to lack of exposure due to their native language in that they are also bilingual, such that they have to manage two languages, and use the appropriate constraints for each language. It could be argued that the processing of an L2 learner's L2 would be expected to be very different from the processing of a native language, even under attrition condition, because an L2 has been acquired after the critical period, and might be hypothesized to be stored and represented very differently from a native language (see e.g. Lenneberg (1967), Johnson & Newport (1989), Long (2005)). However, Sorace & Filiaci (2006) and Tsimpli et al. (2004) showed that near-native (L2) and native speakers under attrition show very similar patterns of behaviour (e.g. overuse of overt pronouns) in the comprehension and production of null and overt pronouns in Italian. These results suggest that exposure to another language which has different form-function mappings at the syntax-discourse interface can affect performance at the interface. However, this does not apply uniformly to all aspects of the interface. The syntactic dependencies formed between a null pronoun and its antecedent in Italian seem to be less vulnerable than the discourse dependency formed between an overt pronoun and its antecedent. This hypothesis, specifically that discourse dependencies would be more vulnerable to cross-linguistic influence than syntactic dependencies is tested in the thesis.

Although children seem to be sensitive to global measures of salience, there is evidence (e.g. Bittner (2007), Gagarina (2007))to suggest that they use inappropriate measures of salience. Younger children seem to rely more on animacy cues than grammatical role cues. It is possible that L2 learners would similarly use inappropriate cues. This could be due to an inability to integrate the appropriate sources of information in online processing, or a transfer of constraints from the native language.

Currently a representational deficit cannot be ruled out for L2 learners at the syntax-discourse interface. However, if the deficit is purely representational, then no effects associated with a processing deficit, such as the lack of a Repeated Name Penalty would be predicted.

Finally, the role of proficiency and experience of the L2 is hypothesized to be a factor. Song & Fisher (2007) show that older children, and those with higher vocabulary levels are able to interpret pronouns in a more targetlike manner than younger children, and those with lower vocabulary levels. If this result is due to the higher levels of linguistic experience which the higher performing children had experienced, then it might be expected that L2 learners who have spent more time in an environment where the L2 is widely spoken would perform in a more targetlike fashion. However, the Interface Hypothesis (Sorace & Filiaci 2006) proposes that there will be residual difficulty at the syntax-discourse interface even at near-native speaker levels, so it is possible that performance would plateau at higher levels of proficiency or experience.

2.4 The Syntax-Discourse Interface: Summary and Conclusions

In this chapter I have discussed theories of the syntax-discourse interface formulated with respect to native speaker processing. A recent approach to the interface, the Form Specific Multiple Constraint Approach (Kaiser & Trueswell 2008) was shown to go some way towards resolving differences between the theories discussed. A review of the literature on L2 acquisition and the syntax-discourse interface suggests that although there seems to be difficulty at the interface for L2 learners, that these difficulties are not uniform. The FSMC approach allows a detailed examination of different aspects of the interface, which is necessary for determining the locus and nature of the difficulties at the interface. Other populations which also show deficits at the syntax-discourse interface allow the formulation of predictions about the nature of these difficulties, primarily a lack of processing resources and competition from the native language.

CHAPTER 3

Methodology

3.1 Introduction

This thesis presents data from nine experiments: one judgement task, seven visual-world experiments, and one dual task experiment which combined the visual-world paradigm with a digit recall task. In this section I discuss the choice of these methodologies as tools for investigating processing at the syntax-discourse interface in both native speakers and L2 learners. Recently there has been growing awareness that traditional methods of analysing visual-world data (typically ANOVA) have serious limitations; here I present an alternative method using mixed effects modelling which seeks to address these limitations.

3.2 The Visual-world Paradigm

Several different techniques have been used to investigate the syntax-discourse interface. In self paced reading, used by, for example Carminati (2002) and Almor (1999), the participant reads sentences or short texts divided into sections, pressing a button to read the next section. Reading times for given sections in different experimental conditions are compared, with longer reading times being interpreted as an indication of processing difficulty. However, self paced reading is rather unnatural, as participants are forced to press a button to get the next section of text, a situation removed from most natural language use.

Eye-tracking during reading, (see e.g. Frazier, Clifton, Rayner, Deevy, Koh & Bader (2005)) allows a somewhat more naturalistic method of presentation, as participants are able to view the whole text simultaneously, allowing regressions to earlier parts of the text. A more detailed analysis is also possible using eye-movements, as several measures are possible, including first pass reading time, second pass time, and total time including regressions. However, different measures of the same region can give different results in relation to a given hypothesis, sometimes making it difficult to draw definite conclusions. Probably the most important drawback of both self paced reading and eye-tracking during reading is the fact that they measure processing difficulty rather than interpretation: we know that certain features of the text are more difficult than others, but not how participants are interpreting them. This is particularly important in the investigation of the syntax-discourse interface in L2 learners, because it is possible that L2 learners may demonstrate the same levels of difficulty in a given condition as native speakers, yet interpret the sentence in a very different way.

Sorace & Filiaci (2006) used a picture verification task to investigate the interpretation of null and overt pronouns in near native and native speakers of Italian. Participants were asked to choose which picture best matched the sentence which was presented. Unlike reading based measures, this measure allows insight into the interpretation of the experimental materials. However, the data is offline, in that we do not have access to the incremental interpretation of the experimental stimuli. It is possible that the initial interpretation of, for example, a pronoun, may change over time as different constraints are processed. Kaiser & Trueswell (2004*b*) used the visual-world paradigm to investigate the processing of the information structure implications of different word orders in Finnish. The visual-world paradigm exploits the fact that the interpretation of linguistic input influences eye-movements around a scene or series of images (see e.g. Allopenna, Magnuson & Tanenhaus (1998), Altmann & Kamide (1999)). Typically participants listen to a sentence or short text while their eye-movements around a scene are recorded. This methodology has the advantage that it allows an incremental insight into the interpretation of an utterance. Furthermore, looking at a scene while listening to linguistic input is relatively naturalistic.

The visual-world paradigm is particularly suitable for use with L2 learners. Studies which use measures of reading may not be a reliable measure of L2 processing; Hoover & Dwivedi (1998) found that both native speakers and L2 learners use syntactic information differently, depending on whether they are fast or slow readers. Their data suggest that slower readers are less able to utilize syntactic information efficiently. Although all of the L2 participants who participated in the experiments presented in this thesis report that they have had formal instruction in German, it is likely that there is wide variation in their experience of reading: those participants who are studying German at university level are likely to have extensive reading experience, while those who have learned German in a predominantly naturalistic setting may not have extensive reading experience. It is possible to argue that using an auditory presentation would generate similar differences. However, in Experiments 7 and 8, all participants had lived in Germany for at least three months; in Experiment 2, where participants had a much wider range of German learning experience, all participants had spent some time in Germany. Methodologies such as questionnaires or the picture verification task allow the possibility that participants are using explicit knowledge. The visual-world paradigm rules out this possibility, not least because participants are typically unaware of the link between their interpretation of an utterance and their eye-movements. Finally, as mentioned above, because the visual-world paradigm allows for a relatively naturalistic presentation of the stimuli, there are fewer additional demands on participants. This is a particularly important point for L2 learners, whose language processing may be particularly affected by high processing load.

3.3 Mixed models for visual-world data

Recently there has been a growing awareness of the inadequacies of traditional methods of analysing visual-world data (Barr 2008). I aim to briefly point out some of the problems with previous methods of analysis, and discuss a different method of analysis: mixed models, which are less problematic than traditional analyses. I then consider in more detail the application of these models, with respect to the methods used in model building. Finally, an example of the use of mixed models is given.

3.3.1 Traditional methods of analysing visual-world data and mixed modelling

There are several different ways of analysing data from visual-world experiments. Typically, measures such as the proportion of fixations on a set of entities of interest, or the length of time spent looking at a given entity within a given time window have been calculated. Subsequently these data are analysed using ANOVA, by conducting a separate analysis for each time window (see, e.g. Kamide, Scheepers & Altmann (2003)). However, this approach runs into problems, as data from different time regions is correlated, because what a participant is fixating in a given time region is more likely to be the same in adjacent time regions compared to more distant (in time) time regions. However, this correlation is not accounted for by running separate ANOVA models for each time region, as this would assume independence of the data between time regions. Furthermore, as post hoc tests are carried out to specify the precise nature of any interactions or main effects, it is not clear how to correct significance levels to prevent the occurrence of type I errors. As pointed out by J. Steinberg (personal communication, June 2007), standard corrections such as the Bonferroni lead to impracticably small significance boundaries.

In addition to the problem of correlated levels of a variable, there are more general problems with ANOVA. Typically, psycholinguists conduct both a by subjects and by items ANOVA. The F values obtained from these analyses are then combined, following Clark (1973). This is to allow for the fact that there is random variation among both subjects and items which is not interesting to the experiment. As discussed by Baayen, Davidson & Bates (2008), both the participant pool and the list of experimental items are samples from a larger population, and each individual may differ in the degree to which it/they is representative of the population as a whole. For example, it could be that some participants are tired when participating in the experiment, and this leads to a different response to the stimuli, potentially affecting the outcome of the experiment, but not interesting to the hypotheses of the experiment. Although the use of ANOVA does take both subject and item random effects into account, it does not allow a more detailed examination of the random effects.

Jaeger (2008) points out that the use of ANOVA for experiments with categorical outcomes, such as visual-world experiments is problematic. Typically, the proportion of fixations to the target entities is calculated, and compared. However, since proportions are limited to a range of between 0 and 1, this can lead to nonsensical confidence intervals. For example, if a proportion of 0.1 is obtained, and a 95% confidence interval of 0.1 ± 0.2 is calculated, leading to a lower limit of -0.1, which is uninterpretable as a proportion. Jaeger notes that even the arcsine-square-root transformation (e.g. Rao (1960), see Kaiser & Trueswell (2004*b*) for an example in visual-world data) does not solve this problem, because the closer that proportions are to 0 or 1, the more the arcsine transformation underestimates changes in proportions. This is particularly problematic for visual-world data, where proportions are frequently around 0.1.

Taken together, the two problems outlined above suggest that the use of ANOVA in analysing data from visual-world experiments is problematic. Fortunately, however, there is a powerful alternative to ANOVA. Recently, interest in mixed models has grown (see, e.g. Baayen et al. (2008), Brysbaert (2007), Barr (2008), Jaeger (2008), Quené & van de Bergh (2008)) as they offer a more refined approach to random effects modelling, and have been suggested (Lancaster University Statistics Consultancy Service, personal communication), as being particularly suitable for longitudinal data, such as data from visual-world data, as mixed models are able to account for the correlations between time regions in the data. Using mixed models it is possible to specify the precise relationships of the random effects to the fixed effects, for example, in an experiment using reaction times as the dependent variable it is possible to account for the fact that different people will have different reaction times in a baseline condition (i.e. the intercept), and be differentially affected by the different experimental treatments (i.e. the slope). Quené & van de Bergh (2008) note that compared to ANOVA analyses, mixed modelling has a lower risk of Type I errors, that is, that there is less chance of the null hypothesis being rejected incorrectly. However, one strength and weakness of using mixed models rather than ANOVA is that there are various techniques for selecting the best model to fit the data, which can affect the conclusions drawn from

the data. In the next section I discuss the advantages and disadvantages of different techniques, and define a methodology for model building.

3.3.2 Model Selection

Choosing the appropriate model to fit the data is a far from obvious process, with many possible ways of proceeding, the choice of which can drastically affect the conclusions which can be drawn from the data. Mixed models have the added complication of two sets of variables: random and fixed, which, depending on the data set, may or may not interact. It is therefore necessary to determine a theoretically motivated and transparent algorithm for model building, not only to allow the conclusions drawn from the data set to be fully interpreted and evaluated by others, but to allow replication of the experiment in future. There is a wide ranging literature on model selection for regression models, though relatively little dealing with the full range of issues for mixed models. However, many of the principles involved apply equally to mixed and fixed effects only models, so we will consider the issues involved in model building in fixed effect only models, and then discuss these issues in the light of mixed effects models.

Stepwise approaches to model building are frequently used in regression models. As discussed in Whittingham, Stephens, Bradbury & Freckleton (2006), stepwise approaches use algorithms which either add or remove significant or non-significant terms (forward selection adds significant terms, while backwards elimination removes non-significant terms). The aim of a stepwise method is to find the Minimally Adequate Model, that is, the model which contains the minimum number of predictors needed to satisfy a criterion, which is typically that predictors are all significant at a certain specified level. Crawley (2005), for example, suggests using a backwards elimination method, where the fully specified model is initially calculated, and then non-significant terms are gradually removed, starting with higher order interactions. Following the Marginality Principle (Fox 1984), if a higher order interaction is significant, then lower order interactions and main effects must be maintained, so model simplification would stop when the highest order interaction remaining in the model is significant. However, if the deviance increases, Crawley recommends using a likelihood ratio test to compare models. If the likelihood

ratio test is significant, the term of the model removed most recently should be left in the model. Although the stepwise method is widely used, it is not accepted universally. Whittingham et al. (2006) argue against using a stepwise method for multiple regression models. They discuss the validity of eliminating non-significant terms from the model, giving the example of a linear model shown in (3.1) which models an observation y_i , with parameters α and β, predictor value x, and the error term ϵ:

$$y_i = \alpha_i + \beta_x i + \epsilon_i \tag{3.1}$$

Stepwise methods would compute the estimate of β, and determine whether it is significantly different from zero. If it is not, then the term is removed. However, this then assumes that the estimate for β is zero, underestimating β. If, for example, the calculated estimate of β were 0.5, choosing zero is a "silly null" (Whittingham et al. 2006, p1187). Choosing to use the calculated estimate of 0.5 is as plausible as using zero, and indeed, more plausible if there are theoretical reasons to believe that this parameter is of importance. This is known as model selection bias, and is of importance if the model is to be used predictively. Whittingham et al also point out that the order of parameter entry or deletion can affect the model chosen, however, by stating precisely the algorithm (which should be theoretically grounded) used to add or delete terms, the model can at least be presented in a transparent and replicable way. Finally, they state that it is possible that more than one model may fit the data equally well, so aiming to choose the minimally adequate model may be misleading. However, they note that it is possible to ameliorate the negative aspects of stepwise methods using additional techniques.

What possible techniques are there? Johnson & Omland (2004) discuss different methods of model section for multiple regression models in the context of research in ecology and evolution. They discuss three main types of model building: maximising fit, null hypothesis tests and model selection criteria. Maximising fit, as the name suggests, involves choosing a measure of goodness of fit of the model, and choosing the model which provides the best fit, ignoring the complexity of the model. This conflicts with the principle of parsimony, furthermore, since models with more parameters generally have a better fit, it is possible to choose an overly complex model which suffers from

a reduction of predictive power. Null hypothesis testing methods typically use the Likelihood Ratio Tests, which compare models by judging whether the more complex model is more likely relative to the simpler model (using a Chi-squared statistic). This helps avoid overly complex models, as only those models where the added complexity can be justified are accepted. However, using this method involves performing several non-independent tests, which inflates the possibility of a Type I error. Model selection criteria enable multiple models to be compared simultaneously. This method uses measures such as Akaike Information Criterion (AIC) and Bayesian Information Criterion, which provide an indication of both fit and complexity, smaller values indicating a better model, as overly complex models are penalized. The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) score are associated with the inclusion of different random effects. When there are p parameters and n responses, AIC = -2 Loglikelihood + 2p, while the BIC = -2 Loglikelihood + p log(n). However, when applying model selection criteria to mixed models, it is frequently the case that while the random effects affect AIC and BIC values, changing the fixed effects specified in the model has little effect, suggesting that for the mixed modelling context, AIC and BIC are perhaps best used as a judge of the random effects used in the model.

What should we use for mixed models, given that there are both fixed and random effects? Whittingham et al. (2006) (discussing multiple regression models) suggest that for analyses of experimental data, where there are a limited number of parameters which were all included as they were hypothesized to be of importance, that it is valid to use a fully specified model for fixed effects, as the expected parameter effects are unbiased. They cite Burnham & Anderson (2002), who suggest that the parameter estimates of one variable should be unaffected by the inclusion or otherwise of other factors. However, as can be seen from analysis of the data from the experiment discussed below, this is not necessarily the case when dealing with interactions: removing higher order interactions following the algorithm suggested by Crawley does lead to changes in the estimates and the significance levels associated with each parameter. Using likelihood ratio tests as suggested by Crawley, that is, to compare models only when the deviance starts to increase, reduces the number of tests needed, lowering the risk of a Type I error. How, then, should

we deal with the random effects? Using model selection criteria such as AIC and BIC seem to yield differences between models. Both of these measures penalise a model for having more parameters; for both measures models with the best fit result in a lower score. Again, it is possible to perform likelihood ratio tests on models where no obvious difference between models can be determined by AIC and BIC, which can give conflicting results. Finally we need to consider the order of approaching fixed and random effects: should we determine the random effects to be specified in the model before or after determining the fixed effects? By considering the underlying reason for using mixed models, this dilemma can be solved. By including random effects, for example the effect of Experimental Item, we can factor out an effect caused by a rogue item (Brysbaert 2007), for it is possible that an item which is different from other items is responsible for a spurious significant effect not caused by the factor assumed to be causing the effect. Indeed, random variables are often talked about as those variables whose effects which we are not interested in, but which may have an impact on the model. Therefore it seems logical to determine the random factors to be included in the model first, and then deal with the fixed factors.

3.3.3 *Example: Experiment to investigate the antecedent preferences of anaphoric demonstratives and pronouns in German*

In order to make the steps I plan to follow explicit, I am here giving an example from a visual-world experiment which had the aim of determining the antecedent preferences for anaphoric demonstratives and pronouns (Experiment 5, discussed in Chapter 5. The experiment had a two by two design, with two word orders (SVO and OVS) for antecedent sentences, which were presented with both demonstrative and personal pronouns; looks to either the pre-verbal (NP1) or post-verbal NP (NP2) were investigated over a 2000ms period, starting from the onset of the pronoun, and divided into eight time windows of 250ms. The dependent variable was look to either target object. The model shown below was developed for one condition out of four, OVS word order with personal pronouns. Data pertaining to the fixations on each of the two target areas in the scene (in this example the areas depicting the pre- or post-verbal NP) during the critical time regions (in this example the 2000ms

following the onset of the pronoun) were entered into the model, allowing a comparison of the relative number of looks to each of these two entities. For experiments 5-9 fixations which started before the onset of the pronoun were excluded from the analysis, to ensure that fixations in the analysis could be more reliably attributed to the effect of the pronoun (amounting to approximately 6% of fixations, precise proportions are reported for each experiment).

The model has the following Fixed factor: object, i.e. whether the pre- or post-verbal NP was fixated. We also consider the following Random factors, subj, i.e. which participant, and Item, i.e. which experimental item was fixated.

This experiment is analysed using R version 2.5.1 (R Development Core Team 2007). For each stage of the analysis I will give the line of code used, and the output (excluding the covariance matrices).

Random Effects

To start with we shall examine the random effects. It is important to do this first, as we need to partial out the variance which we can account for before turning to the fixed effects. These models were running including the fully specified model for fixed effects, while the random effects were built up.

The model is built up by comparing the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) score associated with the inclusion of different random effects. As only the AIC and BIC of nested models can be compared, we first calculate the intercept and slope terms of each random effect crossed with fixed effects. Importantly, each crossed model can only be compared with the intercept model, as only these models can be considered to be nested. In Table 3.1 we use the notation commonly used in the statistical package R. For further details see Baayen (in press). As can be seen in 3.1, in the *subj* (Participant) random effect terms, the *object by subj* term has the lowest scores, indicating a better model fit. In the *Item* group, the *object by Item* term has the lowest BIC, though not the lowest AIC score. In this case it is necessary to prioritize either BIC or AIC, here we choose the BIC score, as it includes a penalty for parsimony. The best term for each group of random effects is then chosen, giving the term on the final row of the table.

AIC	BIC	
3270	3300	(1— fsubj) (Intercept term)
3197	3239	(1+fobject— fsubj) (Crossed with object)
3272	3314	(1+Time— fsubj) (Crossed with Time)
3503	3533	(1— fItem)
3547	3499	(1+fobject— fItem)
3507	3549	(1+Time— fItem)
3149	3209	(1+fobject— fItem)+ (1+fobject— fsubj)

Table 3.1: AIC and BIC scores of a mixed effects model

Fixed Effects

From here we turn to the fixed effects. The factors in the model, and the tables of random and fixed effects are reported. We proceed following Crawley (2005). He proposes starting with a fully specified model, and then, starting with the highest order interactions, removing the least significant terms. However, he does not specify how to proceed when the different levels of an interaction have different significance levels, in cases where a variable has more than two levels. We retain any interactions with a level of the interaction significant at $p<0.05$; where no levels are significant we calculate an approximate mean significance, and remove the least significant interaction, giving priority for elimination to theoretically uninteresting interactions. We also follow the principle of marginality (Fox, 1984), which states that if a higher order interaction is significant, all lower order interactions and main effects contained in that higher order interaction should be retained.

Model 1 (Table 3.2) shows the table of fixed effects (Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)). Examining this table, we see that the interaction of Object and Time is not significant, this is removed from Model 2.

In Model 2 (Table 3.3) we see that Time, but not Object is significant (Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)). Theoretically, it would be possible to remove Object from subsequent models, leaving only significant terms for Time. However, since we are interested in the estimates

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-1.41	0.22	***
fobjectNP2	0.24	0.29	
Time	0.10	0.03	***
fobjectNP2:Time	0.01	0.04	

Table 3.2: Fixed effects for Model 1

for Object, we note that the effect is not significant, but that the direction of the effect indicates a slight NP2 preference. In larger models, where there are more fixed factors, model selection would proceed, with the highest order interaction which is least significant removed from the model at each stage.

Model 2

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-1.45	0.20	***
Object	0.31	0.23	
Time	0.11	0.02	***

Table 3.3: Fixed effects for Model 2

3.3.4 Summary

In this section I have discussed traditional methods of analysing visual-world data, and concluded that the use of mixed effects modelling offers a solution to the shortcomings of these methods because it offers a solution to the problems associated with longitudinal data and a more sophisticated method for dealing with unwanted variance. Mixed effects modelling is still a relatively new technique for analysing visual-world data; I present a method for applying the technique to data of this kind.

CHAPTER 4

Word Order and Pronominalisation

4.1 Introduction

In this chapter I present 3 experiments which investigate the role of word order variation and pronominalisation in German information structure for native speakers and L2 learners of German. Word order variation and the use of pronominalisation are hypothesized to be the means by which information which is discourse-new and discourse-old (given) is encoded syntactically in German. However, previous work on native speakers, while finding that OVS word order is marked relative to SVO word order has proved inconclusive about the precise information structural implications about word order. Similarly, pronominalisation is thought to play an important role in processing at the syntax-discourse interface for two reasons. Firstly, the repeated name penalty (see e.g. Almor (1999)), where a lexical NP is repeated rather than using a pronoun for the second and subsequent mention of an entity in discourse is reported to cause processing difficulties in native speakers. Secondly, the Preferred Argument Structure (PAS) proposed by DuBois (1987) makes predictions about the relationship between the use of lexical NPs, pronouns and information structure. However, there is currently limited empirical evidence for the PAS. Experiment 1 examines the information structure implications of word order and pronominalisation in native speakers of German.

The relationship between discourse status, i.e. whether an item is discourse-new or old (given) and the encoding of that discourse structure syntactically,

and the extent to which L2 learners can acquire and use that relationship is central to the investigation of processing at the syntax-discourse interface in L2 learners. Previous research has predominantly used offline measures (though see Reichle (2008)) or has not included an online measure of the unfolding interpretation of such phenomena. Experiment 2 investigates the processing of word order variation and pronominalisation with respect to information structure in L2 learners of German.

The extent to which L2 learners transfer representations or processing strategies of the syntax-discourse interface from their L1 is currently not clear. For example, although English has limited word order variation, word order in English is relatively fixed, and is not hypothesized to be used to signal discourse status to the same extent as in German. Pronominalisation, on the other hand, is predicted to behave in the same way in both English and German, so any differences in behaviour observed could not be attributed to transfer. Experiment 3 addresses the issue of transfer by investigating how native English speakers behave with respect to these phenomena in English.

4.2 Information Structure Processing in Native Speakers

Languages allow different options for encoding the same propositional content. For example, many languages allow different word orders, such as SVO or OVS, which, although the syntactic form is different, encode the same semantic meaning. However, these different options are not in free variation: different options have different discourse implications, and are used to indicate the discourse status of entities in the discourse, which can be thought of in terms of relative salience, or prominence, or accessibility for the interlocutors. Put another way, starting from a discourse perspective, in any given discourse, different entities have a greater or lesser degree of salience or prominence for the interlocutors, and different syntactic structures can be used as a means of encoding levels of salience or prominence. Importantly, although it is certainly the case that entities which are already salient can be encoded as salient linguistically, it is also the case that entities can be made more salient by encoding them in salient syntactic positions, such as that of Subject.

As discussed previously, the notion of salience is difficult to define; furthermore, it is difficult to compile a list of all relevant factors determining salience; the factors which contribute to salience being both linguistic and extra-linguistic. However, the distinction between an entity which is new to the discourse, having previously been unmentioned, and a previously mentioned entity, or discourse-old entity is clear: the former is less salient than the latter, and we would expect this distinction to be encoded linguistically. (For further discussion of information structure processing see Chapter 2, Section 2.2.2.) Sections 4.2.1 and 4.2.2 discuss two phenomena which are hypothesized to be related to the encoding of new and given entities in German.

4.2.1 Information structure and word order in German

The precise information structural effects of word order variation have proved hard to determine. German, since it has a relatively flexible word order, allows investigation of this phenomenon. German is a V2 language, which means that in an independent declarative clause the verb occurs in second position. Standardly (following, e.g. Frey (2005), the position preceding the verb is referred to as the Prefield, or Vorfeld. Following Frey, a maximal constituent may be moved to the prefield of a German V2 clause. This may be, among other possibilities, either a Subject or an Object, as shown in (4.1). However, these different word orders do not occur in free variation. Relative to SVO, OVS order is marked, being less frequent (Bornkessel, Schlesewsky & Friederici 2002), and more difficult to process (Fiebach, Schlesewsky & Friederici 2001).

(4.1) a. *Der Kellner erkennt den Detektiv.*
the-nom waiter recognises the-acc detective
The waiter recognises the detective.

b. *Den Kellner erkennt der Detektiv.*
the.acc waiter recognises the.nom detective
The waiter is recognised by the detective.

Weskott (2003) has shown that discourse factors can facilitate the processing of non-canonical sentences, such as OVS word order sentences in German. For example, if the element in the Vorfeld is discourse-old, and if the preceding

sentence has a parallel structure, then the processing difficulty associated with OVS order is eliminated. Furthermore, the pre-verbal position (or Vorfeld) is frequently described as a Topic position, as there is typically an ”aboutness” relationship between the NP in Topic position and the rest of the sentence. Usually the Topic is an entity which has been previously mentioned in the discourse (discourse-old), or can be inferred from the context (e.g. the existence of a waiter can be inferred in a restaurant context). It should however be noted that a distinction is often made between the syntactic Topic, being a sentence initial, pre-verbal position, and the psychological Topic, which refers to an entity which is salient and has been previously mentioned or is inferable from the context (e.g. the existence of a waiter can be inferred in a restaurant context). (For further discussion see Cowles (2003)). Here, however we will use the term *Topic* to refer to an NP which is both the syntactic and psychological Topic. However, it should be noted that it is not necessarily the case that the left-preposed NP has been previously mentioned or ”stands in a cognitive salient relation to an already introduced discourse referent”, nor does it need to be a Topic (Frey 2005, p106).

The information structure implications for word order variation in German remain unclear. Kaiser & Trueswell (2004*b*) found that in Finnish, OVS word order signalled a discourse-old, discourse-new relationship; in a visual-world experiment native Finnish speakers were more likely to anticipate the post-verbal referent to be a discourse new entity in OVS sentences relative to SVO sentences. However, there is conflicting evidence for German. In general, it is reported that German exhibits a preference for ordering discourse-old arguments before discourse-new arguments (see e.g. Johnson (1998); Uszkoreit (1986)), hence, in OVS word order sentences we would expect to find the sentence initial O is discourse-old. However, it is unclear whether there is a difference in the discourse-old before discourse-new preference between SVO and OVS word orders as found by Kaiser and Trueswell in Finnish (2004). A corpus based study by Weber & Müller (2004) found that while there was evidence of a given (discourse-old) before new preference in a corpus of newspaper articles, there was no difference between SVO and OVS word order with this respect. Indeed, they conclude that German is different from Finnish as reported in Kaiser & Trueswell (2004*b*). This study has certain limitations,

though. Firstly, the corpus is based on newspaper articles; written text may be different from spoken texts in this respect. Secondly, their definition of *given* (discourse-old) includes frame induced referents, whereas Weskott (2003) found that explicit mention was necessary to license OVS word order, rather than induced entities. This may have lead to a distortion of the results obtained. Furthermore, a recent forced choice completion task and visual-world study by Weskott, Hornig, Kaiser, Féry, Kern & Kliegl (2007) suggests that German does behave like Finnish in this respect, in that OVS sentences with a given NP1 allow the parser to predict a previously unmentioned NP2. However, the results from the eye-tracking experiment should be treated with caution due to difficulties with the analysis. Weskott et al analyse their data using ANOVA, and although they calculate this by Items and by Subjects, they do not calculate minF. As Brysbaert (2007) points out, even if significant F values are obtained for both the by Items and by Subjects analyses, this does not entail a significant minF value.

To conclude, although recent experimental evidence suggests a role for word order, specifically the SVO/OVS alternation, in German, this is far from controversial. Experiment 1 addresses this issue.

4.2.2 Information structure and pronominalisation

The use of a pronoun signals that an entity already salient in the discourse, or discourse-old, is referred to (see e.g. Ariel (2001)). In an experiment investigating word order ambiguities, Kaan (2001) found that a pronoun can be used for disambiguation of word order ambiguities, as pronouns are used for given information, which typically coincides with the grammatical Subject, since Subjects are typically salient information. DuBois's (1987) Preferred Argument Structure Hypothesis (PASH), based on a corpus of Sacapultec Maya, states that there is a preference for speakers to avoid having more than one lexical argument, and avoid more than one new piece of information in a clause. By contrasting a pronoun with a lexical NP it will be possible to determine whether this holds in German. Furthermore, it is not clear the extent to which DuBois' PASH interacts with the encoding of information structure encoded by word order variation. Is it possible, for example, that a

pronoun in pre-verbal position makes more salient the fact that the pre-verbal NP is discourse-old, and allows or licenses a discourse-new post-verbal NP?

The use of a pronoun can avoid processing difficulties in native speakers. If a full lexical NP is used for second and subsequent mentions of an entity rather than a pronoun, native speakers have been observed to show processing difficulties. For example, in Example (4.2), the second reference to Rick could be realised as either a pronoun or a lexical NP, however, while the use of a pronoun is felicitous, the repetition of Rick is not.

(4.2) Rick saw a catalogue advertising new bicycles. He/Rick wanted to buy a new bicycle which was featured.

Various related hypotheses have been developed to account for this effect. Almor (1999) proposes that by using a lexical NP, the Gricean Maxim of Quantity (Grice 1975) has been violated; a lexical NP provides more information about the referent than is necessary to identify it. This notion is similar to Ariel's Accessibility Hypothesis, which also states that the more salient an entity, the less informative the anaphor should be. Since a recently mentioned entity is typically considered salient, an uninformative anaphor such as a pronoun is most acceptable. Almor would argue that the processing cost is related to the processing effort needed to integrate the full semantic representation of a lexical NP into the discourse representation. Camblin, Kerry, Boudewyn, Gordon & Swaab (2007) propose that the use of a pronoun makes the processor search for a potential antecedent, whereas the lexical NP wrongly causes a new semantic entity to be introduced to the discourse. The availability of a prominent antecedent modulates the difficulty of each process. They propose that the additional processes needed to establish the coreference relation in the repeated lexical NP case cause the Repeated Name Penalty. However, irrespective of the precise nature of the underlying causes of the Repeated Name Penalty, it is clear that consideration of pronominalisation is necessary when considering the processing of information structure.

4.3 Experiment 1: Information Structure Implications of Word Order Variation and Pronominalisation in German

Experiment 1 is based on Kaiser & Trueswell's (2004*b*) visual-world study, which investigated the information structure implications of word order variation in Finnish. However, Experiment 1 extends their design to incorporate a pronominalisation condition. This additional condition is important since the use of pronouns is strongly linked to information structure, as pronouns are used for entities that are discourse-old; this is related to the fact that the repetition of a lexical NP is infelicitous and would lead to processing difficulty.

4.3.1 Experiment 1: Summary of Aims and Predictions

Experiment 1 investigates the role of two factors in German information structure: word order and pronominalisation.

- Word order. As discussed above, there is conflicting empirical evidence regarding the role of word order in German information structure. In a study with a similar design to Experiment 1, Weskott (2003) found a difference between SVO and OVS word order, such that the post-verbal Subject in OVS word order is used to encode discourse-new information. Although this finding has not been replicated in corpus studies (Weber & Müller 2004), it was hypothesized that these differences were due to differences in the nature of the discourse-old and new entities between the studies discussed in Weber & Müller (2004) and Weskott (2003). It was therefore predicted that participants would be more likely to interpret the post-verbal Subject (in OVS word order) as discourse-new entity than the post-verbal Object (in SVO order).
- Pronominalisation. The inclusion of the pronominalisation condition was based on two factors. Firstly, the design of Kaiser & Trueswell's (2004*b*) study entailed the repetition of a lexical NP, which could result in a Repeated Name Penalty. It is therefore possible that pronominalisation may interact with word order, with facilitation of the interpretation of the post-verbal NP as discourse-new in the OVS condition, as the pronominalisation condition is hypothesized to be easier to process

than the NP condition. Secondly, pronominalisation is hypothesized to play a role in information structure, since pronouns are used to encode discourse-old information. The use of a pronoun pre-verbally is hypothesized to make it more salient that the pre-verbal NP is discourse-old, facilitating anticipation of a discourse-new post-verbal NP.

4.3.2 Experiment 1: Design

The visual-world paradigm is particularly suited for research into the syntax-discourse interface for several reasons. It enables us to gain insight into the online interpretation of an utterance as it unfolds, and because it allows the participants to process language in a relatively natural way, without extra processing demands. Crucially, research by Kamide et al. (2003) has shown that anticipatory effects can be measured using the visual-world paradigm. Their study, investigating the processing of case-marking in SVO and OVS sentences in German, demonstrated that case-marking on a pre-verbal noun could, when integrated with lexical information from the verb, be used to predict the post-verbal NP. This is particularly relevant for the current study, which investigates the extent to which native speakers of German are able to anticipate whether the post-verbal NP is discourse-new or old, however, in contrast to Kamide et al. (2003), the post-verbal NP can only be disambiguated with respect to discourse constraints.

The design of the experiment allows us to separate the effects of grammatical role and linear order, and of pronominalisation. Participants heard a context sentence, which identified two human entities (named typically by their profession, e.g. secretary and boss) in a scene by indicating their location. A third entity in the scene remained unmentioned, but was, however, potentially ambiguous with one of the mentioned entities by also being of the same profession as one of the mentioned entities, as shown in Figure 4.1. Following the context sentence (Example (4.3a)), a target sentence was heard (Examples (4.3b), (4.3c),(4.3d), (4.3e)) which either had SVO or OVS word order, and had either a full lexical NP or pronoun pre-verbally which referred to the male entity in the scene, in this example, *the boss*. The post-verbal NP was potentially ambiguous between the mentioned entity or the unmentioned entity. We analysed whether the number of looks to either entity

was modulated by word order variation or pronominalisation. We predicted that OVS word order in the target sentence would promote looks towards the previously unmentioned secretary relative to the SVO sentence, and that pronominalisation would strengthen this effect.

(4.3) a. *Es ist Montag abend im Büro. Ein Chef und eine*
it is Monday evening in office. a boss and a
Sekretärin arbeiten am Fenster.
secretary work at window
It is Monday evening in the office. A boss and a secretary are working at the window.

b. *Er liebt offensichtlich die Sekretärin.*
he.nom loves apparently the secretary
Apparently he loves the secretary.

c. *Ihn liebt offensichtlich die Sekretärin.*
he.acc loves apparently the secretary
He is loved apparently by the secretary.

d. *Der Chef liebt offensichtlich die Sekretärin.*
the.nom boss loves apparently the secretary
Apparently the boss loves the secretary.

e. *Den Chef liebt offensichtlich die Sekretärin.*
the.acc boss loves apparently the secretary
Apparently the boss is loved by the secretary.

4.3.3 Participants

Twenty native speakers of German (9 Female, 11 Male) from both the university community and the German speaking congregation in Edinburgh participated in Experiment 1. Participants were aged over 18 years (the precise age of participants was not recorded). Participants were rewarded £5 for participation.

4.3.4 Procedure

Participants completed a judgement task discussed in more detail in Experiment 4 (Chapter 5). The experiment used EyeTrack software in conjunction with an SMI EyeLink II headmounted eye-tracker. Participants wore a

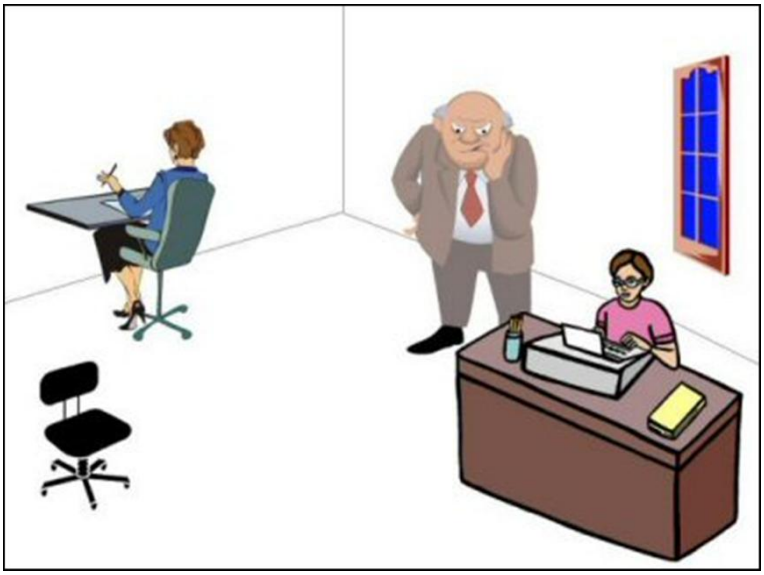

Figure 4.1: Picture corresponding with Example (4.3)

swimming hat and an SMI EyeLinkII headmounted eyetracker, sampling at 500Hz. (Participants wore a swimming hat to prevent the eyetracker from slipping.) Their eyes were approximately 25" from the display, which is a 21" colour display. A simple test before the experiment determined each participant's dominant eye; the movement from this eye was tracked. Viewing was binocular, and headmovements unrestricted. The eyetracker was calibrated using a 9-point fixation stimulus. The calibration was validated using EyeLink software, and repeated until calibration was good. Before each item participants fixated a dot located in the centre of the screen to check that calibration remained accurate. Sentences were played through speakers attached to the display monitor. Images were presented 1000ms before the onset of the spoken stimulus. Before the experiment, participants were instructed to listen and try to understand the sentences and look at the images presented. After 25% of trials (including fillers) participants were asked a yes/no question relating to the previous experimental. Each item was viewed only once, in one of the four conditions by each participant. Each participant viewed the same number of items in each condition. The questions were presented as text on screen, and answered using a game pad. At the start of the experiment there was a short practice phase, consisting of 3 filler items, and including one

item which had a question following it to familiarize participants with the task. The experiment lasted approximately 30 minutes.

4.3.5 Materials

Twenty-eight scenes were developed using a commercial clip art package. Each scene included 1 male entity and 2 female entities, and a distracter item. Scenes were semi-realistic, and designed to suggest a certain context, such as in a hospital. Each scene (e.g. Figure 4.1) corresponded to a context sentence (4.3a), followed by a target sentence in one of four conditions: SVO + pronoun, OVS + pronoun, SVO + lexical NP, and OVS + Lexical NP, as shown in Examples (4.3b), (4.3c), (4.3d), (4.3e). In addition to the experimental materials, 28 filler items were constructed, which consisted of a scene and a sentence accompanying the scene. The filler items were designed such that balance of genders depicted was varied (e.g. 2 men and 1 woman), and that there was not always the potential ambiguity between a discourse-old and discourse-new entity. The order of presentation was randomized individually for each participant. The materials were pretested to ensure that there were no plausibility biases, and to ensure that the images were true depictions of the entities in the sentences.

4.3.6 Analysis

The eye-tracker recorded the X-Y coordinates of each fixation. For each image (experimental items only) a template file was developed, showing the regions in each scene depicting the two target items and the background. The X-Y coordinates for each fixation were then matched to the template files, providing a coding for each fixation regarding which target object (or whether the background was fixated) was fixated. Blinks were added to previous fixations, and contiguous fixations shorter than 80ms were pooled. Time regions of 250ms relative to the onset of the post-verbal NP were defined (in Experiments 5-9 the time regions were defined relative to the onset of the pronoun). It was then calculated whether each participant had fixated on either of the two target objects in each of the time regions.

4.3.7 Results

In this experiment we are interested in looks to either the discourse-old or new potential depiction of the post-verbal NP. 4 time windows of 250ms, commencing 500ms before the onset of the post-verbal NP were calculated, and looks to either entity were calculated. The log odds of looks to either the discourse-old or new objects are plotted in Figures 4.2 and 4.3. The odds of a fixation to the discourse-old entity relative to the discourse new entity were calculated, and then the natural logs taken, such that a value greater than zero can be interpreted as an overall preference for the discourse-old entity, and a value of less than zero as a preference for the discourse-new entity. It can be seen that in Experiment 1 there was an overall preference for the discourse-old entity, however, this was modulated over time and condition.

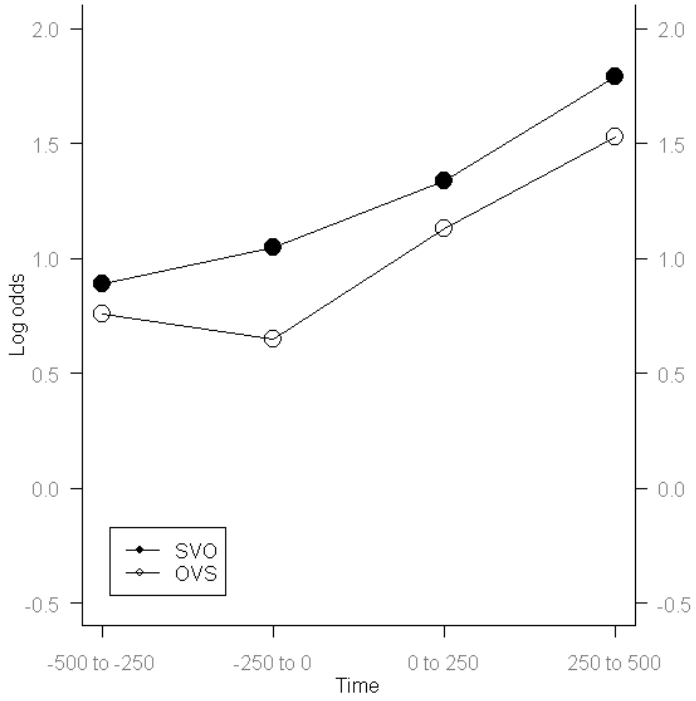

Figure 4.2: Log odds of looks to discourse-new and discourse-old entity in the lexical NP condition in Experiment 1

The data were analysed using mixed effects modelling, using a logit link. The fully specified model included the factors Word order (SVO (base level) or OVS), lexical NP (base level) or Pronoun, Object (Discourse-old (base level)

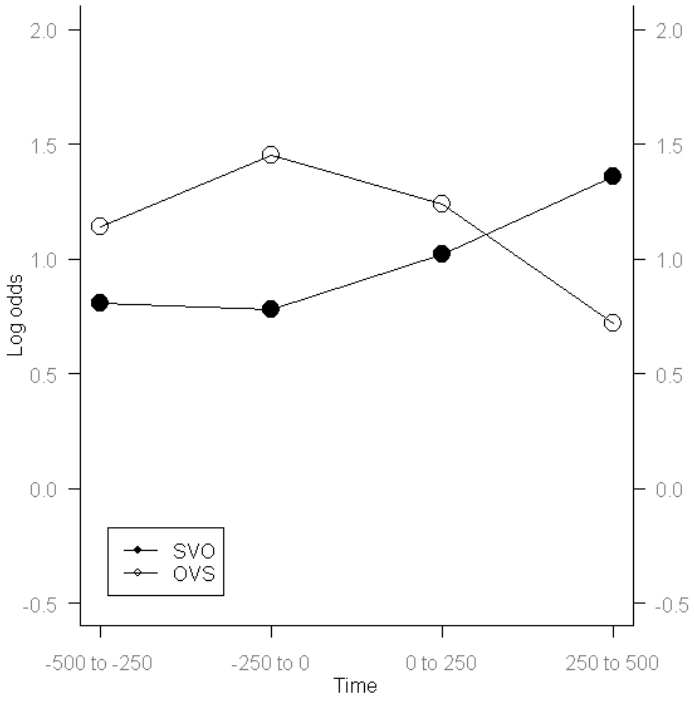

Figure 4.3: Log odds of looks to the discourse-new and discourse-old entity in the Pronoun condition in Experiment 1

or new), Time (4 regions of 250ms commencing 500ms before the onset of the post-verbal NP (initial region is the base level)). A three way interaction of pronominalisation (NP or Pronoun), Object (Discourse old or new) and Time was obtained, such that there were more looks to the discourse-old entity in the pronoun condition relative to the lexical NP condition, and the difference between looks to the discourse-old and new entities increased over time in the lexical NP condition. Word order was not a significant factor: the predicted interaction between Word Order and Object was not significant. Table 4.1 shows the fixed effects (Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)). Figures 4.4 and 4.5 show the lexical NP and pronoun conditions respectively.

	Estimate	Std. Error	t value	$Pr(>\|z\|)$
(Intercept)	-1.92	0.31	-6.27	***
Word order	0.35	0.26	1.37	
NP or Pronoun	1.31	0.29	4.50	***
Object	-0.54	0.46	-1.19	
Time	0.16	0.09	1.91	.
Wordorder:NP or Pronoun	-0.05	0.19	-0.26	
Word order:Object	-0.016	0.20	-0.08	
NP or Pronoun:Object	-1.11	0.47	-2.36	*
Word order:Time	-0.04	0.08	-0.50	
NP or Pronoun:Time	-0.26	0.10	-2.63	**
Object:Time	-0.36	0.14	-2.64	**
NP or Pronoun:Object:Time	0.38	0.18	2.17	*

Table 4.1: Fixed effects for Experiment 1

4.3.8 Discussion

Our results are substantially different from those of Kaiser & Trueswell (2004*b*) and Weskott et al. (2007). While their studies found an interaction between word order and looks towards a discourse-old or new entity, the current study did not find any interaction between word order and the discourse-old or new entity. What could explain these differences? There were slight differences between the stimuli: Weskott et al included a look-away distracter clause between the context and the target sentence. However, although this would have made both the mentioned entities slightly less salient (assuming salience diminishes with time and intervening referents), it is not clear how this would have promoted any interaction. A more promising line of inquiry seems to be the analysis. As previously mentioned, both Weskott et al and Kaiser and Trueswell used ANOVA (by Subjects and items) to analyse the data. A preliminary analysis of the data from the current experiment used ANOVA (by subject only), and indeed found a similar interaction to Weskott et al for German, and Kaiser and Trueswell for Finnish. When our data were analysed more thoroughly using mixed effects modelling, which allows for a much more detailed analysis of random effects, this interaction disappeared, suggesting that, for the current experiment at least, that the interaction was

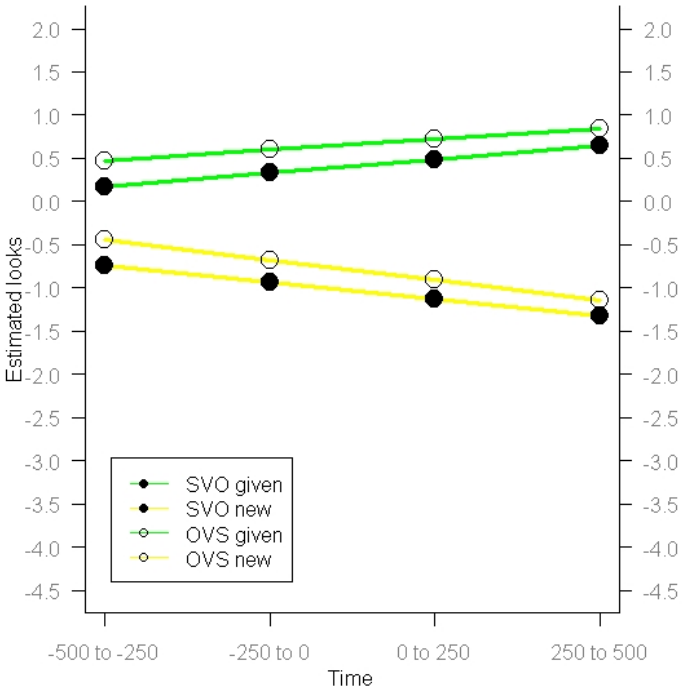

Figure 4.4: Looks to the discourse-new and discourse-old entity in the lexical NP condition in Experiment 1

due to rogue experimental items or subjects. However, it is impossible to confirm that this would also be the case for Weskott et al's data without full reanalysis of their data.

Although there was no effect of word order in our data, there was a significant interaction between pronominalisation and looks to the given or new entity. In the pronoun condition, there were more looks to the given entity than in the lexical NP condition. This is exactly the opposite finding to the prediction based on DuBois' Preferred Argument Structure hypothesis, that use of a pronoun, used for given entities, in sentence initial position could facilitate looks to the unmentioned entity. What could explain this result? The repeated name penalty (see e.g., Gordon & Hendrick (1998) further developed by Almor (1999)), predicts that when a noun phrase is repeated, as is the case in the lexical NP condition, there will be greater processing difficulty than

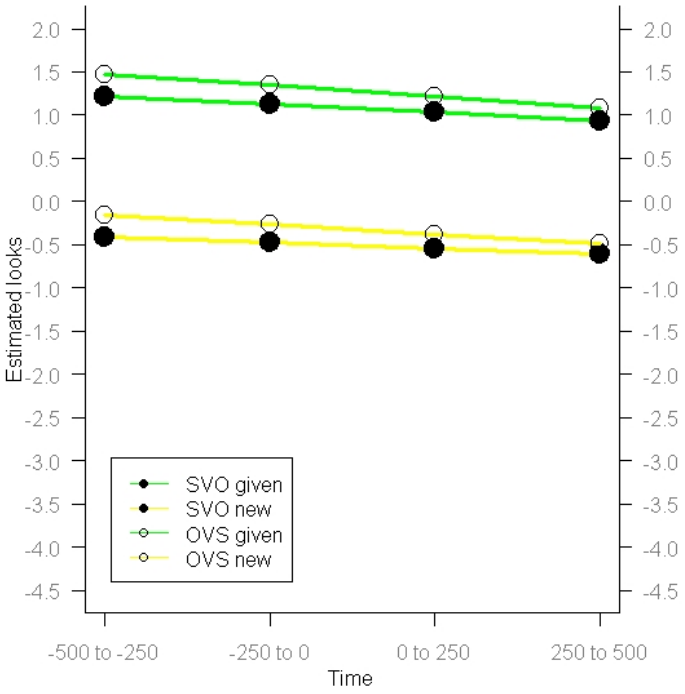

Figure 4.5: Looks to the discourse-new and discourse-old entity in the pronoun condition in Experiment 1

when a non-repetitive anaphor is used. Although it should be clear that the referent (the male entity in the scene) of the pre-verbal NP or pronoun was unambiguous, it seems reasonable to assume that the processing difficulty associated with the repeated NP would affect the ability to anticipate the referent of the post-verbal antecedent. By examining the estimates of the model in more detail, and Figures 4.4 and 4.5, we can see that participants did indeed appear to have greater early processing difficulty in the lexical NP condition. In the lexical NP condition there is a smaller difference between looks to the mentioned and unmentioned entity compared to the pronoun condition in the early time windows. This could be due to the fact that this condition is genuinely ambiguous in the experimental context provided. However, as this difference, or lack of it, changes over time, it seems more likely that a small difference in looks to each entity is an indicator of processing difficulty: due to a difficulty in resolving the ambiguity, looks are made to both entities.

Furthermore, Altmann & Steedman's (1988) principle of parsimony predicts that comprehenders prefer to maintain the current discourse model, that is, the relative salience and number of entities in the discourse, so we would expect an early preference for looks to the old entity. In the lexical NP condition, in contrast to the pronoun condition, participants seemed initially more unsure whether to update the discourse model. Importantly, when we look at these effects over time, in the lexical NP condition the difference between looks to the discourse-old and new object increases as time progresses, further suggesting that interpreting the correct referent for the post-verbal NP was more difficult, and thus slower. In the pronoun condition, on the other hand, we see looks to both entities decrease slightly over time, suggesting that the referent was determined quickly.

To summarize, our native speaker participants did not show any interaction of word order with looks to the discourse-old or new entity, suggesting that word order does not play as important a role in German information structure as proposed by Weskott et al. (2007). However, pronominalisation showed a significant interaction with looks to the discourse-old and new entity, with more looks to the discourse-old entity in the pronominalisation condition. This is attributed to disruption of processing in the lexical NP condition rather than to a specific information structure role for pronominalisation.

4.4 Processing of Information Structure by L2 Learners

Previous research on the L2 acquisition of information structure and the means by which information structure is encoded syntactically has produced mixed results. While Reichle's (2008) study suggests that high proficiency L2 learners showed the same ERP effects (P600 and N400) as native speakers in response to information structure violations, Lozano (2006, 2008) suggests that L2 learners are unable to achieve targetlike use of Focus marking strategies. Carroll et al. (2000) however, suggest that transfer from the L1 may play a role in the acquisition of this type of phenomenon. Thus far very few studies have used an online methodology, indeed to the best of our knowledge nobody has used an online behavioural technique to investigate the acquisition of the encoding of information structure in L2 learners. By using an online methodology,

particularly one (such as the visual-world paradigm) which allows an insight into online interpretation of such phenomena, it is possible to understand the nature of the similarities and differences to native speaker behaviour in more detail. (See Chapter 2, Section 2.3.4 for further discussion.)

Experiment 2 uses the same experimental design as Experiment 1 to investigate the information structure implications of word order variation and pronominalisation in L2 German. Somewhat surprisingly, Experiment 1 did not find a significant effect of word order on the interpretation of the post-verbal NP as either discourse-new or old. However, since cross-linguistically word order variation is used to signal information structure, it is not clear how L2 learners will behave with respect to word order variation in this context. In the lexical NP versus pronominalisation condition native speakers seemed to show a clear Repeated Name Penalty. In Sections 4.4.1 and 4.4.2 the predictions for L2 learners of German with respect to these two phenomena are discussed.

4.4.1 Word order in L2 learners

In Experiment 1 native speakers of German did not show any effect of word order with respect to information structure: unlike in Finnish, OVS word order did not seem to signal a discourse-old - discourse-new ordering of discourse entities. What might we expect for L2 learners? It might be hypothesized that processing OVS word order would be more difficult for L2 learners if their L1 does not allow word order variation to the same extent as German. Wilson (2005) found that while L2 learners were able to use case-marking on a pre-verbal Object in OVS word order sentences to anticipate the upcoming Subject, they found this more difficult than SVO word order, and that this correlated significantly with the length of time which the L2 learner had spent living in a German speaking country. It seems likely, therefore, that L2 learners who have spent shorter periods of time in a German speaking country will have greater difficulty processing OVS sentences overall.

How might L2 learners comprehend word order variation with respect to information structure? Lozano & Mendikoetxea (2008) propose that post-verbal Subjects are used universally to encode discourse-new information. Indeed, they note that even in a language such as English, where word order variation

is limited, that for unaccusative verbs under certain condition post-verbal Subjects are licensed. If this assumption is correct, it is possible that even though native speakers did not show any effects of word order variation, L2 learners would use this universal information and show information structure effects with word order in a non-nativelike manner. However, native speakers of German did not show evidence of using post-verbal Subjects to encode discourse-new information, casting doubt on the hypothesis that this is a true universal.

4.4.2 Pronominalisation in L2 learners

In contrast to word order variation, the system of pronominalisation seems very similar in English and German. However, although there are differences between the two languages, most notably that German has an additional system of pronouns, anaphoric demonstratives, it is not clear that this would affect the distinction between a lexical NP and personal pronoun. However, despite the frequency of pronouns in the input, they are known to be vulnerable to processing deficits in other populations, such as patients with Alzheimer's disease (Almor 1999), where a repeated NP, typically problematic in healthy native speakers, is shown to be less problematic than a pronoun. Furthermore, pronouns are typically acquired late by children (Sekerina, Stromswold & Hestvik 2004). Research on the L2 acquisition of the antecedent preferences of null and overt pronouns in Italian (Sorace & Filiaci 2006) has shown that L2 learners of Italian do not show nativelike behaviour with respect to overt pronouns (although the interpretation of null pronouns was targetlike), suggesting that it is likely that L2 learners will show difficulty with pronominalisation. If the L2 learners show differences from the native speaker group in their interpretation of pronouns, it is hypothesized that this is due to a processing difficulty of some sort, either due to a limitation of processing resources or the inability to integrate the appropriate information when processing.

4.5 Experiment 2: Information Structure Implications of Word Order Variation and Pronominalisation in L2 Learners of German

Experiment 2 uses the same design and experimental materials as Experiment 1 to investigate the information structure implications of word order and pronominalisation in L2 German; prior to the eye-tracking session participants completed a proficiency test (see Section 4.5.2 for details) and a short biographical questionnaire.

4.5.1 Participants

Twenty L2 learners of German (14 Female, 6 Male) participated in Experiment 2. The participants in the L2 group were native speakers of English, who had learned German after the age of 11. The L2 participants ranged from lower intermediate level (GCSE/Standard Grade) to advanced level on the Goethe Institut placement test (Goethe Institut 2005). The proficiency test was designed by the Goethe Institute as a placement test to place L2 learners of German in the proficiency bands as described by the Council of Europe (maximal score 30); participants scored from band B1(Independent User) to C2, (Proficient User) according to this scale (Language Policy Division 2008). Table 4.2 shows the mean and standard deviation of participants with respect to Test Score and time spent living in Germany in Experiment 2.

	Test Score	Months lived in Germany
Mean	18.61	11.48
St.Dev	5.35	26.07

Table 4.2: Participant details in Experiment 2

4.5.2 Procedure

Twenty L2 learners participated in Experiment 2. L2 learner participants were sent a list of vocabulary before the test, and asked to check whether they understood all items. Only those who reported familiarity with the majority of items were invited to take part in the experiment. Before the eye-tracking

session, L2 learners completed a biographical questionnaire, detailing their language learning history, and a short multiple choice proficiency test (Goethe Institut 2005), which tested morphosyntactic and lexical knowledge. The procedure for the eye-tracking session was identical to that in Experiment 1. Following the eye-tracking session participants were tested on their knowledge of the lexical items used in the experiment. Experimental items where participants were not familiar with all lexical items were discarded from the analysis, however, if fewer than 75% of items remained after this process, participants were removed entirely from the analysis. This was the case for 4 participants, who were replaced.

4.5.3 Analysis

The procedure for the analysis was identical to that for Experiment 1.

4.5.4 Materials

The materials were identical to those used in Experiment 1.

4.5.5 Results

The log odds of looks to either the discourse-old or new objects are plotted in Figures 4.6 and 4.7. The odds of a fixation to the discourse-old entity relative to the discourse new entity were calculated, and then the natural logs taken, such that a value greater than zero can be interpreted as an overall preference for the discourse-old entity, and a value of less than zero as a preference for the discourse-new entity. It can be seen that in Experiment 1 there was an overall preference for the discourse-old entity, however, this was modulated over time and condition.

The L2 data were analysed following the same procedure, and using a model with the same fixed effects as the L1 data in Experiment 1. Main effects of word order (more looks in the OVS condition), pronominalisation (more looks in the pronoun condition), object (more looks to the discourse-old entity) and time (fewer looks over time) were obtained. There was also an interaction of word order and time, showing that over time, there were fewer looks to either

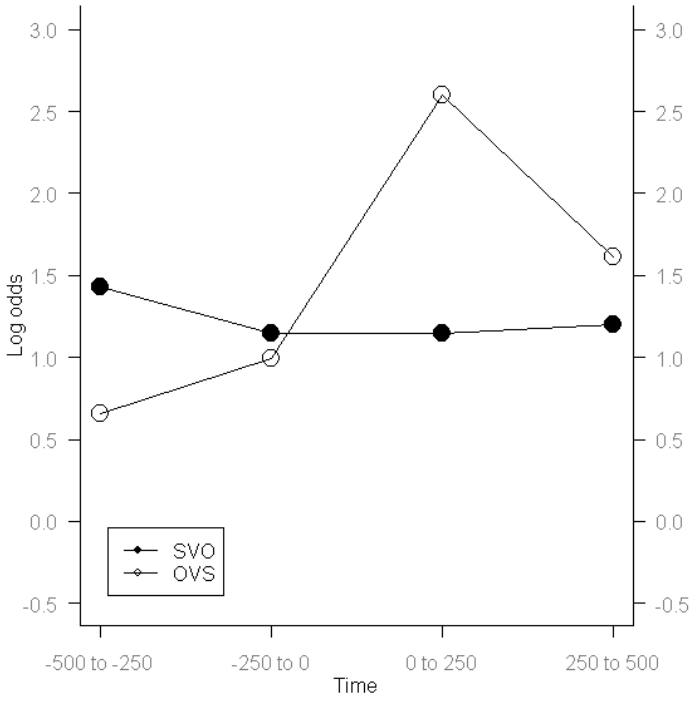

Figure 4.6: Log odds of looks to discourse-new and discourse-old entity in the lexical NP condition in Experiment 2

object in the OVS condition. Table 4.3 shows the fixed effects for Experiment 2 (Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)). Figures 4.8 and 4.9 show the NP and Pronoun conditions respectively.

	Estimate	Std. Error	t value	$Pr(>\|z\|)$
(Intercept)	-1.36554	0.26116	-5.229	***
Word order	0.72604	0.23344	3.110	**
NP or Pronoun	0.31514	0.10132	3.110	**
Object	-1.38055	0.31289	-4.412	***
Time	-0.15385	0.06531	-2.356	*
Word order : Time	-0.21043	0.09018	-2.333	*

Table 4.3: Fixed effects for Experiment 2

Table 4.4 shows that the proficency in German of participants in Experiment 2 varied as shown by a proficiency test. The proficiency score was based on

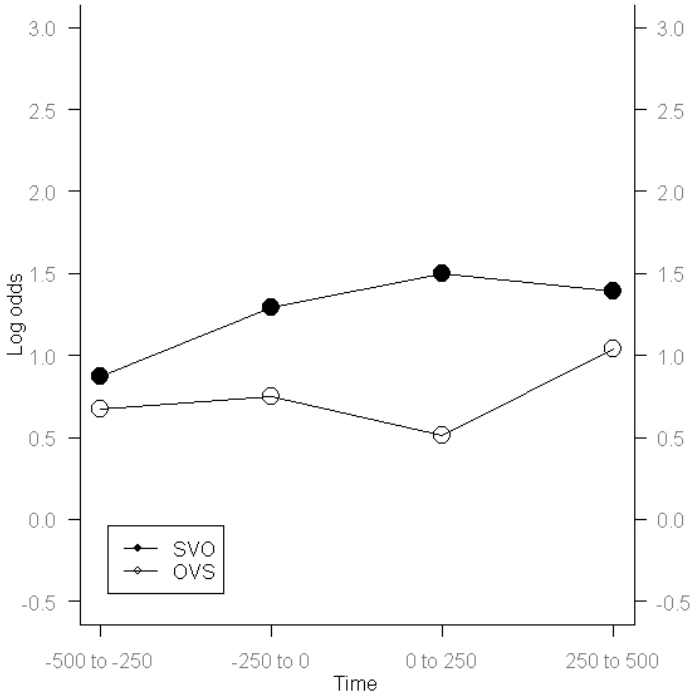

Figure 4.7: Log odds of looks to the discourse-new and discourse-old entity in the Pronoun condition in Experiment 2

scores on a 30 point proficiency test (Goethe Institut), with a score of 30 being the highest score. Furthermore, participants reported having previously spent varying levels of time living in Germany. Wilson (2005) showed that the time spent living in Germany affected the integration of morphosyntactic and semantic information in online processing. Since it is possible that proficiency or time spent in a German speaking country would affect processing behaviour, additional analyses were conducted with the addition of the covariates *Proficiency* and *Time spent living in Germany*. The results of these analyses should be interpreted with caution, due to the small number of participants at each level of these covariates. Prior to the main analysis, *Proficiency* was shown to be a better predictor of behaviour, so to avoid colinearity issues, *Time spent living in Germany* was eliminated from the analysis. A regression analysis showed that Proficiency is a significant predictor of time spent living in Germany ($\beta = 2.36, t(18) = 2.32, p < 0.05, R^2 = 0.23, F(1, 18) = 5.38, , p < 0.05$). The

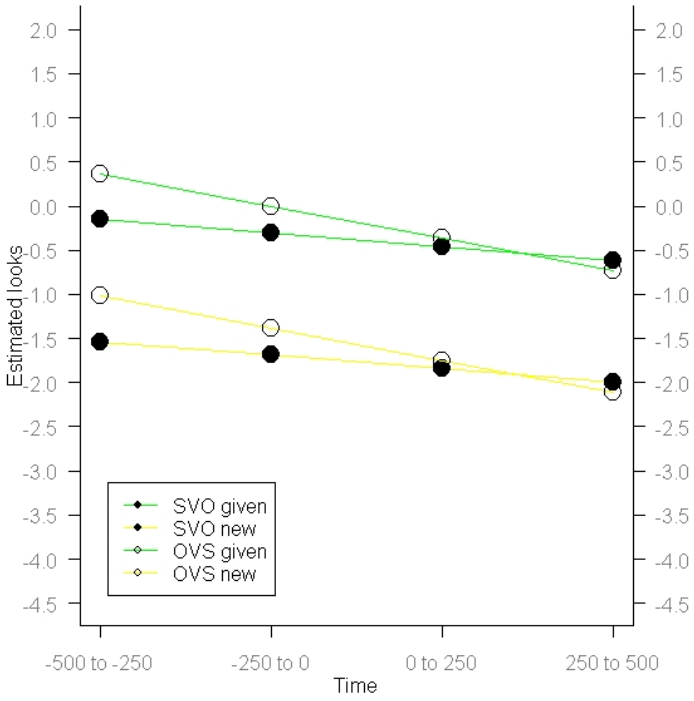

Figure 4.8: Looks to the discourse-new and discourse-old entity in the lexical NP condition in Experiment 2

fully specified model included the factors Word order (SVO (base level) or OVS), NP or Pronoun, Object (discourse-old (base level) or discourse-new), Time (4 regions of 250ms commencing 500ms before the onset of the post-verbal NP(initial time region is base level)) and Proficiency. Table 4.5 shows the fixed effects with the additional factor of proficiency.(Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)). Since proficiency, as measured by the Goethe Institut Placement Test was a significant predictor, separate graphs for each of four proficiency levels are plotted, corresponding to a score of 10, 15, 20 and 25 on the test (Figures 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16, and 4.17). These scores correspond to the upper and lower bounds of the data; since the participants had a wide range of proficiency levels, and the interactions with other factors are rather complex, two intermediate levels are plotted rather than the mean (as in Experiments 7 and 8). Table 4.4 shows the distribution of proficiency levels across the participants. A significant five way interaction

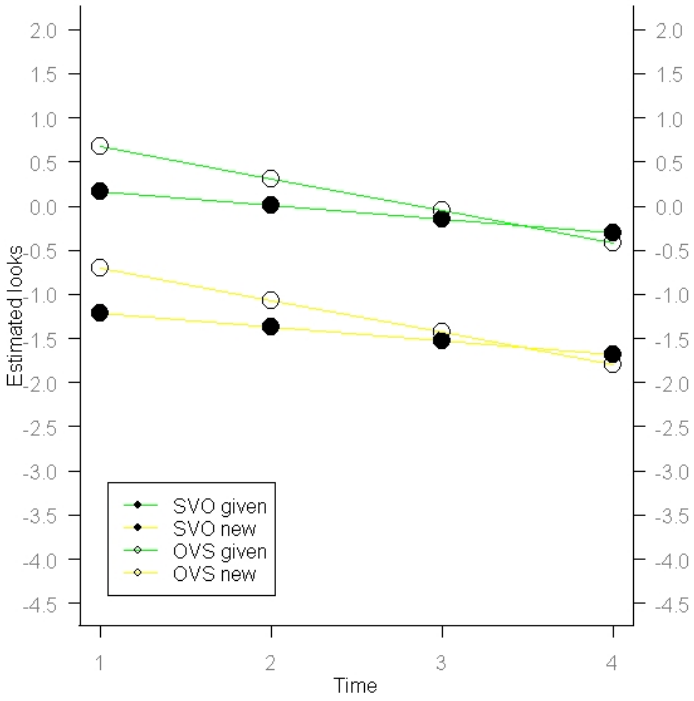

Figure 4.9: Looks to the discourse-new and discourse-old entity in the pronoun condition in Experiment 2

of Word Order, pronominalisation (NP or Pronoun), Object (discourse-old or new), Time and Proficiency was obtained. At the lowest proficiency levels, in the lexical NP condition, an early preference for the discourse-old entity decreases over time in the SVO word order condition, however, in the OVS condition the reverse effect is obtained. At higher proficiency levels the preference for the discourse-old entity develops earlier. At the highest proficiency levels, the effect of pronominalisation lessens in the SVO condition, and to a lesser extent in the OVS condition.

Test Score	10-14	15-19	20-24	25-30
N	4	8	5	3

Table 4.4: Distribution of proficiency levels in participants in Experiment 2

	Estimate	Std. Error	t value	$Pr(>\|z\|)$
(Intercept)	-1.28	1.16	-1.11	
Word order	-1.51	1.46	-1.03	
NP or Pronoun	-2.09	1.62	-1.29	
Object	-2.32	2.06	-1.13	
Time	-0.67	0.42	-1.61	
Proficiency	-0.01	0.06	-0.19	
Word order:NP or Pronoun	3.37	2.07	1.63	.
Word order:Object	4.83	2.53	1.91	.
NP or Pronoun:Object	5.57	2.65	2.10	*
Word order:Time	1.01	0.56	1.82	.
NP or Pronoun:Time	0.45	0.60	0.74	
Object:Time	0.97	0.71	1.37	
Word order:Proficiency	0.12	0.08	1.51	
NP or Pronoun:Proficiency	0.16	0.09	1.84	.
Object:Proficiency	0.032	0.11	0.29	
Time:Proficiency	0.03	0.022	1.50	
Word order:NP or Pronoun:Object	-8.59	3.42	-2.51	**
Word order:NP or Pronoun:Time	-0.87	0.79	-1.10	
Word order:Object:Time	-2.51	1.013	-2.48	**
NP or Pronoun:Object:Time	-2.56	1.08	-2.36	*
Word order:NP or Pronoun:Proficiency	-0.20	0.11	-1.78	.
Word order:Object:Proficiency	-0.21	0.14	-1.50	
NP or Pronoun:Object:Proficiency	-0.28	0.14	-1.96	*
Word order:Time:Proficiency	-0.06	0.03	-2.10	*
NP or Pronoun:Time:Proficiency	-0.03	0.03	-1.05	
Object:Time:Proficiency	-0.05	0.04	-1.26	
Word order:NP or Pronoun:Object:Time	4.05	1.42	2.86	**
Wordorder:NP or Pronoun:Object:Proficiency	0.43	0.19	2.31	*
Word order:NP or Pronoun:Time:Proficiency	0.04	0.043	1.02	
Word order:Object:Time:Proficiency	0.11	0.06	1.98	*
NP or Pronoun:Object:Time:Proficiency	0.12	0.06	2.22	*
Word order:NP or Pronoun:Object:Time:Proficiency	-0.18	0.08	-2.40	*

Table 4.5: Fixed effects for Experiment 2 with additional factors

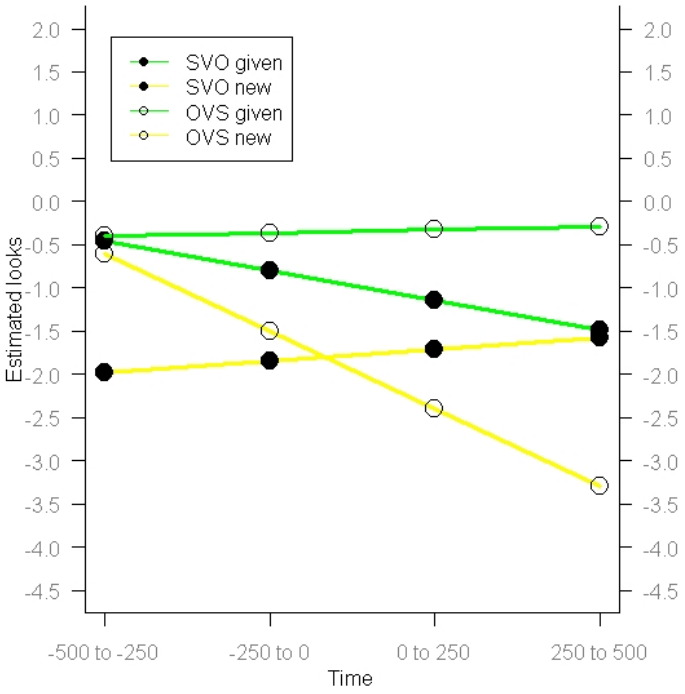

Figure 4.10: Looks to the discourse-new and discourse-old entity in the lexical NP condition at proficiency level 10 in Experiment 2

4.5.6 Discussion

The native speaker data from Experiment 1 suggest that word order does not play an important role in determining information structure in German, whereas the use of a lexical NP or pronoun pre-verbally does affect ability to anticipate the referent of the ambiguous post-verbal NP. In Experiment 2 we found main effects of word order, pronominalisation and object, and an interaction of word order with time. L2 learners made more looks to the discourse-old entity, indicating that, like the native speakers in Experiment 1, L2 learners maintained a model of the entities in the discourse, and anticipated that this model would be maintained. Unlike the native speaker group in Experiment 1, there was no interaction of pronominalisation and object, which suggests that the L2 learners were not showing evidence of the Repeated Name Penalty. However, despite the fact that it seems to be the case that L2

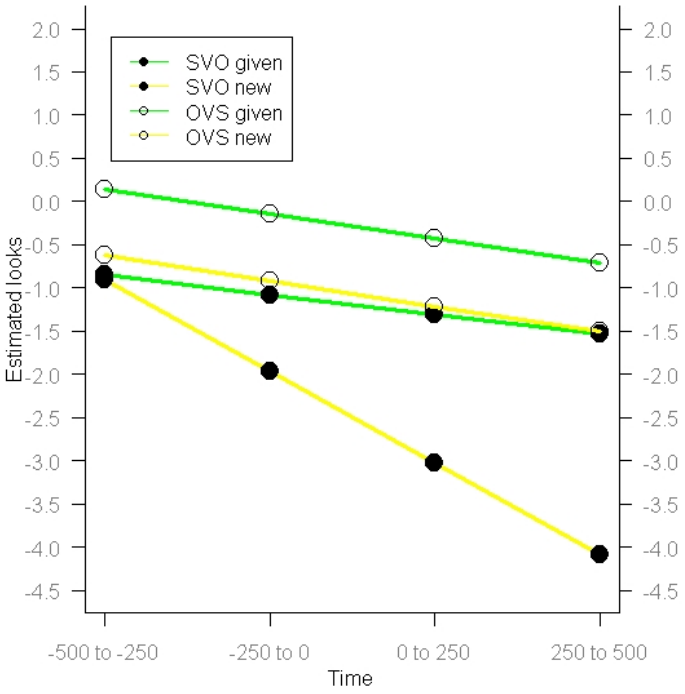

Figure 4.11: Looks to the discourse-new and discourse-old entity in the pronoun condition at proficiency level 10 in Experiment 2

learners do not seem to be using pronominalisation or word order to show information structure, it is not clear how to interpret the significant main effects found. For example, it is not clear whether making more looks to either entity in the pronoun condition is an indication that this condition was found to be easier in some way by L2 learners. Interestingly, the estimates suggest that there were more looks in the conditions hypothesized to be more difficuly (OVS and pronoun). The interaction of word order and time, which shows that over time the difference between the OVS and SVO conditions is reduced indicates that it is possible that the greater number of looks might be associated with greater difficulty. In the case of the OVS condition it has been shown that OVS word order is processed more slowly by L2 learners (Wilson 2005), so it is possible that the decrease in looks over time in the OVS condition is an indication that the OVS condition is initially more difficult.

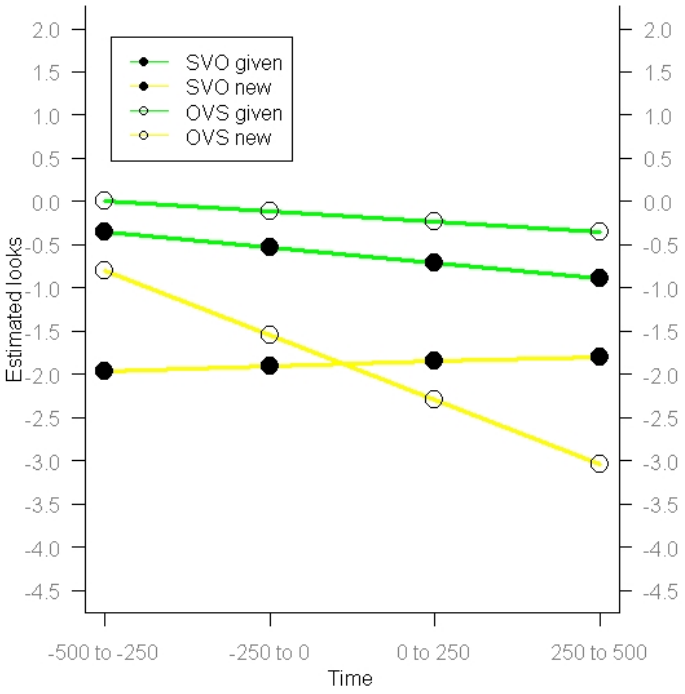

Figure 4.12: Looks to the discourse-new and discourse-old entity in the lexical NP condition at proficiency level 15 in Experiment 2

However, based on the current data, this hypothesis is somewhat speculative, and requires further empirical support.

We found a significant five-way interaction of word order, pronominalisation, object, proficiency and time, indicating that both word order and pronominalisation are important factors in L2 German information structure. The main effects of word order, pronominalisation and time obtained in the initial analysis were not obtained in the expanded model, nor the interaction of word order and time. However, any conclusions drawn from examining the effect of proficiency should be tentative, due to the small number of participants at each proficiency level. The results from the L2 group are discussed by examining proficiency levels; the estimated values for four proficiency levels spanning the range of participants in the data are examined in detail, showing learners from lower intermediate to advanced. It should be clear that the

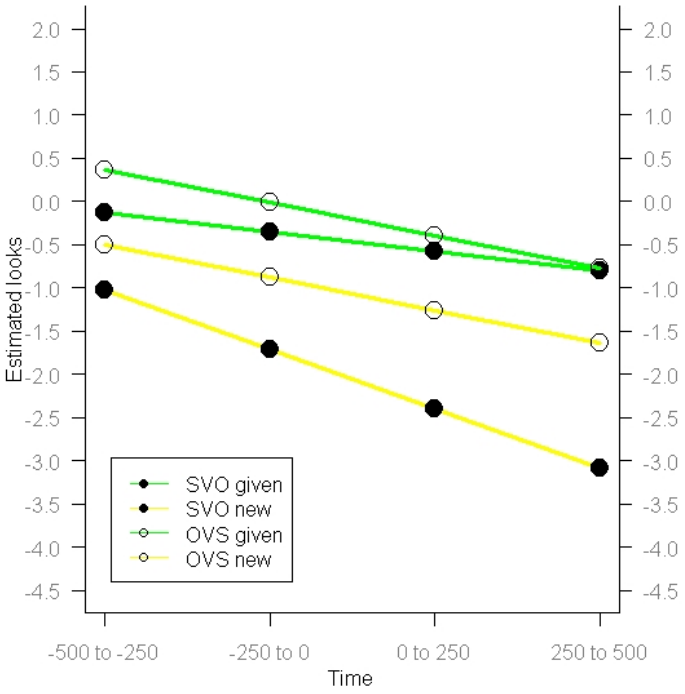

Figure 4.13: Looks to the discourse-new and discourse-old entity in the pronoun condition at proficiency level 15 in Experiment 2

discussion of each of these levels should be considered to be indicative of the trend found across the entire data set; further experiments with larger numbers of participants at each proficiency level would be necessary to be more conclusive. However, taking these limitations into consideration, it seems that overall, as proficiency increases, learners do seem to behave in a more nativelike manner, however, do not fully converge with native speakers.

We turn first to the lowest proficiency, showing estimates for a learner with proficiency level 10 (on a thirty point scale). This corresponds to the Council of Europe band A2. In the lexical NP condition (Figure 4.10), with SVO word order, there is an early preference for the old entity, however, this reduces over time. In the OVS condition with a lexical NP, we see the reverse pattern, with no difference early, but ultimately leading to a strong preference for the old object. In the Pronoun condition (Figure 4.11) with SVO word order there is

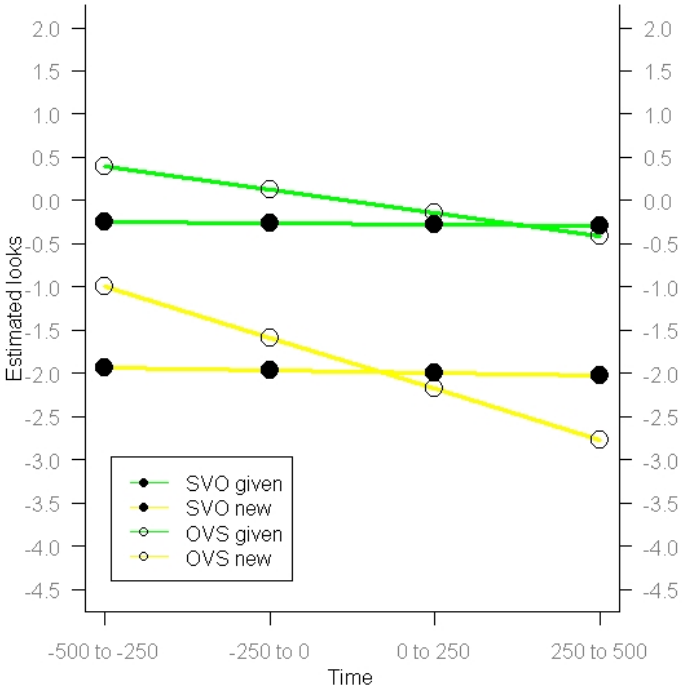

Figure 4.14: Looks to the discourse-new and discourse-old entity in the lexical NP condition at proficiency level 20 in Experiment 2

initially no preference for the new or old entity; however, over time, there are fewer looks to the new entity, suggesting a preference for the old entity. In the OVS condition with a pronoun, there is a very small preference for the old entity, but this does not change over time.

Why should we see very similar patterns for the SVO pronoun condition and the OVS NP condition? In both these conditions, it appears that the learner is initially unsure which entity to anticipate, however, over time a preference for the given entity develops. The OVS word order is likely to be more difficult for the learner than the SVO condition. SVO word order is both more prevalent in the input (Weber & Müller 2004), and more similar to the learners' L1, English, which has canonical SVO word order and not OVS word order. In a visual-world study, Wilson (2005) found that L2 learners were slower to process case-marking in OVS sentences, suggesting that OVS word order is indeed

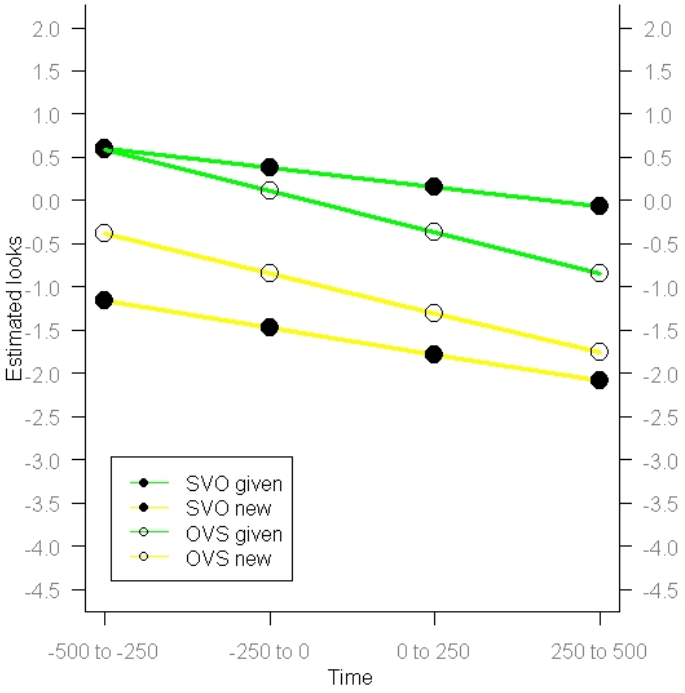

Figure 4.15: Looks to the discourse-new and discourse-old entity in the pronoun condition at proficiency level 20 in Experiment 2

more difficult for L2 learners, which explains why the lower proficiency level L2 learners may be slower to determine a preference for the referent of the post-verbal NP. This appears to be a morphosyntactic processing difficulty impacting on the ability to make discourse related inferences. Furthemore, the results from the initial model (which did not include proficiency as a factor) are consistent with the hypothesis that the OVS condition may have been more difficult in some way. This does not explain why processing a pronoun should be slower than an NP, as the native speakers found the lexical NP more difficult to process. However, if we consider the literature on the use of pronouns by two very different populations: children and people with Alzheimer's disease, this result is not so surprising. As discussed in Sekerina et al. (2004), children acquire pronouns late, and show difficulty assigning the correct referent to the pronoun. Almor et al. (1999) present data suggesting

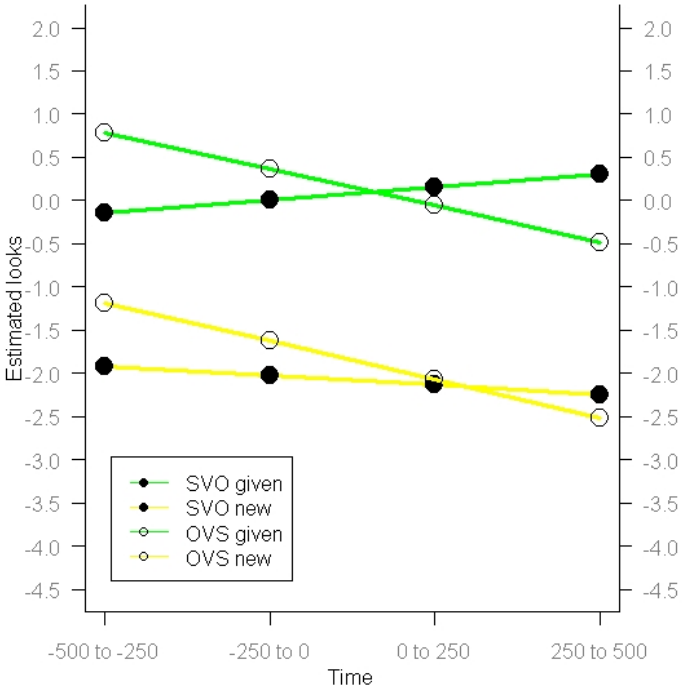

Figure 4.16: Looks to the discourse-new and discourse-old entity in the lexical NP condition at proficiency level 25 in Experiment 2

that people with Alzheimer's disease have impaired comprehension of pronouns, finding lexical NPs easier. Almor (1999) proposes that this result can be explained in terms of working memory: Alzheimer's patients have impaired working memory, and so the representation of discourse entities in memory may be degraded, similar to the representation of non-prominent discourse entities, such that hearing a lexical NP can facilitate retrieval of the entity by providing a fuller semantic representation than a pronoun. Although it is clear that the working memory capacity of L2 learners as such is not impaired, it is plausible that the greater memory demands of processing an L2, particularly at lower levels of proficiency, may lead to behaviour similar in some respects to those people with a working memory impairment. If this were the case, then we would expect to be able to simulate L2 learners' behaviour in native speakers by artificially reducing their processing resources, by placing them under additional processing load (See Chapter 6). An alternative, but related

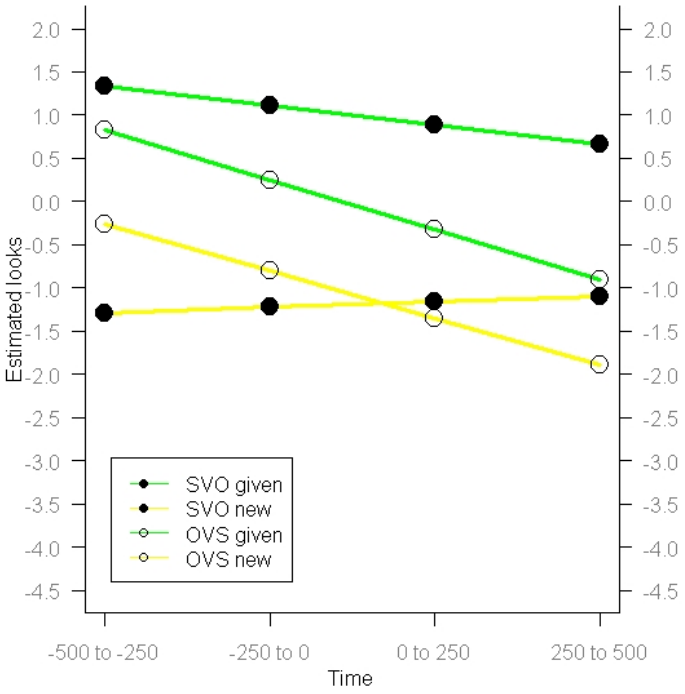

Figure 4.17: Looks to the discourse-new and discourse-old entity in the pronoun condition at proficiency level 25 in Experiment 2

explanation can be seen in work on native speaker processing by Camblin et al. (2007). They present a study which suggests that native speakers do not show a Repeated Name Penalty during faster presentation of stimuli with repeated names, and indeed show facilitation for the repeated name. They attribute this to the fact that Repetition Priming, which shows facilitation for repeated lexical items in word lists (see e.g. Gernsbacher (1990)) is evident, but the increased speed of presentation prevented their participants from integrating information about the discourse prominence of coreferential antecedents. It seems likely that if processing in L2 learners is less automatic, that they may behave like native speakers experiencing speeded presentation.

Examination of the SVO NP and OVS pronoun condition supports this hypothesis. The SVO word order with an NP should be easier than the other conditions, as both ”easy” conditions coincide. This is exactly what we see

initially, as there is a preference for the old entity: the processor is able to anticipate the referent of the post-verbal NP early. However as time progresses this preference reduces. This could be due to a "catch-up" effect - it takes time for the repeated name penalty to take effect, or it could be due to a reanalysis of the initial preference. Currently it is difficult to determine the reason for this reduction in preference over time. The fact L2 learners seem to show a (late) repeated name penalty as the native speaker group does suggests that this condition may be easier. When we consider the OVS Pronoun condition, there is only a very small preference for the old entity, which stays unchanged over time. It seems likely that the OVS Pronoun condition is simply too difficult for the L2 learner to resolve at this proficiency level.

In Experiment 1, native speakers did not seem to find OVS word order more difficult to process. This is as expected, following Weskott (2003), as the licensing conditions necessary to contextually license OVS word order (parallel order, discourse-old pre-verbal NP) were met. However, the L2 learners did seem to find OVS word order more difficult. This could be either a representational deficit, in that L2 learners have not acquired the licensing conditions for OVS, or a processing deficit: the L2 learners were unable to integrate the licensing information to license OVS word order. Alternatively it is possible that L2 learners are showing difficulty processing morphosyntactic information in non-canonical sentences.

Are all the observed effects due to processing difficulty? Although it is impossible to be certain, it seems unlikely that processing difficulty could account for the strong preference for the old entity seen in both the OVS NP condition and the SVO pronoun condition, as these differences are much larger than the preference seen in the SVO NP condition. It therefore seems likely that for the low proficiency level learner, OVS word order and use of a pronoun does have an information structure implication: however, these are the reverse of the predictions for the native speaker. It was predicted that OVS word order and a pronoun would facilitate looks to the new entity; in these data the reverse seems to happen. It is not clear however, why OVS word order or a pronoun could cause an information structure effect in this direction. More plausibly, due to the extra processing demands of these conditions, once a preference has been established, the processor is no longer able to maintain both new

and old entities as potential referents, and so discards the new entity. It is further possible that the effects seen in the pronoun condition could relate to a transfer effect from the L1, while the OVS effect is solely due to a difficulty in morpho-syntactic processing. However, it should be noted that although these data are suggestive of a processing difficulty, the design of this experiment is such that it is impossible to rule out a representational difficulty.

At the subsequent proficiency levels, level 15 (Figures 4.12, 4.13), and 20 (Figures 4.14, 4.15), corresponding to Council of Europe levels B1, B2 (Independent User) and C1 (Proficient User), we see a very similar pattern, however, preferences for the discourse-old entity seem to develop sooner, suggesting that processing difficulties are lessening as proficiency increases. In the SVO NP and Pronoun conditions, the learners become very similar to the native German speakers at the higher proficiency levels (Figures 4.16, 4.17), suggesting that at a high enough level of proficiency, demands on working memory are not sufficient to impede processing of the pronoun relative to the NP. However, in the OVS condition, we do not see a repeated name penalty effect, suggesting that under higher processing load (in this case processing the marked OVS word order), L2 learners are not able to behave in a nativelike manner. Further work is needed to measure the extent to which the OVS and pronoun conditions cause a higher degree of processing load in order to confirm this hypothesis.

4.6 Experiment 3: The Role of Transfer

The data presented above do not confirm or rule out a possible role of transfer. It is possible that different syntactic realisations of information structure between English and German may affect the L2 group. Although English does not allow the same word order variation as German, certain types of verbs allow inversion for information structural purposes. However, these are typically unaccusative verbs (Levin & Rappaport Hovav 1995). Perhaps the closest equivalent to the SVO/OVS alternation in German is the active/passive alternation in English (although, of course, German has an active/passive alternation too). From a thematic role perspective, the pre-verbal NP in both OVS and passive sentences is the Patient, while the Agent is post-verbal. If

L2 learners transfer the information structure constraints of passive sentences into their L2 German, we would expect to see similar patterns, though it should be noted that it cannot be considered directly equivalent to OVS order, as the pre-verbal constituent in a passive sentence is a Subject.

In order to investigate this, a visual-world experiment was carried out using an approximate translation of the stimuli into English, retaining the pronominalisation conditions.

4.6.1 Participants

Twenty native English speakers (12 Female, 8 Male) from the University of Edinburgh student community participated in the experiment, and were rewarded £5 for participation. Participants were aged over 18 years of age (the precise age of participants was not recorded).

4.6.2 Materials

Materials for the previous experiment were translated into English, with the substitution of one item, which relied on grammatical rather than semantic gender. The post-verbal adverb was also changed to make the sentences more acceptable. (4.4a) shows an example context sentence, depicted in Figure 4.1. Examples (4.4b), (4.4c), (4.4d), (4.4e) show the four conditions, active, lexical NP; active, pronoun; passive, lexical NP; passive; pronoun.

(4.4)
a. It is 5 o'clock in an office. A manager and a secretary are working by the window.
b. The manager loves seemingly the secretary.
c. He loves seemingly by the secretary
d. The manager is loved seemingly by the secretary
e. He is loved seemingly by the secretary

4.6.3 Procedure

The procedure was identical to the eye-tracking procedure used in Experiment 1.

4.6.4 Analysis

The data were analysed using the procedure outlined in Experiment 1.

4.6.5 Results

The log odds of looks to either the discourse-old or new objects are plotted in Figures 4.18 and 4.19. The odds of a fixation to the discourse-old entity relative to the discourse new entity were calculated, and then the natural logs taken, such that a value greater than zero can be interpreted as an overall preference for the discourse-old entity, and a value of less than zero as a preference for the discourse-new entity. It can be seen that in Experiment 3 there was an overall preference for the discourse-old entity, however, this was modulated over time and condition.

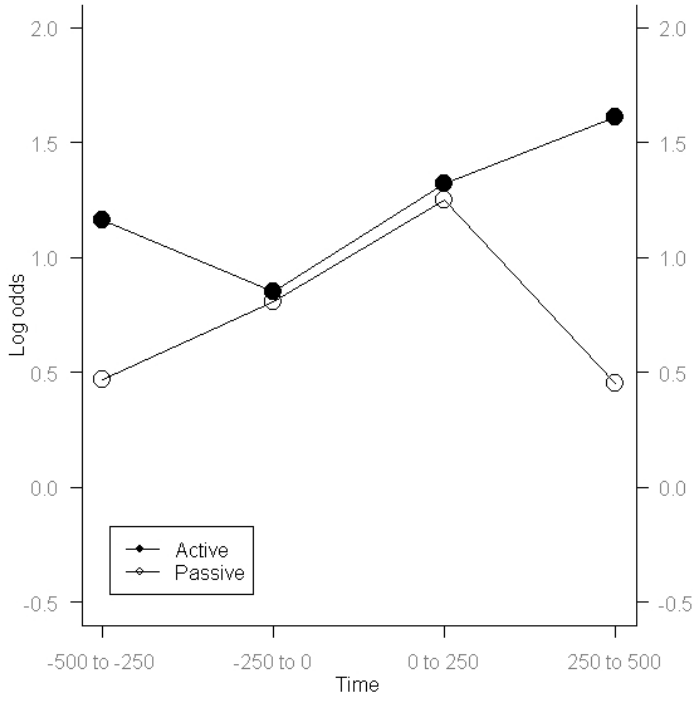

Figure 4.18: Log odds of looks to discourse-new and discourse-old entity in the lexical NP condition in Experiment 3

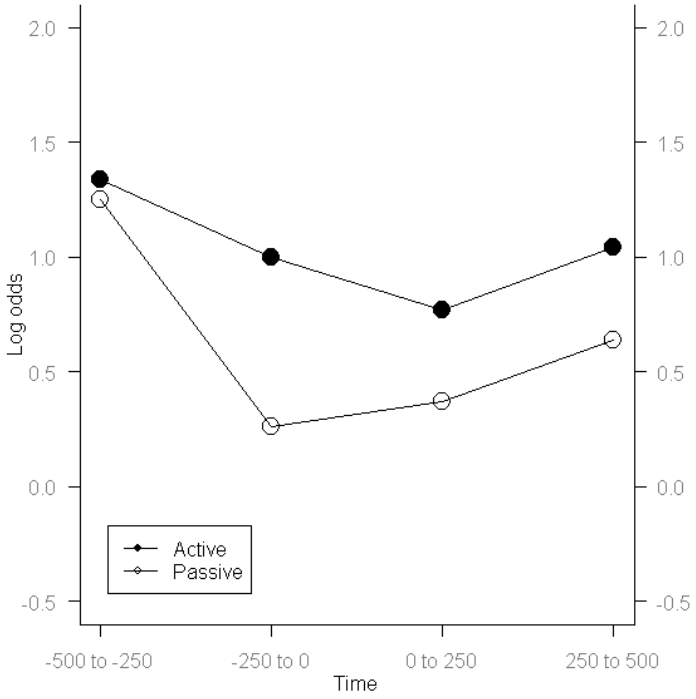

Figure 4.19: Log odds of looks to the discourse-new and discourse-old entity in the Pronoun condition in Experiment 3

As in the previous experiment, the data were analysed using mixed effects models, with the fixed effects of object (discourse-old (base level), discourse-new), voice (active (base level), passive), time (four regions of 250ms, commencing 500ms before the onset of the post-verbal NP), NP Pronoun (Lexical NP (base level), Pronoun). The latter condition was eliminated from the final model. Table 4.6 shows the fixed effects, which are plotted in Figure 4.20. Two way interactions of voice and time, were obtained, such that in the Active condition, the discourse-old entity was preferred, whereas there was little preference in the passive condition. In the Passive condition looks to both discourse-old and new entities increased over time, while there was a slight decrease in looks to both entities in the Active condition.

	Estimate	Std. Error	t value	$Pr(>\|z\|)$
(Intercept)	-2.92	0.20	-14.56	***
Voice	-1.07	0.33	-3.26	***
Object	-1.07	0.31	-3.47	***
Time	-0.09	0.07	-1.22	
Voice:Object	0.90	0.29	3.09	**
Voice:Time	0.20	0.10	1.97	*

Table 4.6: Fixed effects for Experiment 3

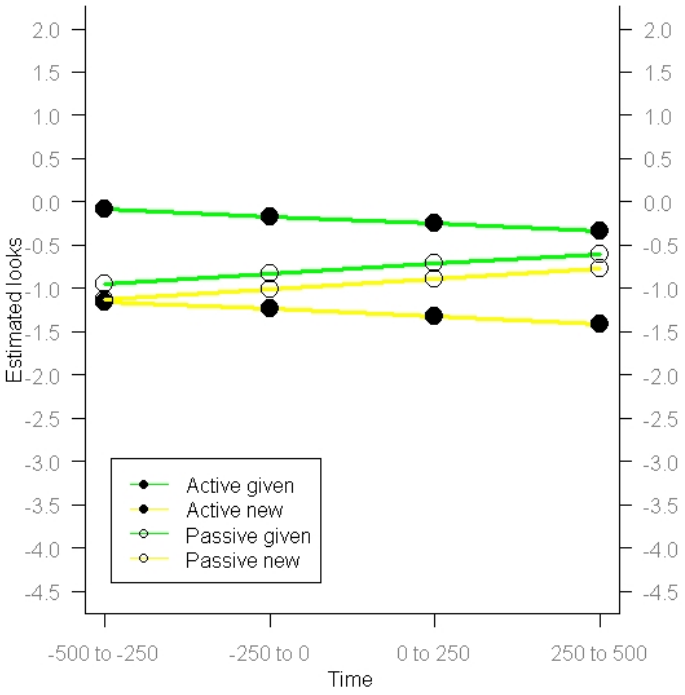

Figure 4.20: Looks to the discourse-new and discourse-old entity in Experiment 3

4.6.6 Discussion

The model reveals an interaction between the object looked at and voice. Surprisingly, pronominalisation was not significant, and was removed from the model. The lack of an effect of pronominalisation is unexpected, as we would expect to see similar effects as shown by the native German speakers in the

lexical NP condition, that is, a disruption to processing as shown by a lack of clear preference for either entity which is resolved over time. Clearly, the effects of pronominalisation in the L2 group cannot be due to transfer of a strategy from their L1. Although this does not rule out a representational deficit, it does suggest that transfer from the L1 does not necessarily lead directly to a non-targetlike representation in the L2. Closer examination of the estimates (Table 4.6), and Figure 4.20 reveals that in the active condition, participants preferred to interpret the old entity as the referent of the post-verbal NP, whereas in the passive condition, there was very little preference. This suggests, that just as for the native German speakers, there is a preference to maintain the current discourse model, and so more looks are made towards the old entity in the active condition. Thus far, we have taken a lack of preference for either entity as the referent of the post-verbal NP to be an indication of processing difficulty, in particular because the lack of preference is generally resolved as time progresses. However, this does not happen in the passive condition, as the lack of preference remains constant over time. It is possible that the passive condition may simply be ambiguous: use of the passive increases the likelihood that the post-verbal NP refers to a new entity.

It could be hypothesized that rather than transferring the information structure implications of syntactic structures, L2 learners could transfer the information structure implications of marked thematic role orders. In passive sentences, the Patient role is pre-verbal, while the optional Agent is post-verbal. Transfer of information structure as related to thematic roles would be consistent with Clahsen & Felser's (2006*b*) Shallow Structure Hypothesis, which proposes that L2 learners process sentences shallowly, relying more on thematic roles than syntactic structure. However, the L2 learners showed, over time, a strong dispreference for the new entity in the OVS condition (which also has a pre-verbal Patient and post-verbal Agent), suggesting that learners were not transferring information structure strategies at even a thematic level.

4.7 General Discussion and Conclusions

Experiments 1-3 are informative about issues in both native and non-native speaker processing. The results from Experiment 1 showed that word order, in

particular the marked OVS order, does not seem to play the role in information structure which might be expected in native speaker processing. L2 learners of German also do not seem to attach information structure implications to OVS word order, but do show evidence that OVS word order is harder to process. The use of a pre-verbal lexical NP or pronoun however does seem to affect processing. In Experiment 1, native speakers of German found the lexical NP condition more difficult, indicating a Repeated Name Penalty effect, but L2 learners seemed to find the Pronoun condition more difficult. However, native English speakers did not show a Repeated Name Penalty as might have been expected. Overall, it seems likely that the L2 learners in were not transferring representations from their L1, but had a processing difficulty, as their behaviour was not consistent with either native speakers of German nor native English speakers processing English sentences and they did not seem to show a Repeated Name Penalty effect. Although further work on the Repeated Name Penalty (or lack thereof) in L2 learners is necessary, it seems likely that the apparent lack of Repeated Name Penalty shown by L2 learners in Experiment 2 is a processing deficit, since the Repeated Name Penalty is typically assumed to hold across languages, since cross-linguistically lexical NPs are used for less accessible antecedents which have not been mentioned immediately before the anaphor (Ariel 2001). However, it cannot be ruled out that the differences observed between the native and L2 groups are an indication of different underlying representations. In Sections 4.7.1, 4.7.2 we discuss the implications for theories of native speaker and L2 processing of information structure with respect to word order and pronominalisation.

4.7.1 Native speakers

It was hypothesized that native speakers of German would show an effect of word order variation with respect to information structure, namely, that OVS word order would promote more looks to the unmentioned entity. However, this was not the case. It is possible that the failure to replicate Weskott et al.'s (2007) results was a result of differences in the precise materials across the experiments. However, the structure of the materials was very similar, such that it seems unlikely that this is the case. Despite this, this cannot be ruled out. A further explanation could come from the participants themselves: the

participants in Experiment 1 were all resident in Scotland at the time of testing. Processing at the syntax-discourse interface, at least in the field of anaphor resolution, has been shown to be vulnerable to attrition. Could it be the case that participants in Experiment 1 were affected by language attrition? Although Experiment 9 shows that attrition effects become evident even a short period after a move away from an environment where the target language is spoken, the majority of the participants in Experiment 1 were involved in the German speaking community in Edinburgh, with several participants reporting (anecdotally) that they worked as tour guides for German groups in the city. However, further work is needed to rule out the possibility of attrition effects completely.

One explanation which requires more detailed examination is that of prosody. Weskott et al. (2007) manipulated prosody to determine whether intonational cues influence the interpretation of the post-verbal NP in an experimental set up similar to that of Experiments 1 and 2. They found that native German speakers were able to use prosodic information to predict whether the post-verbal NP is discourse-new or old. It is therefore possible that prosodic differences between the stimuli used in Experiment 1 and Weskott et al. (2007) could account for the differences in results. Furthermore, it is possible that the neutral prosody used in the stimuli for Experiments 1 and 2 could have moderated any word order effect. Future work in this area needs to consider the role of prosody more carefully, in order to determine exactly which prosodic cues can influence discourse processing in this way. Weskott et al found that prosodic cues had a weaker effect than word order; further work into the ranking of these cues by the processor is necessary.

The factor pronominalisation was significant in Experiment 1 (native German speakers), but not in Experiment 3 (native English speakers). In Experiment 1, participants seemed to find the lexical NP condition more difficult than the pronominalisation condition. It is not wholly clear why this Repeated Name Penalty did not seem to occur in Experiment 3. Camblin et al.'s (2007) work on the Repeated Name Penalty suggests that the speed of presentation of the stimuli across experiments could explain these results. They found that under a speeded presentation, the Repeated Name Penalty did not occur, because the speed of presentation meant that their participants were unable

to integrate discourse information quickly enough, such that the infelicitous repeated lexical NP did not cause processing difficulty. However, in both Experiments 1 and 3, the stimuli were recorded at a natural speech rate; the English stimuli were not faster than the German stimuli in Experiment 1, so the speed of presentation is unlikely to be a factor. One possible explanation of the difference between the results in Experiments 1 and 3 is that English and German have different pronominal systems. Whereas English is typically limited to lexical NPs or personal pronouns, German also has anaphoric demonstrative pronouns which are used for less salient entities (see Chapter 5 for discussion). In German, lexical NPs and personal pronouns are further apart on the Givenness Hierarchy (Gundel et al. (1993),Warren & Gibson (2002)) than in English (See Chapter 2, Section 2.2.1 for further discusion of the Givenness Hierarchy), which might result in the fact that the Repeated Name Penalty was evident in Experiment 1 and not Experiment 3, as the stimuli were broadly similar.

4.7.2 L2 learners

The data presented in Experiment 2 suggests that L2 learners have a processing difficulty which reduces as proficiency increases. However, even at the highest proficiency levels of the participants in the study, there was no complete convergence with native speakers. It is possible, though, that the L2 participants in this study were not sufficiently advanced to show convergence. Future work on near-native and other more advanced learners is necessary to determine this.

Evidence for a processing deficit in L2 learners comes from their behaviour with respect to pronominalisation. Unlike the native speakers, the L2 learners did not show the Repeated Name Penalty, except at the highest proficency level in the SVO condition, instead the pronominalisation condition seemed to be more difficult for the L2 learners. What could explain this difference? Camblin et al. (2007) found that native speakers did not show the Repeated Name Penalty under speeded presentation. If L2 processing is impaired, either merely because it is slower, or because L2 learners find it more difficult to integrate the appropriate information when processing, then we might expect them to behave like native speakers under speeded presentation, which is

indeed what we find. By not being able to integrate the discourse information with the processing of the lexical NP, the processing of that lexical NP is facilitated. However, it could also be the case that L2 learners also find pronominalisation hard independently of lexical NPs. The search for an antecedent which is triggered by a pronoun leads to working memory demands, because the processor must store salience (of whichever type) information about the entities in the discourse, and integrate this information with the information on the pronoun. L2 learners show similarities with other populations, namely children (Sekerina et al. 2004) and adults with Alzheimer's (Almor et al. 1999), suggesting that a pronominal deficit is likely, as well as a facilitation for L2 learners for lexical NPs. Chapter 5 explores the nature of the difficulties which L2 learners show with two different types of pronoun.

Experiment 3 was conducted to determine whether L2 learners' behaviour in Experiment 2 can be directly attributed to transfer from their L1. Since English has a more fixed word order than German, and does not allow the same SVO/OVS alternations as German, a contrast between active and passive sentences was chosen, as the nearest construction. However, this approach is limited to the extent that English does allow post-verbal Subjects, albeit under very limited conditions (among others, with unaccusative verbs, phonologically heavy and encoding discourse-new information). Therefore it is possible that L2 learners might transfer their use of post-verbal Subjects to these more limited contexts only. However, Experiment 3 demonstrates that L2 learners do not seem to over extend the use of post-verbal Subjects to encode discourse-new information to contexts in an L2 (namely with transitive verbs) where this is not targetlike for the L2. One possible limitation of Experiment 3 is that the native speakers of English did not behave as predicted with respect to pronominalisation, not showing the Repeated Name Penalty as native German speakers did on parallel stimuli in German. It is clear that further investigation into why this effect was not apparent in the data from Experiment 3 is necessary.

4.7.3 Conclusions and future work

To conclude, Experiments 1-3 have demonstrated that word order does not seem to have information structure implications for German native speakers,

at least in the same way as seen in Finnish (Kaiser & Trueswell 2004*b*). However, German native speakers were shown to have processing difficulty with repeated lexical NPs, replicating the well established Repeated Name Penalty. The data presented in this chapter are consistent with the hypothesis that L2 learners of German showed a processing difficulty, however, in contrast to native speakers of German, L2 learners found lexical NPs easier than pronouns. Chapter 5 examines L2 learners' processing and interpretation of two pronominal forms in German in more detail. The effect of pronominalisation interacted with word order, however, it remains unclear whether L2 learners found OVS sentences more difficult due to a morphosyntactic deficit, or the inability to use the licensing cues for OVS order in the linguistic stimuli. Proficiency, as measured by a test measuring morphosyntactic and lexical knowledge was a significant predictor of L2 learners' performance, such that the higher proficiency learners behaved more like native speakers with respect to pronominalisation, at least in the SVO condition. In summary, it seems possible that L2 learners are suffering from processing difficulties of some sort, however, the precise nature of these difficulties remains to be explored.

CHAPTER 5

Antecedent Preferences of Anaphoric Demonstratives and Pronouns

5.1 Introduction

In this chapter I present five experiments examining the antecedent preferences for two anaphors in German: anaphoric demonstrative pronouns (the *der, die, das* series) and personal pronouns (the *er, sie, es* series). An investigation into the constraints governing the antecedent preferences of these two anaphors sheds light on issues in both native speaker and L2 learner processing at the syntax-discourse interface. The link between an anaphor and its antecedent and the relationship between different types of anaphor has been widely researched in native speaker processing (see e.g. Almor (1999)). Ariel's Accessibility Hierarchy (Ariel 2001), for example, ranks anaphors by informativeness, and shows that less informative anaphors, such as null pronouns, typically have very salient antecedents. However, recent work (see e.g. Carminati (2002), Kaiser & Trueswell (2008)) has shown that rather than considering antecedent preferences purely in terms of informativeness, different types of anaphor have been demonstrated to be sensitive to different types of constraints. Anaphoric demonstrative pronouns and personal pronouns in German can be considered equally informative; showing that they are subject to different constraints, and have different antecedent preferences would provide further cross-linguistic evidence that an approach based solely on informativeness is limited. Experiments 4-6 examine the role of three different

constraints: topicality, Thematic role and grammatical role in determining the antecedent preferences of anaphoric demonstratives and personal pronouns in native speakers of German.

The antecedent preferences of anaphoric demonstratives and pronouns can shed light on important issues in the processing of the syntax-discourse interface in L2 learners. By examining the role of different constraints, it is possible to determine which aspects of the interface are problematic: for example, if L2 learners seem to use syntactic dependencies but not discourse dependencies when processing anaphors, we can determine that syntactic dependencies are less problematic than discourse dependencies. Previous research on anaphor resolution in L2 learners (Sorace & Filiaci 2006) has not distinguished between Grammatical and Thematic role; Experiments 7 and 8 aim to separate the role of topicality, Thematic role and grammatical role in determining the antecedent preferences of anaphoric demonstratives and personal pronouns in L2 German.

5.2 Anaphor Resolution in Native Speakers

Typically, sentences do not occur in isolation, but as part of a discourse spanning several sentences. The speaker and listener in a discourse must keep track of the discourse participants, and the relative levels of salience which each has in the discourse. However, discourse participants can be tracked using several different forms, such as personal pronouns, null pronouns, definite articles, etc. These different forms are said to interact based on several discourse and structural factors (see e.g. Gundel et al. (1993)). Many theories of anaphor resolution seek to provide a universal explanation of the different antecedent preferences of different types of anaphors. Typically, more reduced forms, such as null pronouns are associated with more salient antecedents, while less reduced forms, such as NP anaphors are said to refer to less salient antecedents (see Bresnan (1998) for a discussion of universal tendencies). This pattern is often explained in terms of accessibility or informational load of the anaphor (Almor 1999), there being a higher processing cost associated with a more specific (less reduced, higher informational load) anaphor for a very salient anaphor.

Recently a different approach to anaphor resolution has arisen: the Form-Specific Multiple Constraint Approach (Kaiser & Trueswell 2008) (See Chapter 2, Section 2.2.3). Research on Italian (Carminati 2002, Carminati 2005) has suggested that for Italian, null Subjects have a strong preference for antecedents in a particular structural position, spec IP, whereas overt Subjects prefer antecedents which are structurally lower (Position of Antecedent Strategy (PAS)). However, the antecedent preferences of overt Subjects are much more flexible than those of null Subjects. There is a lesser processing cost when the PAS is violated for overt Subjects relative to null Subjects. For example in (5.1), the null pronoun refers to the Subject (*Il portiere* (the doorman)), while the overt pronoun *lui* is more flexible as to whether it refers to the Subject (*Il portiere* (the doorman)) or the Object (*il postino* (the postman)).

(5.1) *Il portiere*$_i$ *saluta il postino*$_k$ *mentre* $\emptyset_i$/*lui*$_k$ *apre la porta.*
the doorman greets the postman while null/he opens the door
The doorman greets the postman while he opens the door.

(Sorace & Filiaci 2006, p342)

This is hypothesized to be related to pragmatic factors (Sorace & Filiaci 2006), as the use of the overt Subject is less likely to cause a violation of an *Avoid miscommunication* principle (Engelhardt et al. 2006). Engelhardt et al. (2006) found that native speakers of English were more likely to provide redundant information in descriptions, violating Grice's (1975) Maxim of Quantity. The overuse of overt pronouns is similar to providing extra, redundant information in a description, as an overt pronoun (in Italian) contains information about the number and gender of the referent, more information than a null pronoun. It can thus be seen that different types of anaphor, even within one language, are sensitive to different factors to differing degrees. This is particularly interesting when considering the antecedent preferences of anaphoric demonstratives: whereas differences between null and overt pronouns could be ascribed to the difference in informational load between null and overt pronouns, as null pronouns inherently contain no information such as gender or number marking to identify the antecedent, it could be argued that stricter,

or merely different, constraints on possible antecedents would be necessary to avoid ambiguity for null pronouns. Demonstrative pronouns, on the other hand, generally contain similar information (number, gender marking, etc) to overt personal pronouns, yet are widely reported to have different antecedent preferences (see, e.g. Diessel (1999)). The question is thus raised: which factors affect the antecedent preferences of demonstrative pronouns and personal pronouns, and to what extent are these factors universal? Currently research has focussed mainly on three languages: Finnish, Dutch and German. In Section 5.3 the literature on these three languages is reviewed. Although the currently available empirical evidence is limited, in part due to a lack of appropriate statistical analysis in some areas, it is possible to draw some preliminary conclusions.

5.3 Cross-linguistic Variation: Anaphoric Demonstratives and Pronouns

In several languages, such as German, Finnish, Dutch and Czech, demonstrative pronouns can be used anaphorically, so that they are coreferential with an entity in the previous discourse. Traditionally, however, particularly in German, the study of anaphoric pronouns has not received much attention, probably because the use of the anaphoric demonstrative is associated with colloquial and or pejorative usage (Winter 2003). Furthermore, the use of an anaphoric demonstrative is also sometimes associated with a sense of distance from the referent (Bosch, Katz & Umbach 2007).

In German, both the anaphoric demonstrative (the *der, die, das* series of demonstratives), which are homophonous with the definite article, can be used instead of the personal pronoun (the *er, sie, es* series) to refer to an entity in the previous sentence.

(5.2) *Der Anwalt$_j$ sprach mit einem Klienten$_i$. Da er$_j$/der$_i$ nicht*
the lawyer spoke with a client. since he/this not
viel Zeit hatte, vereinbarten sie ein weiteres Gespräch
much time had, agreed.on they a further conversation
nächste Woche.
next week

> The lawyer talked to a client. Since he did not have much time, they agreed to have another meeting next week.
>
> (Diessel, 1999 p96)

Following Diessel (1999), in (5.2) the personal pronoun *er* is interpreted to refer to *Anwalt, lawyer*, whereas the demonstrative *der* refers to *Klienten* (client). Wiltschko (1998), referring to German demonstratives in a sentence internal context, suggests that there is a division of labour between personal pronouns and demonstratives, in that personal pronouns are AgrDPs, and Subject to binding principle B, whereas demonstratives are R-expressions, and hence subject to binding principle C (Chomsky 1981). Since demonstratives are R-expressions, she argues that they cannot be bound by a quantified NP, whereas personal pronouns can be bound variables. Additionally, she suggests that demonstratives require a full lexical antecedent, while pronouns do not. Cross-linguistically this is partially supported by evidence from Czech, as null pronouns are unable to antecede demonstratives (Sturgeon in press). However, Sturgeon provides evidence which indicates that in Czech, clitic pronouns are available as antecedents for demonstrative pronouns. Additionally, in a corpus study on Swedish, Lindstroem (1996) found that anaphoric demonstratives were more likely to be used to refer to non-Topics. This suggests that demonstratives prefer the less prominent antecedent: where there is a choice between a null and overt pronoun, the overt pronoun is less prominent, and thus preferred, but when the null pronoun option is not available, the choice is between a lexical NP and pronoun, and the demonstrative prefers the less prominent lexical NP.

Although there seems to be a division of labour intrasententially, what can explain the division of labour for demonstrative pronouns intersententially, as seen in (5.2) above? Diessel (1999), drawing on cross-linguistic evidence from German, Dutch, To'aba'ita and Russian, suggests that "anaphoric demonstratives are coreferential with non-topical antecedents, which are usually less expected" (Diessel 1999, p97), whereas a personal pronoun is coreferential with a continuing Topic. Furthermore, he claims that a demonstrative is used to establish a new discourse Topic.

Sturgeon (in press) presents evidence from Czech which supports the proposal that demonstratives prefer non-Topic antecedents. In Czech, null pronouns alternate with demonstratives. Sturgeon, basing her analysis on Rizzi's (1997) analysis of the left periphery, claims that an XP in [spec, FinP] is not available as the antecedent of a demonstrative, however, DPs which are pre-verbal, but not in this position can antecede demonstratives. However, it is difficult to determine the strength of the preference for non-Topics, as the data are based on the intuitions of a small number of people, and no experimental confirmation of these intuitions is provided.

While the evidence from Czech seems to support the notion that demonstratives prefer non-Topic antecedents, it is not clear whether this is universal. For German, Diessel only gives examples of antecedent sentences with SVO word order where the element in Topic position (pre-verbal) coincides with the Subject. As non-Subjects can move to Topic position in German, it is possible that demonstratives may have an anti-Subject bias in German. This is reinforced by the notion that encoding an entity in either the Topic position, or assigning it the Subject role are both ways of encoding salience, so it is possible that demonstratives in German, rather than having an anti-Topic bias, have an anti-Subject bias. A Topic based account would predict that a personal pronoun would prefer any Topicalised element, regardless of whether the NP is a Subject or Non-Subject, while a demonstrative would prefer a non-Topic NP, which could be either Subject or Non-Subject. However, if the grammatical role account holds, then we would predict that a pronoun would take a Subject as an antecedent, regardless of the structural position, and that a demonstrative would always prefer a non-Subject antecedent, even if this NP were topicalised.

In a corpus study on German, Bosch, Rozario & Zhao (2003) report a preference for personal pronouns to be anteceded by a Topic, while demonstrative pronouns prefer a non-Topic antecedent. However, Bosch et al in fact only recorded whether the antecedent of demonstratives and pronouns was nominative or non-nominative case, while not controlling for word order. In German, non-nominative, or non-Subjects can be Topics (e.g. OVS word order), and so their study does not confirm Diessel's hypothesis, while suggesting that grammatical role may be more important for German demonstratives.

Unfortunately, due to a lack of statistical analysis, it is difficult to interpret these results with any certainty.

Bosch, Katz and Umbach (in press) extended this corpus study in a reading time experiment, a sentence completion experiment and a questionnaire study. In the reading time study, a context was given, in either SVO or OVS order (5.3a) and (5.3b), followed by a target sentence using either a Subject demonstrative or pronoun in sentence initial position (5.3c). In the sentence completion study, participants were asked to complete sentences such as (5.3d), in which *xxx* represents the missing word which participants were asked to complete.

(5.3) a. *Im Krankenhaus*
in hospital
In hospital

b. *Der Oberarzt untersucht den Notfallpatienten.*
the senior.doctor examines the emergency.patient
The senior doctor examines the emergency patient.

c. *Der/Er ist gerade erst gekommen.*
Dem/Pron is now just come
He has only just arrived.

d. *Der xxx ist gerade erst gekommen.*
the xxx is now just come
The xxx has only just arrived.

The target sentence biased the reader towards interpreting the anaphor as either the Subject (Subject support), the Object (Object support), or neither, although no pre-testing to confirm the strength of these biases is reported, so it is not clear whether these biases were of equal strength. It is difficult to interpret the results of this study clearly, as little statistical information is supplied. However, for the SVO antecedent, in the Subject support condition, reading times for the target sentence with a demonstrative appear to be numerically larger, suggesting that this might have caused more difficulty. However, the measure of reading time relates to the whole sentence, (such as (5.3c)) and is thus not a particularly precise measure. In particular, it is not clear how anaphor resolution unfolds over time, as this measure does not indicate the interpretation of the anaphor. Furthermore, this technique is not very fine

grained: it is possible that if one type of anaphor were resolved more slowly, then particular support conditions may cause less slowing of reading times. For both the corpus and the experimental studies, Bosch et al found a Subject preference for pronouns, but an Object preference for demonstratives. However, these results are interpreted as tendencies; given the limitations of the methodologies used, it is difficult to draw firm conclusions. In a subsequent paper, Bosch & Umbach (2006) reinterpret their data, and conclude that since the dispreference of a demonstrative for a Subject antecedent is much stronger in the SVO condition compared to the OVS condition, and the preferences for personal pronouns appear to be less strong than for demonstratives, the relevant constraint is Discourse Topic, rather than grammatical role, as they had previously concluded. They support this claim with native speaker intuitions on several examples, although since they do not test these examples empirically, it is not clear whether these examples truly support their claim. Most strikingly, however, Bosch and colleagues assume that only one factor can be relevant for both pronouns and demonstratives. However, a Form Specific Multiple Constraint Approach would argue that different anaphors can have different constraints: this seems to be apparent in Bosch and colleagues' data, as they report that the preferences for personal pronouns are less strong than those for demonstratives. It is possible that more than one constraint is acting on personal pronouns, leading to a preference which seems to be less strong.

Kaiser & Trueswell (2004*a*) carried out two experiments using Dutch demonstratives and pronouns. While they argue that salience determines the antecedent preference of demonstratives and pronouns (demonstratives preferring less salient antecedents), based on the finding that pronouns preferred Subject antecedents, and demonstratives Object antecedents, in both a sentence completion experiment and a visual-world paradigm experiment they only used SVO anteceding sentences. As the Subject was also always in a Topic position and the Object therefore in a non-Topic position these results are also consistent with a Topic based hypothesis. Interestingly, however, in the visual-world study, anaphor resolution seemed to be quicker for demonstratives than pronouns, however, as no statistical information is given, it is not clear whether this is significant. Furthermore, the time slices used are relatively long, being approximately two thirds of a second in length.

The completion study (Bosch et al. 2007) used very similar stimuli to the reading experiment; however, as seen in (5.3d), the noun is removed, and participants were asked to fill in the appropriate noun (either *Oberarzt*, senior doctor or *Notfallpatienten*, emergency patient), to show which they believed was the intended referent of the anaphor (either demonstrative or pronoun) in the preceding sentence 5.3c. Again, no statistical analysis is reported; however, from the data presented, it appears that context (either Subject or Object supporting) appears to be of greater importance than the choice of anaphor. This is slightly surprising, based on Diessel's suggestion that demonstratives are used to change the Topic, especially when this is unexpected. Following Diessel, we might expect that a demonstrative would lead the reader to interpret the proposed referent as the entity not predicted by context. In the unsupported context, with SVO order, it appears that there is a bias towards an Object antecedent for demonstratives. However, the pronoun does not show a clear Subject preference. In the OVS condition, there appear to be no preferences for either anaphor. The questionnaire study required participants to remember which anaphor they had read in previous experiments. Again, however, no statistical analysis is reported, making it difficult to draw conclusions from the experiment. Interestingly, none of the three experiments reported by Bosch et al seem to confirm that either grammatical role or topichood is of greater importance. However, without further statistical information, it is impossible to draw firm conclusions.

Kaiser & Trueswell (in press) examine these phenomena with Finnish, manipulating whether there is an information structure bias, or a grammatical role bias. An information structure account would make similar predictions to the Topic account, (as suggested by Diessel) in that it predicts that personal pronouns would always prefer the topicalised element, regardless of whether this is a Subject or Object. This is because topicalised entities are typically old information. For example, a demonstrative following an SVO sentence would be interpreted as having an O antecedent, whereas a personal pronoun would have an S antecedent. Following an OVS sentence, however, the demonstrative would take the S as antecedent, and the pronoun the O. The information structure account is compatible with Sturgeon's account of demonstratives in Czech: [spec FinP], which she argues is not available for antecedents of a

demonstrative, is associated with Old information. However, in contrast to the Topic based account, for the Information Structure account, we would not necessarily expect to see complete symmetry between SVO and OVS sentences for Finnish or German, as in German and Finnish the SVO order is canonical, and less marked, and hence has fewer information structural implications compared to the OVS order, which is considerably more marked.

Kaiser & Trueswell (in press) compared this approach to a grammatical roles based approach, that is, that personal pronouns prefer Subject antecedents, but demonstratives prefer Objects (or non-Subjects). This could also be seen in terms of a dispreference: for example demonstratives could have a dispreference for Subjects, but personal pronouns could not have preferences for any particular grammatical role.

Kaiser & Trueswell (in press) and Kaiser & Trueswell (2008) found that while the personal pronoun *hän* consistently preferred a Subject antecedent, the anaphoric demonstrative *tämä* preferred an Object antecedent with an SVO anteceding sentence, but no clear preference with an OVS antecedent. They conclude that pronouns and demonstratives are constrained by different factors for antecedent preference: pronouns seem to prefer Subjects regardless of word order, whereas demonstratives seem to be affected by both grammatical role and word order. Kaiser & Trueswell (in press) and Kaiser & Trueswell (2008) argue that the demonstratives and pronouns seem to be most sensitive to different levels of representation because pronouns seem to consistently prefer Subjects, while demonstratives are affected by both word order and grammatical role. Therefore they suggest that pronouns work more at the syntactic-semantic level, whereas demonstratives are at the discourse level. Their data are not inconsistent with Bosch et al. (2007), who also did not report results which supported the influence of just one factor.

If, as Kaiser & Trueswell (2008) and Kaiser & Trueswell (in press) suggest, these pronouns work more at the syntactic-semantic level, while demonstratives are at the discourse level, this could reveal the possible differences in speed of anaphor resolution seen in Kaiser & Trueswell's (2004*a*) study on Dutch demonstratives, where anaphor resolution for demonstratives seemed to be quicker than for pronouns. If pronouns operate at the syntactic-semantic

level, it is possible that anaphor resolution is slower because deeper level of processing is required, as the full syntactic structure must be computed. However, in Kaiser and Trueswell's study on Finnish, the opposite appears to be the case: grammatical role information appears to be processed more quickly than discourse information. This could be motivated by the fact that syntactic processing is more automatic, whereas more different factors must be integrated for discourse.

Thus far we have discussed three main proposed constraints affecting the antecedent preferences of anaphoric demonstratives and pronouns: topicality, grammatical role and Information Structure. Table 5.1 shows the predicted preferred antecedents for the Topic based theory, the grammatical role theory, and Table 5.2 the findings from the Kaiser & Trueswell (in press) study (Finnish) and from the later Bosch et al paper. The data are organised as follows: SVO pron refers to an SVO sentence followed by a pronoun, SVO dem refers to an SVO pronoun followed by a demonstrative. From Table 5.1 it seems clear that there is cross-linguistic variation regarding the preferred antecedents of pronouns and demonstratives. None of the predictions which rely on one factor alone seem to correspond to the data available from Finnish, German and Dutch, suggesting that more than one factor is responsible for antecedent preferences in different conditions, though the Czech data is consistent with a Topic based approach.

	SVO pron	SVO dem	OVS pron	OVS dem
Topic	S	O	O	S
Information Structure	S/O?	S/O?	O	S
Grammatical role	S	O	S	O
Salience	S	O	S/O?	S/O?

Table 5.1: Predicted antecedent preferences based on different constraints

	SVO pron	SVO dem	OVS pron	OVS dem
Finnish	S	O	S	S/O
German	S/O?	O	S/O?	S/O?
Dutch	S	O		

Table 5.2: Antecedent preferences for pronouns and demonstratives in Finnish, Dutch and German

Grammatical role, topicalisation and information structure all relate to the notion of salience. Subjects, Topics and discourse-old information all encode a high degree of salience. These factors all interact to contribute to the level of salience which an entity has. Often, these factors coincide. For example, Subjects are most likely to be Topics, and most likely to be discourse-old information. However, in an OVS sentence, the Object, in isolation considered to be less salient than a Subject, is in Topic position, increasing the level of salience. It seems likely that these different factors vary cross-linguistically in their contribution to the overall salience of an entity, particularly considering that not all languages (e.g. English) allow extensive topicalisation, so it seems likely to play a different role in determining salience. Despite the fact these factors frequently coincide, it seems mistaken to consider the antecedent preferences of anaphoric demonstratives and pronouns purely in terms of salience because different types of anaphor seem to be sensitive to different aspects of salience.

Bosch & Umbach (2006) argue that since pronouns and demonstratives do not obligatorily have an explicit linguistic antecedent, that rather than investigating the properties of antecedents we should instead look for the properties of the referents of these anaphors. However, the "antecedent properties" such as grammatical role and topicality, as discussed above, can be thought of as different means for encoding salience linguistically. The Form Specific Multiple Constraints approach suggests that different types of anaphor are sensitive to different means of encoding salience linguistically, crucially, this does not rule out the possibility that different types of anaphor can also be sensitive to extra-linguistic salience. Therefore, when an antecedent is present, it is valid to investigate the properties of the antecedent, in order to determine the constraints which an anaphor is sensitive to, while not forgetting that the extra-linguistic context plays an important role in processing. Indeed, the extent to which different types of anaphor are sensitive to extra-linguistic salience constitutes an important area for future research.

Summary

There is clearly a need for further research into the antecedent preferences of anaphoric demonstratives and personal pronouns; current research is re-

stricted to a small number of languages, and few studies which use online data which can allow insight into the time course of anaphor resolution. There is evidence from Finnish (Kaiser & Trueswell 2008) that different anaphors seem to be sensitive to different constraints, as is expected by a Form-specific Multiple Constraints Approach; much of the work on German examines only one constraint: grammatical role. Further work on German, in particular, which allows similar word order variation to Finnish allows cross-linguistic comparison of two typologically distinct languages with regard to this issue. Experiments 4-6 examine the role of three constraints: grammatical role, topicality and Thematic role in the antecedent preferences of anaphoric demonstratives and pronouns.

5.4 Experiments to Determine the Factors Affecting Antecedent Preferences in Native German Speakers

As discussed above, there is currently little empirical evidence on the antecedent preferences of demonstratives and pronouns in German. Research conducted thus far on demonstratives uses mainly a combination of three methodologies: corpus data (Bosch et al. 2007) sentence completion studies (Bosch et al. 2007, Kaiser & Trueswell 2004*a*) and the visual-world paradigm (Kaiser & Trueswell 2004*a*, Kaiser & Trueswell in press). Additionally, Bosch et al. (2007) used a recall task, where participants were asked to recall which type of anaphor they though they had seen in the previous task. However, it is not clear whether recall of a particular anaphor is a result of it being felicitous, or particularly infelicitous. Most of the evidence for German is based on production data, using tasks such as sentence completion. It is not clear whether the same effects will be seen in comprehension.

Here I present 3 experiments designed to investigate the antecedent preferences of German demonstrative pronouns in comprehension: a judgement task and two visual-world experiments. These experiments are designed to separate out the effects of grammatical role, thematic role and topichood in the antecedent preferences of demonstratives and pronouns. Naturally, although not a main aim of these experiments, the implications of the different information structures inherent in SVO and OVS will be considered. However, at

this stage we are not going to examine the role of precise structural position for potential antecedents.

Experiment 4, the judgement task, provides an offline measure of comprehension. Although this method gives only an overall view of the ultimate antecedent preference the use of a judgement scale allows a fairly fine grained view of preference. Experiments 5-8 are visual-world experiments, which have the advantages that we obtain an online, incremental view of how interpretation is progressing, it is possible, for example, that we see an early preference for the first mentioned, or even last mentioned potential antecedent, which then changes over time. As mentioned above, assuming that demonstratives and pronouns are sensitive to different constraints, we may see an early effect for demonstratives and a later effect for pronouns, or vice versa.

5.4.1 Experiment 4

Previous work on German has not fully separated the effects of topichood (pre-verbal position) from grammatical role (Subject/Object). This experiment aims to establish antecedent preferences for demonstratives and pronouns with both SVO and OVS anteceding sentences, as both grammatical roles appear in both Topic and non-Topic positions, it will be possible to distinguish between a straightforward Topic/non-Topic preference and a preference for a grammatical role. For example, if we only have data with SVO anteceding sentences, and we see a demonstrative prefers the Object as antecedent, it is impossible to determine whether the preference is for the grammatical role Object or for Non-Topics. By including OVS sentences as separate conditions, it will be clear whether any preference is determined by either of these two factors, or possible influenced by both. This experiment therefore has the following conditions, as shown in (5.4).

(5.4)
a. SVO + pronoun
b. SVO + demonstrative
c. OVS + pronoun
d. OVS + demonstrative

Based on data presented by Bosch et al. (2007), it was predicted that in the SVO + demonstrative condition, there would be a preference for the Object, or non-Topic. Similarly, cross-linguistic evidence suggests a Subject preference for pronouns in the SVO condition. The OVS conditions are less clearly predicted, as there is a non-typical grammatical role in Topic position: the Object, and the Subject non-typically appears in post-verbal position.

Participants

Twenty native speakers of German participated in the experiment (9 Female, 11 Male). Participants were members of the Edinburgh academic community and wider community of German speakers in Edinburgh. Participants were aged over 18 years (the precise age of participants was not recorded). All participants also took part in an eye-tracking experiment subsequent to the judgement task (Experiment 1, discussed in Chapter 4, and were rewarded with £5 for participation in both experiments.

Materials

Thirty-two short texts were produced, based on materials from Knoeferle (2005). Each text consisted of an antecedent sentence, which was either in Subject-Verb-Object order or Object Verb Subject Order. The antecedent sentences were chosen as these depicted events which were non-sterotypical in either SVO or OVS condition. The second sentence was always Subject initial, commencing with either a personal pronoun (*Er*) or a demonstrative pronoun (*Der*), as shown in (5.5). As only masculine nouns are unambiguously marked for case in German, only masculine nouns were used. Either the pre-verbal or the post-verbal NP was capitalized, and the pronoun or demonstrative; participants were asked to judge co-reference between the capitalized words.

(5.5) a. *DER KNEIPENWIRT bandagiert den Tourist.*
the.nom landlord bandaged the.acc tourist.
ER/DER hat einen Sohn.
Pron/Dem has a son
The landlord bandaged the tourist. He has a son.

b. *Den Kneipenwirt bandagiert DER TOURIST. ER/DER*
the-acc landlord bandaged the tourist. Pron/Dem
hat einen Sohn.
has a son
The landlord was bandaged by the tourist. He has a son.

There is a danger that plausibility effects may affect the interpretation of the anaphor. Therefore, for each item, each NP occurred in both pre and post verbal position, as in (5.6a) and (5.6b).

(5.6) a. *DEN KNEIPENWIRT bandagiert der Tourist. DER/ER*
the-acc landlord bandaged the tourist. Dem/Pron
hat einen Sohn.
has a son
The landlord was bandaged by the tourist. He has a son.

b. *DEN TOURIST bandagiert der Kneipenwirt.*
the.acc tourist bandaged the.nom landlord.
DER/ER hat einen Sohn.
Dem/Pron has a son.
The tourist was bandaged by the landlord. He has a son.

Furthermore, judgements for the coreference for both the pre-verbal and post-verbal NP with the anaphor were obtained. Each item was shown once to each participant, across participants each item was seen in every condition. A further 32 filler items were included. These items included nouns with feminine and neuter gender, some of which had unambiguous anaphor resolution, i.e. where the anaphor was feminine (*sie, die*), and only one feminine NP was in the antecedent sentence.

Procedure

Sentences were presented in a random order visually on a computer monitor using WebExp software (Keller, Corley, Konieczny & Todirascu 1998), run locally in the laboratory. Participants were asked to judge whether they thought it likely that two phrases written in capital letters referred to the same entity, and to provide a rating of this likelihood on a seven point scale: 7 being used if they were absolutely sure that the capitalized phrases referred to the same

entity, one if it were impossible. Participants were given a short practice phase to ensure that they understood the rating scale.

Results

A linear mixed effects model was run, following the procedure outlined in Chapter 3, but as a linear model. Fixed factors in the model were Word order (SVO (base level) or OVS), Pronoun (base level) or Demonstrative, NP (pre- (base level) or post-verbal NP). Baayen's (in press) pvals.fnc was used to calculate p values for the models, taking into account that the p values generated are anti-conservative. Table 5.3 shows the model estimates of the coreference ratings for each NP (Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)); Figures 5.1 and 5.2 show the model estimates in graphic form of the coreference ratings for each NP. A three-way interaction of Word order, Pronoun or Demonstrative, and NP (pre- or post-verbal) NP was obtained, such that in both demonstrative conditions and the OVS pronoun condition there was a preference for the post-verbal NP, which was weaker in the SVO pronoun condition.

	Estimate	HPD95lower	HPD95upper	pMCMC	$Pr(>\|t\|)$
(Intercept)	4.16	3.69	4.64	0.0001	***
Word order	-0.25	-0.72	0.24	0.31	
Pron/ Dem	-1.1250	-1.63	-0.66	0.0001	***
NP	0.56	0.072	1.03	0.02	*
Word order: Pron/Dem	0.95	0.26	1.62	0.007	**
Word order:NP	0.14	-0.56	0.79	0.67	
Pron/Dem:NP	2.0313	1.36	2.73	0.0001	***
Wordorder: Pron/Dem: NP	-1.53	-2.54	-0.59	0.002	**

Table 5.3: Fixed effects for Experiment 4

Discussion

These results differ from Bosch, Katz and Umbach's data on German. The demonstratives showed a clear preference for non-Topics, as distinct from

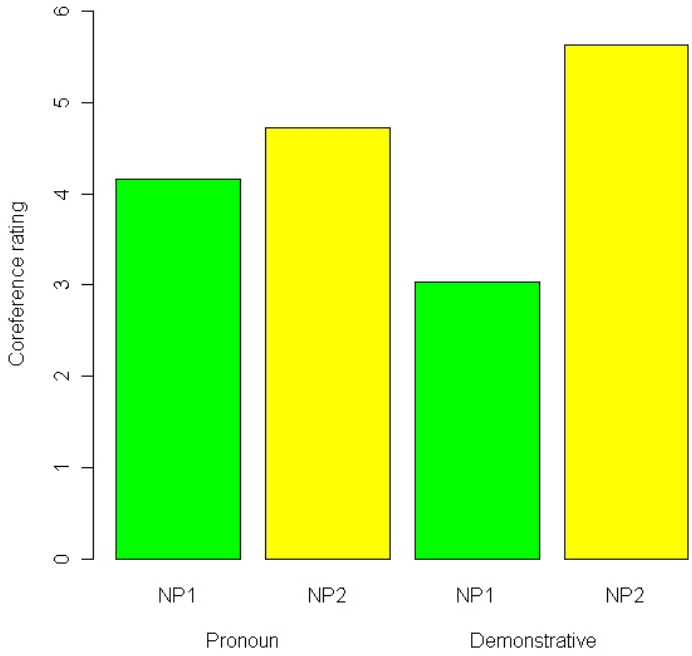

Figure 5.1: Coreferentiality ratings for NP2 and NP1 in the SVO condition in Experiment 4

Objects, as the post-verbal NP was the preferred antecedent for both SVO and OVS conditions, rather than Objects, as suggested by Bosch et al. Pronouns, on the other hand, showed a Subject preference in the OVS condition, but had a much waker preference for the post-verbal NP in the SVO condition. This suggests that grammatical role is more important for pronouns, but does not play the strong role suggested by Bosch et al for demonstratives, which seem to be affected more strongly by a discourse based dependency. This result is consistent with a Form Specific Multiple Constraint Approach, as adopted by e.g. Carminati (2002), Kaiser & Trueswell (2008) in which different anaphors are sensitive to different constraints.

There are issues relating to the presentation of sentences: the effect of capitalizing the phrases for judgment could have influenced their salience, and thus affected the judgements. It is anecdotally reported that demonstrative

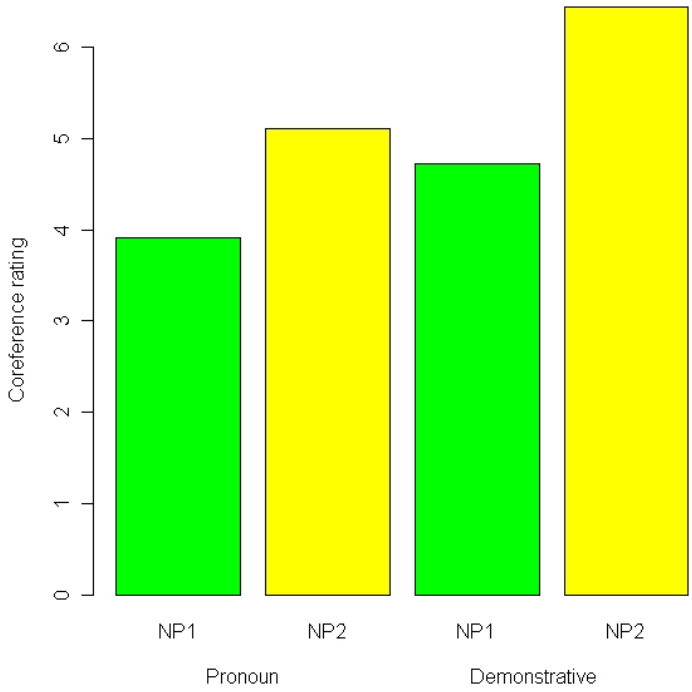

Figure 5.2: Coreferentiality ratings for NP2 and NP1 in the OVS condition in Experiment 4

pronouns are used more frequently in spoken language, so it is possible that visual presentation may have influenced the data The visual-world paradigm allows a more natural presentation of sentences, in a different modality.

5.4.2 Experiment 5

The judgement task in Experiment 4 offers a preliminary view of the antecedent preferences of demonstratives and pronouns. However, the task is an offline study, and so does not provide information about the time course of anaphor resolution. Additionally, as discussed above, the method of presentation of stimuli may have affected the results obtained. The visual-world paradigm allows a more natural presentation of sentences, in a different modality, and so does not present the same problems as the judgement study. The experiment is based on Experiment 4, and uses the same four conditions, however, the

materials were altered to be more suitable for use with L2 learners, and to ensure suitability for the visual-world paradigm. It was predicted that the results would broadly replicate those from Experiment 4, however differences in the time course of resolution may be observed.

Participants

There were 24 participants (16 Female, 8 Male). Participants were students and staff at the University of the Saarland, Saarbr¨cken, Germany, aged approximately 18-35 (the precise age of participants was not recorded). Participants were rewarded €5 for participation.

Materials

Twenty-four short texts were prepared consisting of an antecedent sentence and follow up sentence, an example is seen in (5.7). Just as in Experiment 4, the antecedent sentence consisted of either Subject-Verb-Object order or Object-Verb-Subject Order, with only masculine nouns unambiguously marked for case. However, here the SVO or OVS clause was followed by a subordinate clause, in this case *als das Bier umgekippt wird*, (as the beer is tipped over). The subordinate clause served to cause eye-movements to be moved away from either participant so that fixations on the post-verbal NP would not continue until the onset of the pronoun. The entity in the subordinate clause was inanimate, and of either feminine or neuter gender so that it could not be a potential antecedent for the pronoun. The second sentence began with either a demonstrative pronoun or personal pronoun followed by semantically empty lexical items, such as *scheint offensichtlich sehr*, (seems apparently very...). This allows time for saccades towards the perceived antecedent of the anaphor to be executed before any potentially biasing information about the antecedent is processed. For example, if the second sentence were *Der scheint egozentrisch zu sein*, (he seems to be egocentric), it is possible that participants may perceive one of the potential antecedents to be more egocentric, biasing looks towards that entity. To further avoid plausibility biasing of this kind, all noun phrases appeared in both pre- and post-verbal positions in both SVO and OVS conditions.

(5.7) a. *Der Kellner erkennt den Detektiv als das Bier*
the-nom waiter recognises the-acc detective as the beer
umgekippt wird. Er ist offensichtlich sehr
tipped.over is. he.pron is clearly very
fleißig.
hard.working.
The waiter recognises the detective as the beer is tipped over. He is clearly very hard working.

b. *Der Kellner erkennt den Detektiv als das Bier*
the-nom waiter recognises the-acc detective as the beer
umgekippt wird. Der ist offensichtlich sehr
tipped.over is. he.dem is clearly very
fleißig.
hard.working.
The waiter recognises the detective as the beer is tipped over. He is clearly very hard working.

c. *Den Kellner erkennt der Detektiv als das Bier*
the.acc waiter recognises the.nom detective as the beer
umgekippt wird. Er ist offensichtlich sehr
tipped.over is. he.pron is clearly very
fleißig.
hard.working.
The waiter is recognised by the detective as the beer is tipped over. He is clearly very hard working.

d. *Den Kellner erkennt der Detektiv als das Bier*
the.acc waiter recognises the.nom detective as the beer
umgekippt wird. Der ist offensichtlich sehr
tipped.over is. he.dem is clearly very
fleißig.
hard.working.
The waiter is recognised by the detective as the beer is tipped over. He is clearly very hard working.

Texts were recorded by a female native speaker of German. Intonation was neutral in that intonation patterns which would have led to a marked information structural interpretation were avoided. Vocabulary used in the texts was chosen to be accessible to learners of German, using frequent words and words which are cognates with English where possible. 48 filler texts and images were also produced. These used nouns with feminine and neuter gender, and used verbs in the passive, and intransitive verbs.

Figure 5.3: Picture corresponding with Example (5.7)

Procedure

The procedure was identical to the procedure in Experiment 1.

Analysis

The procedure for the analysis was identical to that for Experiment 1.

Results

The EyeLink data were filtered using software developed at the University of the Saarland. The data were analysed as described for Experiment 1; the statistical analysis followed the method described in Chapter 3. Fixations which commenced before the onset of the pronoun were excluded from the analysis (4.38% of all fixations to either of the target objects which fell within at least one of the target time regions). In this experiment we are interested in looks to either the pre-verbal (NP1) or post-verbal NP (NP2). 8 time windows of 250ms, commencing 500ms before the onset of the post-verbal NP were calculated, and looks to either entity were calculated. The log odds of looks

to either NP1 or NP2 are plotted in Figures 5.4, 5.5, 5.6 and 5.7. The odds of a fixation to the discourse-old entity relative to the discourse new entity were calculated, and then the natural logs taken, such that a value greater than zero can be interpreted as an overall preference for NP2, and a value of less than zero as a preference for NP1.

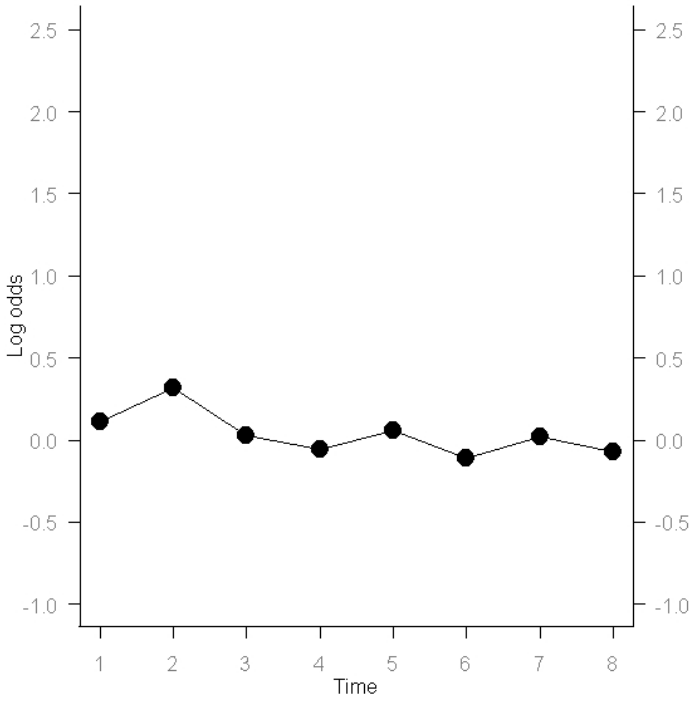

Figure 5.4: Log odds of looks to NP2 and NP1 in the SVO + pronoun condition in Experiment 5

A model for each of the four conditions was run; due to computational limitations it was not possible to run a model for the entire data set. The fully specified models included the factors Time (8 regions of 250ms commencing at the onset of the pronoun), Object (looks to NP1 or NP2, looks to NP1 were used as the base level.). Tables 5.4, 5.5, 5.6, 5.7 show the model estimates for the fixed effects, and significance levels (Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)). Figures 5.8, 5.9, 5.10 and 5.11 show the difference in model estimates of looks to the post- and pre-verbal NP (NP2-NP1)in each of the four conditions, SVO + pronoun, OVS + pronoun, SVO + demonstrative, OVS + demonstrative, for 8 consecutive time regions of 250 milliseconds

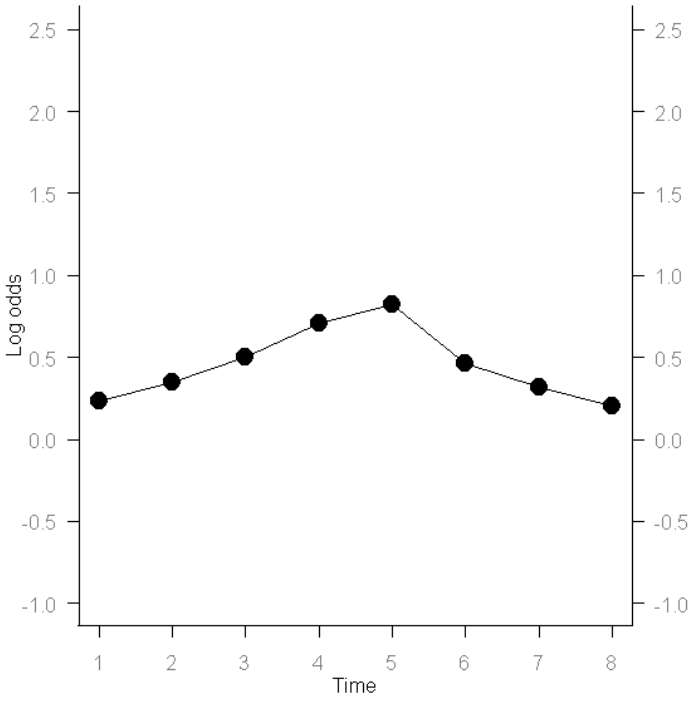

Figure 5.5: Log odds of looks to NP2 and NP1 in the SVO + demonstrative condition in Experiment 5

starting from the onset of the pronoun or demonstrative. A positive value indicates a preference for NP2, and a negative value an NP1 preference. All fixations which began before the onset of the pronoun or demonstrative were eliminated, to ensure that fixations were due to information from the pronoun.

For the SVO + pronoun condition, (Table 5.4 (Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)) and Figure 5.8) a significant interaction of object and time was obtained, such that there was an initial preference for the post-verbal Object (NP2) which switched to a preference for the pre-verbal Subject (NP1). In the SVO + demonstrative condition, we see a strong preference for the post-verbal Object (Table 5.5 and Figure 5.9). In the OVS + demonstratives condition, we similarly see a significant preference for the post-verbal NP, (Table 5.6 and Figure 5.10), however, in the OVS + pronoun condition,

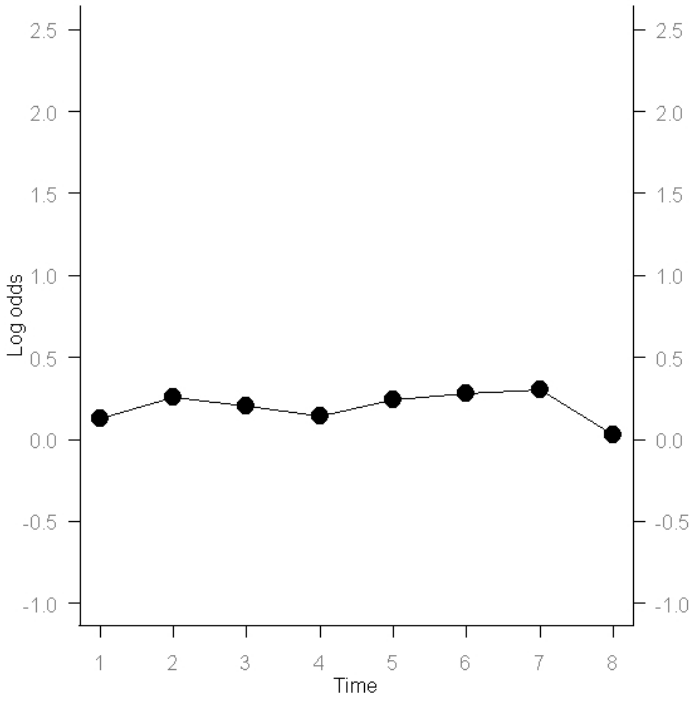

Figure 5.6: Log odds of looks to NP2 and NP1 in the OVS + pronoun condition in Experiment 5

although there was a numerical preference for the post-verbal NP, this was not significant. (Table 5.7 and Figure 5.11)

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-1.71	0.19	***
Object	0.47	0.24	*
Time	0.18	0.03	***
Object:Time	-0.10	0.04	**

Table 5.4: Fixed effects for SVO + pronoun condition in Experiment 5

Discussion

These results are consistent with the conclusions drawn from Experiment 4. For the anaphoric demonstratives, we see a clear preference for the post-verbal

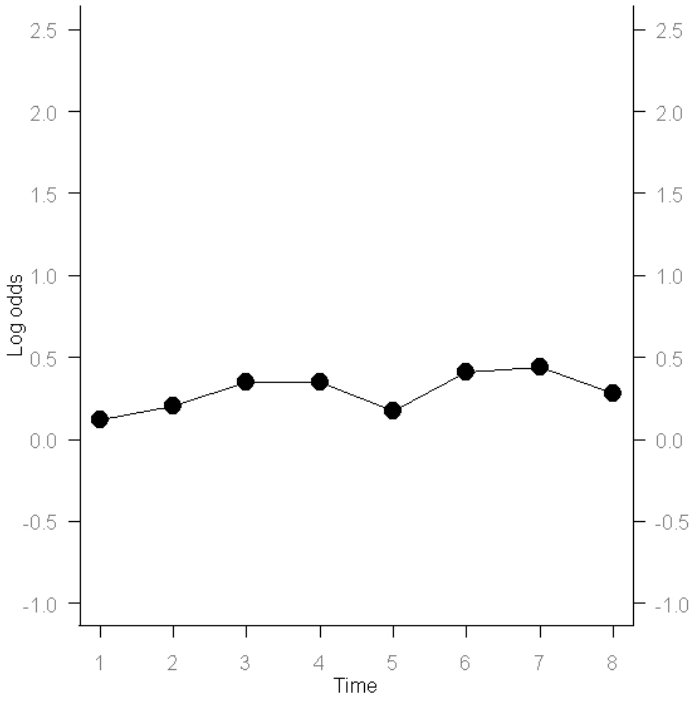

Figure 5.7: Log odds of looks to NP2 and NP1 in the OVS + demonstrative condition in Experiment 5

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-1.87	0.31	***
Object	0.77	0.21	***
Time	0.12	0.03	***

Table 5.5: Fixed effects for SVO + demonstrative condition in Experiment 5

NP, regardless of whether this is a Subject or Object, suggesting that demonstratives are overwhelmingly subject to topicality in their antecedent preferences, as they consistently prefer a non-Topic antecedent. The fact that this preference is less strong in the OVS condition can be explained by the fact that OVS is generally less frequent than SVO order, so we might expect less strong preferences.

The results for the pronoun conditions are similar to those in Experiment 4. The temporal resolution afforded by the visual-world methodology shows

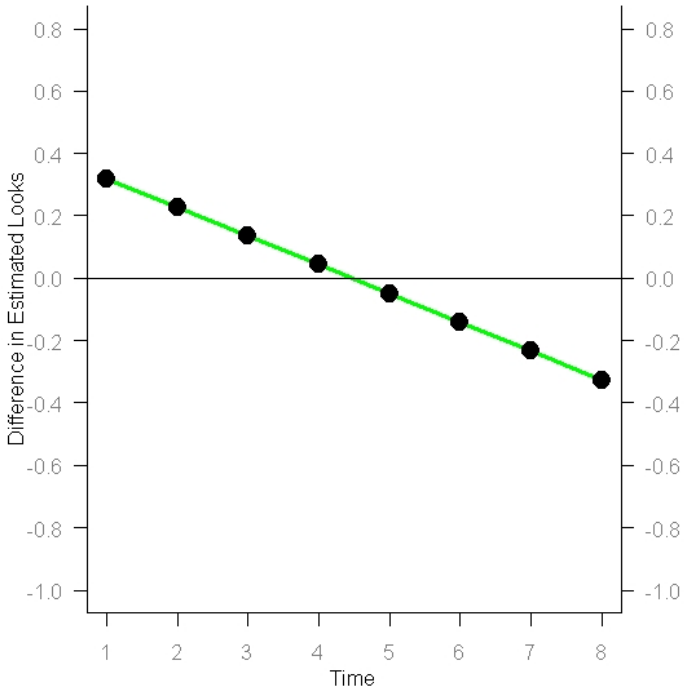

Figure 5.8: Difference in looks to NP2 and NP1 in the SVO + pronoun condition in Experiment 5

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-1.45	0.20	***
Object	0.31	0.23	
Time	0.11	0.02	***

Table 5.6: Fixed effects for OVS + pronoun condition in Experiment 5

that the result in the SVO + pronoun condition in Experiment 4, which approached significance (preference for the post-verbal NP), is actually a switch in preference over time, from the post-verbal NP to the pre-verbal NP. However, although the direction of the preference is the same in the OVS + pronoun condition as in Experiment 4, it is not significant in Experiment 5. These data are, however consistent with the hypothesis that personal pronouns are subject to different constraints from anaphoric demonstratives, being sensitive

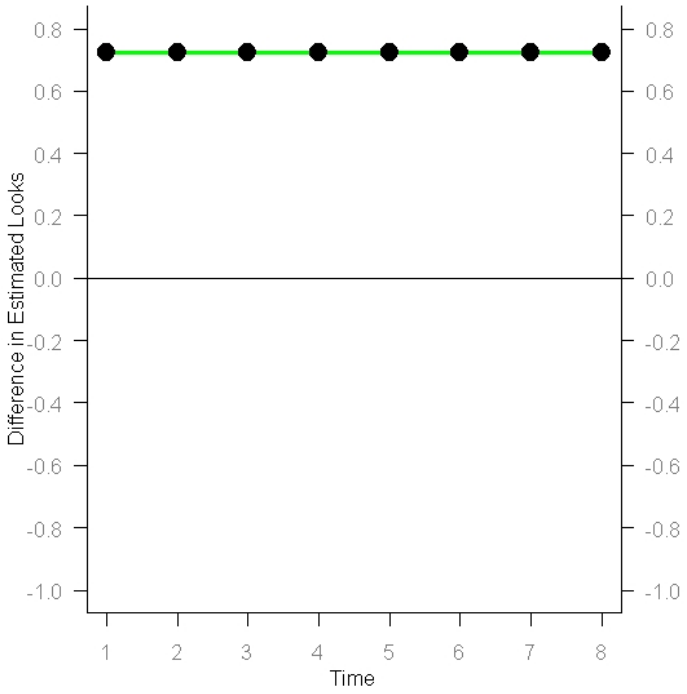

Figure 5.9: Difference in looks to NP2 and NP1 in the SVO + demonstrative condition in Experiment 5

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-1.62	0.15	*
Object	0.33	0.15	*
Time	0.11	0.02	***

Table 5.7: Fixed effects for OVS + demonstrative condition in Experiment 5

to both a grammatical role constraint (Subject preference), and a topicality constraint. In the SVO condition we observe an ultimate preference for the preverbal NP, whereas we see either a post-verbal preference, or no significant preference in the OVS condition, where the Topic and Subject do not coincide.

5.4.3 Experiment 6

In Experiments 4 and 5 we have discussed antecedent preferences only in terms of grammatical role and topicality. However, in both these experiments

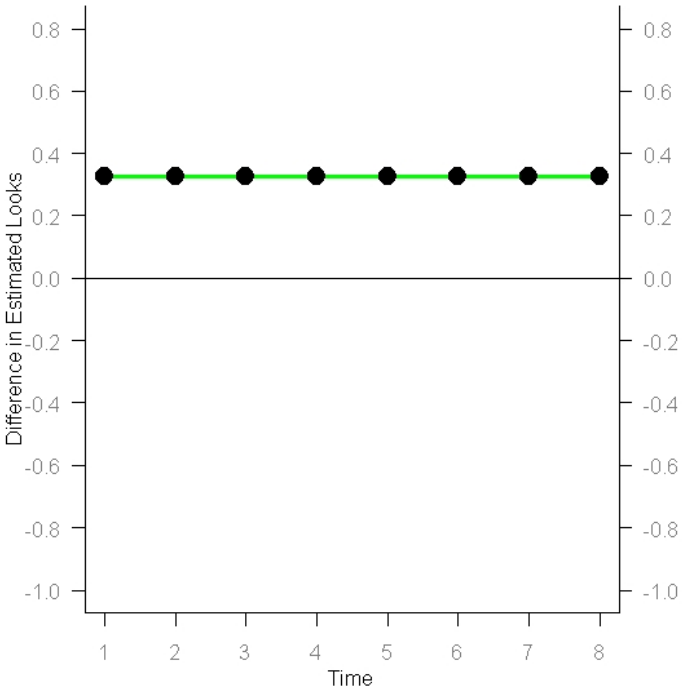

Figure 5.10: Difference in looks to NP2 and NP1 in the OVS + pronoun condition in Experiment 5

grammatical role has also coincided with Thematic role: Subjects have consistently been Agents, and Objects, Patients. It is therefore impossible to conclude whether the observed effects are due to grammatical role or Thematic role. Experiment 6 aims to separate Thematic role from grammatical role to determine whether the antecedent preferences of anaphoric demonstratives and personal pronouns are subject to either of these constraints. Based on the results from Experiments 4 and 5, we would expect demonstratives to be unaffected by Thematic role, as they only seemed to be sensitive to topicality. However, it is possible that personal pronouns are sensitive to Thematic role in addition to, or instead of grammatical role.

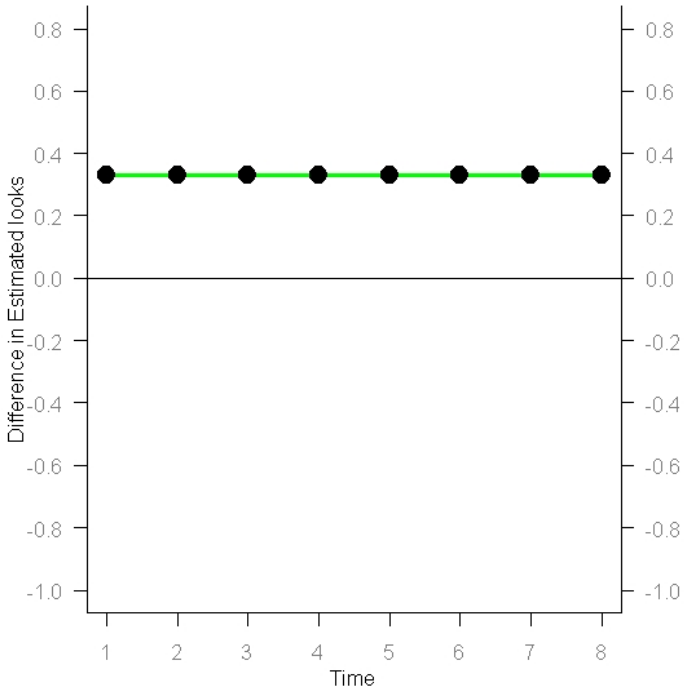

Figure 5.11: Difference in looks to NP2 and NP1 in the OVS + demonstrative condition in Experiment 5

Participants

There were 24 participants (20 Female, 4 Male). Participants were native speakers of German who were students and staff at the University of Edinburgh, aged approximately 18-35 (the precise age of participants was not recorded). Participants were rewarded £5 for participation.

Materials

Twenty-four short texts were prepared consisting of an antecedent sentence and follow up sentence, as in Experiment 5, each with a corresponding semi-realistic visual scene. These short texts used the same lexical items as the materials in Experiment 5, however they were combined in different ways to create new sentences. Rather than using SVO and OVS antecedent sentences,

Active and Passive sentences were contrasted, as in (5.8). The Active condition in Experiment 6 is therefore identical to the SVO condition in Experiment 5. As in Experiment 5, to avoid plausibility effects, both NPs were in both pre- and post verbal positions in both Active and Passive conditions.

(5.8) a. *Der Arzt befragt den Tennisspieler, als die*
the.nom doctor asks the.acc tennis.player as the
Wasserflasche umgekippt wird. Der ist offensichtlich
water.bottle knocked.over is. Dem is apparently
sehr ahnungslos.
very clueless
The doctor asks the tennisplayer as the water bottle is knocked over. He is apparently very clueless.

b. *Der Arzt befragt den Tennisspieler, als die*
the.nom doctor asks the.acc tennis.player as the
Wasserflasche umgekippt wird. Er ist offensichtlich
water.bottle knocked.over is. Pron is apparently
sehr ahnungslos.
very clueless
The doctor asks the tennisplayer as the water bottle is knocked over. He is apparently very clueless.

c. *Der Tennisspieler wird vom Arzt befragt, als*
the.nom tennisplayer is by.the.dat doctor asked as
die Wasserflasche umgekippt wird. Der ist offensichtlich
the water.bottle knocked.over is. Dem is apparently
sehr ahnungslos.
very clueless
The tennisplayer is asked by the doctor as the water bottle is knocked over. He is apparently very clueless.

d. *Der Tennisspieler wird vom Arzt befragt, als*
the.nom tennisplayer is by.the.dat doctor asked as
die Wasserflasche umgekippt wurde. Er ist
the water.bottle knocked.over is. Pron is
offensichtlich sehr ahnungslos.
apparently very clueless
The tennisplayer is asked by the doctor as the water bottle is knocked over. He is apparently very clueless

Texts were recorded by a male native speaker of German. As in Experiment 5, intonation was neutral. Vocabulary used in the texts was chosen to be

accessible to learners of German, using frequent words and words which are cognates with English where possible. 48 filler texts and images were also produced. These used nouns with feminine and neuter gender, and used verbs in the passive, and intransitive verbs.

Procedure

The procedure was identical to that of Experiment 1.

Analysis

The procedure for the analysis was identical to that for Experiment 1.

Results

In this experiment we are interested in looks to either the pre-verbal (NP1) or post-verbal NP (NP2). 8 time windows of 250ms, commencing 500ms before the onset of the post-verbal NP were calculated, and looks to either entity were calculated. The log odds of looks to either NP1 or NP2 are plotted in Figures 5.12, 5.13, 5.14 and 5.15. The odds of a fixation to the discourse-old entity relative to the discourse new entity were calculated, and then the natural logs taken, such that a value greater than zero can be interpreted as an overall preference for NP2, and a value of less than zero as a preference for NP1.

The data were analyzed following the same procedure as in Experiment 5. Fixations which commenced before the onset of the pronoun were excluded from the analysis (6.23% of all fixations to either of the target objects which fell within at least one of the target time regions). Tables 5.8, 5.9, 5.10, 5.11 (Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)) show the model estimates for the fixed effects, and significance levels. Figures 5.16, 5.17, 5.18 and 5.19 show the difference in model estimates of looks to the post- and pre-verbal NP (NP2-NP1)in each of the four conditions, Active + pronoun, Passive + pronoun, Active + demonstrative, Passive + demonstrative, for 8 consecutive time regions of 250 milliseconds starting from the onset of the pronoun or demonstrative. A positive value indicates a preference for NP2, and a negative value an NP1 preference. All fixations which began before the onset of the

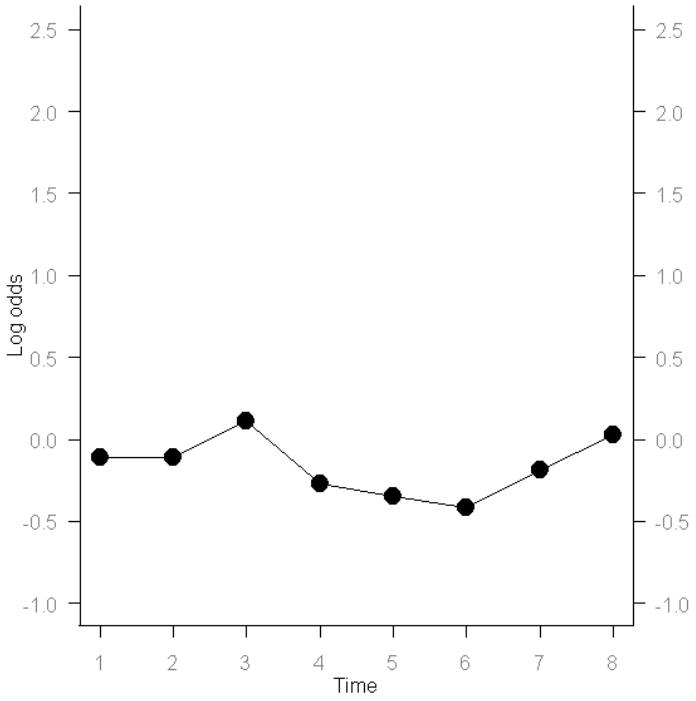

Figure 5.12: Log odds of looks to NP2 and NP1 in the Active + pronoun condition in Experiment 6

pronoun or demonstrative were eliminated, to ensure that fixations were due to information from the anaphor (pronoun or demonstrative).

As the Active conditions should be identical to the SVO conditions in Experiment 5, it was hypothesized that these results would be replicated. However, this was not the case. In the Active + demonstrative condition, the post-verbal NP preference approached significance (Table 5.9, Figure 5.17). None of the other three conditions showed a significant preference for either NP (Active + pronoun, Table 5.8, Passive + pronoun, Table 5.10, Passive + demonstrative, Table 5.11)

Discussion

The results from the passive conditions, which show no significant preference for either NP, suggest that Thematic role does play a role in the an-

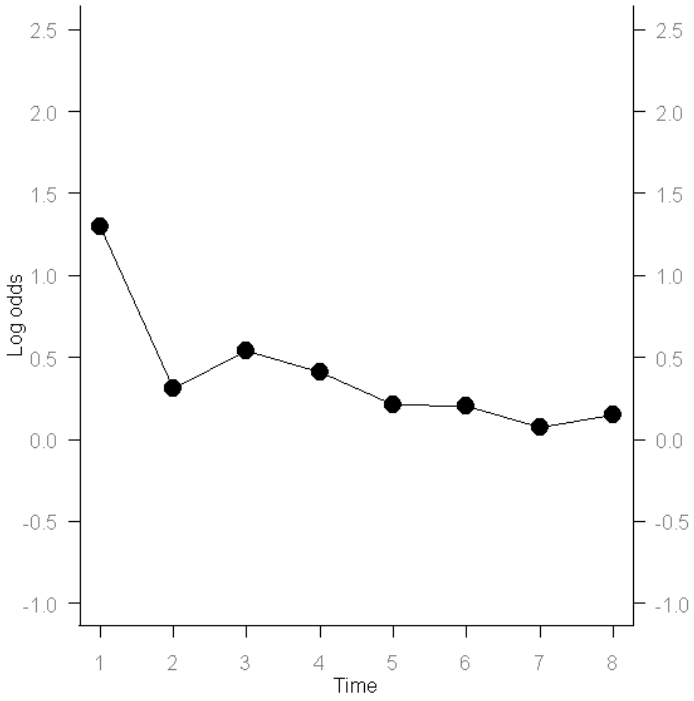

Figure 5.13: Log odds of looks to NP2 and NP1 in the Active + demonstrative condition in Experiment 6

	Estimate	Std.Error	$Pr(>\|z\|)$
(Intercept)	-3.66	0.16	***
Object	-0.20	0.23	
Time	0.17	0.02	***

Table 5.8: Fixed effects for active + pronoun condition in Experiment 6

tecedent preferences of anaphoric demonstratives and personal pronouns. For the passive + demonstratives condition, when the (post-verbal) Non-Topic is an Agent, there is no preference. However, in Experiment 5, in the OVS + demonstrative condition, the post-verbal Non-Topic is also an Agent, which does not seem to affect the preference for the post-verbal NP. Similarly, the lack of preference in the Passive + pronoun condition suggests that when there is a conflict between the Subject and Agent, that there is no preference, just as in the OVS + pronoun condition in Experiment 5.

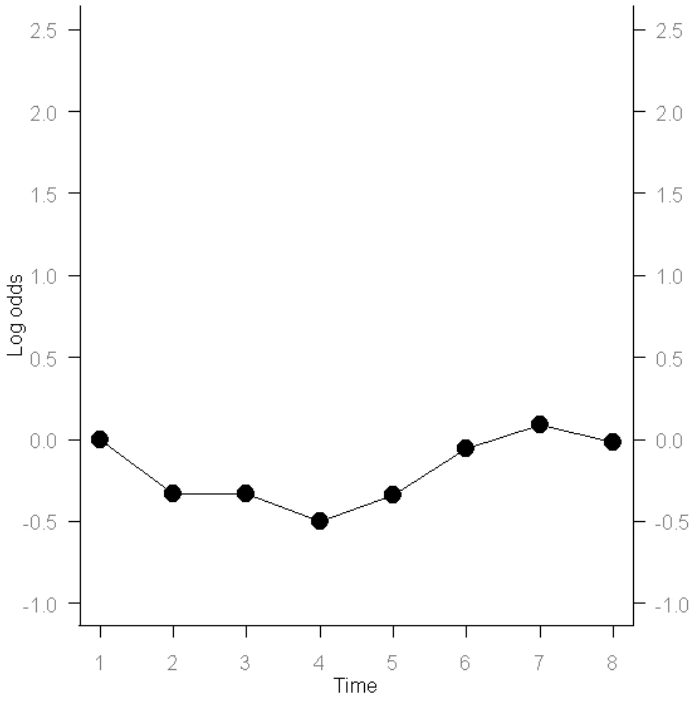

Figure 5.14: Log odds of looks to NP2 and NP1 in the Passive + pronoun condition in Experiment 6

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.62	0.12	***
Object	0.25	0.13	.
Time	0.15	0.02	***

Table 5.9: Fixed effects for active + demonstrative condition in Experiment 6

However, the crucial results in Experiment 6 are those of the Active condition. The Active conditions should yield identical results to the SVO conditions in Experiment 5. However, this is not the case, as the strong post-verbal NP preference for the demonstrative pronoun in the SVO + demonstrative condition in Experiment 5 only approached significance. There was also no significant preference for either NP in the Active + pronoun condition, unlike in Experiment 5. What could explain these differences? Although the materials used different sentences, the materials in Experiments 5 and 6 were very

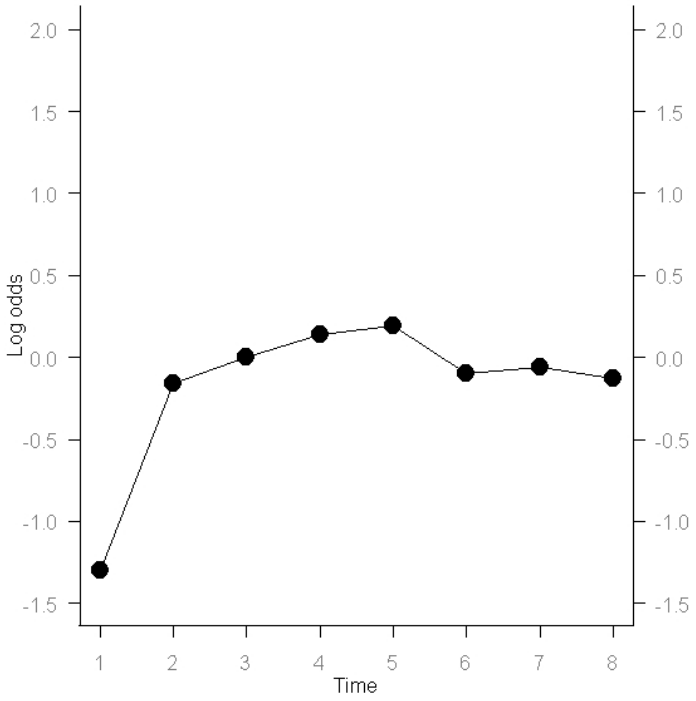

Figure 5.15: Log odds of looks to NP2 and NP1 in the Passive + demonstrative condition in Experiment 6

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.58	0.14	***
Object	-0.22	0.14	
Time	0.17	0.02	***

Table 5.10: Fixed effects for passive + pronoun condition in Experiment 6

similar, so it seems unlikely that the materials caused the difference in results. One outstanding difference between the two experiments is the participant group. In Experiment 5, all participants were resident in Germany at the time of testing, while those in Experiment 6 were all resident in Scotland. It is possible that the participants in Experiment 6 were showing effects of native language attrition. Previous research such as Tsimpli et al. (2004) has shown that it is at the interface of syntax with discourse that native speakers are particularly prone to attrition in the initial stages of the process. The data

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.42	0.12	***
Object	-0.15	0.12	
Time	0.15286	0.02	***

Table 5.11: Fixed effects for passive + demonstrative condition in Experiment 6

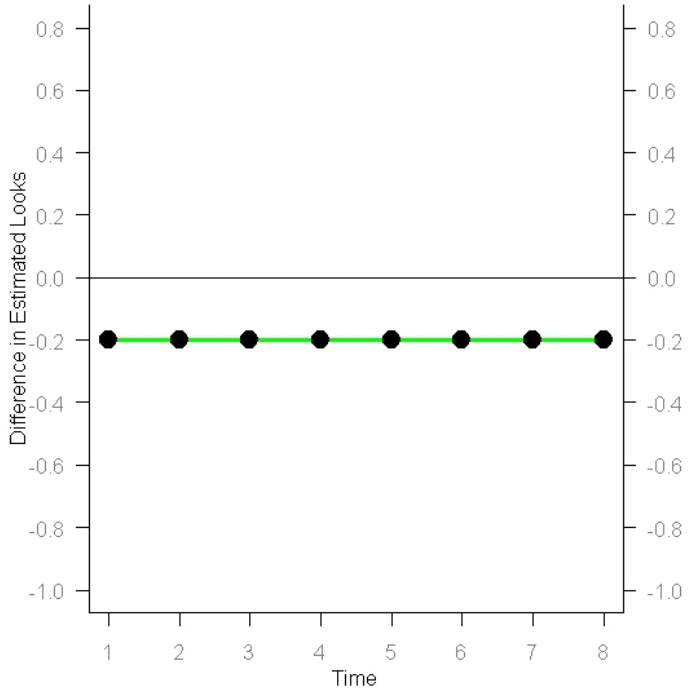

Figure 5.16: Difference in looks to NP2 and NP1 in the active + pronoun condition in Experiment 6

presented in Experiment 9 confirm this hypothesis. In Experiment 9, the materials used in Experiment 5 were used with a participant group comparable to those in Experiment 6 in the Active/SVO conditions. Residence in Great Britain and exposure to English were controlled in this group, so that any changes in behaviour due to attrition effects could be observed. In Experiment 9, for demonstrative pronouns, it was found that the preference for the post-verbal NP was reduced the longer participants had lived in Great Britain. The picture for pronouns was less clear, though strong effects of attrition were

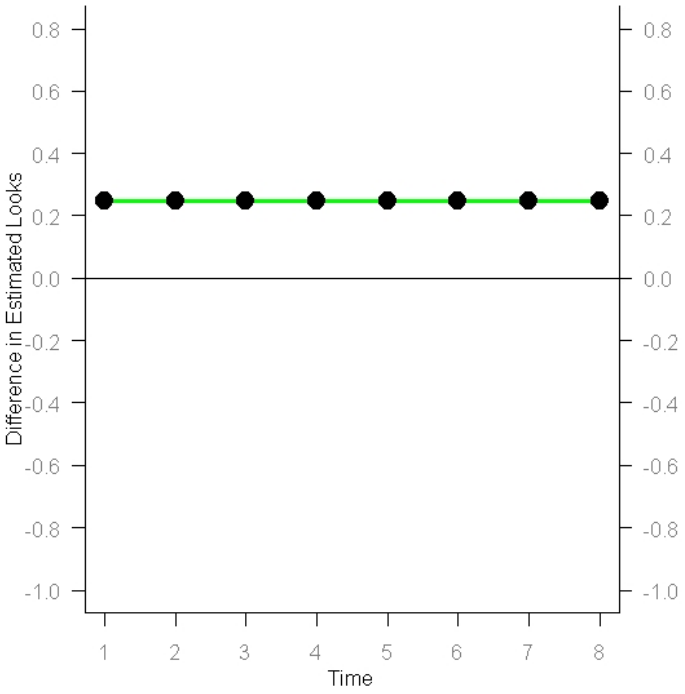

Figure 5.17: Difference in looks to NP2 and NP1 in the active + demonstrative condition in Experiment 6

seen overall, suggesting that the lack of replication in Experiment 6 was due to attrition effects.

5.4.4 *Discussion: antecedent preferences of anaphoric demonstratives and personal pronouns in native speakers of German*

The results from Experiments 4-6 confirm that anaphoric demonstratives and personal pronouns in German are not just subject to one constraint as suggested by Bosch, Katz and Umbach. Table 5.12 gives a summary of the results from Experiments 4-6. Instead, demonstrative pronouns seem to prefer non-Topic antecedents, and so are subject to discourse based constraints. Personal pronouns, on the other hand, are sensitive to both grammatical role and topicality, in Experiment 5, in the SVO condition, personal pronouns had an initial non-Topic preference, which switched to a Subject preference. Thematic

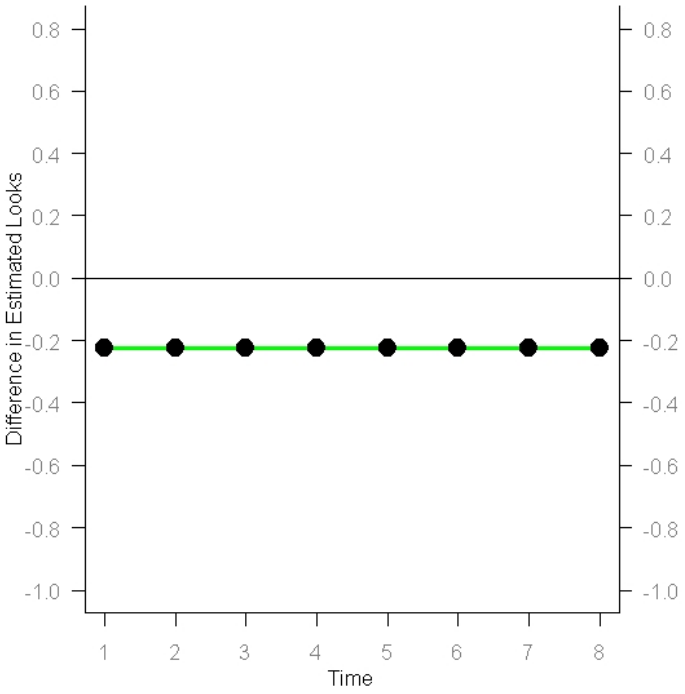

Figure 5.18: Difference in looks to NP2 and NP1 in the passive + pronoun condition in Experiment 6

role, however, does not seem to be a constraint in the antecedent preferences of anaphoric demonstratives or personal pronouns. These results also confirm that there is cross-linguistic variation in the antecedent preferences of anaphoric demonstratives and personal pronouns. Whereas in Finnish, personal pronouns were mainly sensitive to grammatical role, in German personal pronouns are sensitive to both grammatical role and topicality. Furthermore, demonstratives in Finnish are sensitive to both discourse constraints and grammatical role, while German demonstratives do not seem to be affected strongly by grammatical role.

The data from Experiments 4-6 demonstrate that anaphor resolution is vulnerable to attrition, with clear differences between groups on equivalent conditions, which can be attributed to the fact that the participants in Experiment

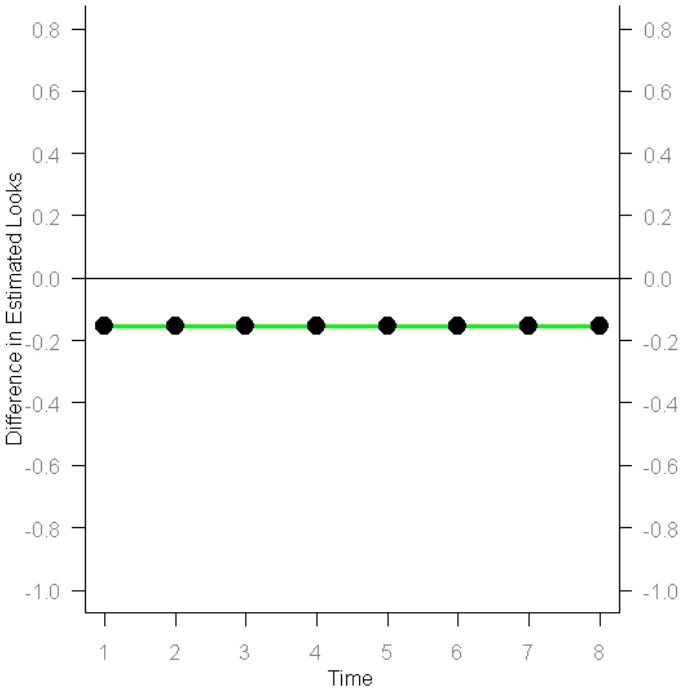

Figure 5.19: Difference in looks to NP2 and NP1 in the passive + demonstrative condition in Experiment 6

5 were all resident in Germany at the time of testing, while those in Experiment 6 were resident in Scotland. It could be argued that the participants in Experiment 4 should be undergoing attrition, as they were also resident in Scotland at the time of testing. However, the participants in Experiment 4 were primarily recruited from German groups, such as the Edinburgh German Church; several of these participants reported informally that they worked as tour guides for German tourist groups. Although no formal data is available, it seems likely that the participants in Experiment 4 were receiving much more native German input than those in Experiment 6, who were working or studying at the University of Edinburgh. The data from Experiment 9, discussed in Chapter 6, in which the amount of German input and the time spent living in Great Britain were controlled confirm this. For further discussion of the link between interface phenomena and attrition see Section 6.2.2 in Chapter 6.

		Experiment 4	**Experiment 5**	**Experiment 6**
Pronoun	SVO	No pref	NP2 to NP1	No pref
	OVS/Passive (Exp6)	NP2	No pref	No pref
Demonstrative	SVO	NP2	NP2	NP2
	OVS/Passive (Exp6)	NP2	NP2	No pref

Table 5.12: Summary of antecedent preference for native speakers of German

5.5 Antecedent Preferences of Anaphoric Demonstratives and Personal Pronouns in L2 Learners of German

[1]The Interface Hypothesis (Sorace & Filiaci 2006) states that L2 learners have difficulties at the interfaces of syntax with other cognitive domains. However, results from Experiments 4-6 show that the syntax-discourse interface, even within the more limited domain of anaphor resolution, is not homogenous, in that different constraints are relevant for different anaphors: anaphoric demonstratives form a discourse dependency with their antecedents, preferring non-Topics, whereas personal pronouns are subject to both grammatical role and topicality. It is therefore likely that L2 learners will show different levels of difficulty at different aspects of the interface. Sorace and Filiaci's (2006) data suggest that L2 learners of Italian interpret null pronouns in a targetlike manner and are able to form syntactic dependencies to do so, whereas they show greater difficulty with overt pronouns, which form a discourse based dependency. However, Sorace and Filiaci did not control for Thematic role: their Subjects had the most Agentlike Thematic role, so it is possible that even though their participants appeared to be using a syntactic dependency, that they were instead relying on Thematic role. (For further discussion of anaphor resolution in L2, see Chapter 2, Section 2.3.3) Experiments 7 and 8 investigate the extent to which L2 learners are able to acquire and use in real time processing the same constraints as native speakers, and where L2 learners' behaviour is non-targetlike, what constraints they are using. Experiments 7

[1]This section will appear in edited form as Wilson, Sorace & Keller (2009).

and 8 are parallel to Experiments 5 and 6: Experiment 7 investigates the role of topicality and grammatical role, and Experiment 8 examines grammatical role and Thematic role.

5.5.1 Predictions for L2 learners

What antecedent preferences would we expect to see in L2 learners of German with respect to anaphoric demonstratives and personal pronouns? Following Sorace and Filiaci's (2006) results, we might expect L2 learners to be able to form syntactic dependencies but not discourse based dependencies. However, as discussed above, it is not fully clear whether the participants in Sorace and Filiaci's study were using syntactic dependencies, or relying on thematic role in some way. Experiments 7 and 8 investigate the whether grammatical role, thematic role and topicalisation are constraints on the antecedent preferences of demonstratives and pronouns in L2 German.

Taking each constraint individually we can make clear predictions about the results: If grammatical role is a constraint, then we would expect the SVO/Active condition and the Passive condition to behave similarly, as the order of grammatical roles is Subject - Object, with opposite preferences for the OVS condition, where the order is Object - Subject. For example, if there is a Subject preference, we would expect an NP1 preference in the SVO/Active and Passive conditions and an NP2 preference in the OVS condition. However, if thematic role is a constraint, then we would expect the OVS and Passive conditions to pattern together, as they have Patient - Agent order, and observe an NP1 preference if Agents are preferred in the SVO/Active condition only. If topicalisation is a constraint, then we would expect all three conditions to pattern together, as we have Topic - non-Topic order in all three conditions.

It is entirely possible that for each anaphor, more than one constraint is acting, and at different stages in processing. Furthermore, it is likely that different constraints are important for each anaphor.

5.5.2 Experiment 7

Experiment 7 shares the same design and materials as Experiment 5, using L2 learner participants, and investigates the role of topicalisation and grammatical role in the antecedent preferences of anaphoric demonstratives and personal pronouns. Biographical details were collected which were included in the analysis.

Participants

Twenty-four participants (17 Female, 7 Male) who had learned German after the age of 10 participated in the experiment. 10 participants were resident in the Saarland, Germany at the time of testing; 14 participants were resident in Scotland at the time of testing, but had spent a period of 3 months or more in a German speaking environment in the two years prior to the time of testing. Participants were aged over 18 years (the precise age of participants was not recorded). Participants were undergraduate students from British universities, postgraduate students from the University of Edinburgh and members of staff at the University of the Saarland, Germany. Participants were Participants were rewarded €5 or £5. Table 5.13 shows the mean proficiency score (maximum score of 30, see Experiment 2 for further details) and length of time spent living in Germany for participants in Experiment 7.

	Test Score	Months lived in Germany
Mean	20.96	58.74
St.Dev	6.06	91.15

Table 5.13: Mean test score and length of residence in a German speaking country for participants in Experiment 7

Materials

The materials were the same materials as used in Experiment 5.

Procedure

The procedure was identical to that in Experiment 2. No participants were excluded from the analysis due to a lack of comprehension of lexical items used in the experiment.

Analysis

The procedure for the analysis was identical to that for Experiment 1.

Results

In this experiment we are interested in looks to either the pre-verbal (NP1) or post-verbal NP (NP2). 8 time windows of 250ms, commencing 500ms before the onset of the post-verbal NP were calculated, and looks to either entity were calculated. The log odds of looks to either NP1 or NP2 are plotted in Figures 5.20, 5.21, 5.22 and 5.23. The odds of a fixation to the discourse-old entity relative to the discourse new entity were calculated, and then the natural logs taken, such that a value greater than zero can be interpreted as an overall preference for NP2, and a value of less than zero as a preference for NP1.

The fully specified models included the factors Time (8 regions of 250ms commencing at the onset of the pronoun), Object (looks to NP1 or NP2). Fixations which commenced before the onset of the pronoun were excluded from the analysis (6.92% of all fixations to either of the target objects which fell within at least one of the target time regions). Tables 5.14, 5.15, 5.16, 5.17 show the model estimates for the fixed effects, and significance levels (Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)). Figures 5.24, 5.25, 5.26 and 5.27 show the difference in model estimates of looks to the post- and pre-verbal NP (NP2-NP1) in each of the four conditions, SVO + pronoun, OVS + pronoun, SVO + demonstrative, OVS + demonstrative, for 8 consecutive time regions of 250 milliseconds starting from the onset of the pronoun or demonstrative. A positive value indicates a preference for NP2, and a negative value an NP1 preference.

In the SVO + pronoun condition, (Table 5.14), a significant preference for the pre-verbal NP was obtained. In the SVO + demonstrative condition, there

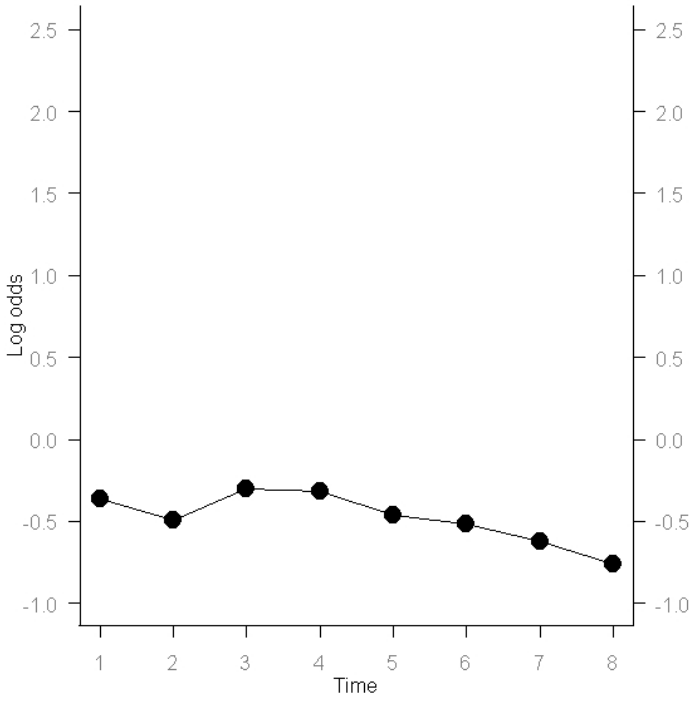

Figure 5.20: Log odds of looks to NP2 and NP1 in the SVO + pronoun condition in Experiment 7

was no significant preference for either NP (Table 5.15). In the OVS + pronoun condition, there is an interaction between Time and Object, such that an initial NP2 preference switches to become an NP1 preference over time (Table 5.16). In the OVS + demonstrative condition no significant preference for either NP was obtained.

Additional analyses investigate the role of proficiency score and Time spent living in a German speaking country. Since these two factors typically show a high degree of colinearity, one of these factors was removed at the start, as described for Experiment 2. In the SVO + pronoun condition, (Table 5.18), a significant preference for the pre-verbal NP was obtained, with a main effect of time spent living in a German speaking country. This main effect did not, however, interact with the preference for the pre- or post-verbal NP. In the OVS + demonstrative condition, there is an interaction between Proficiency

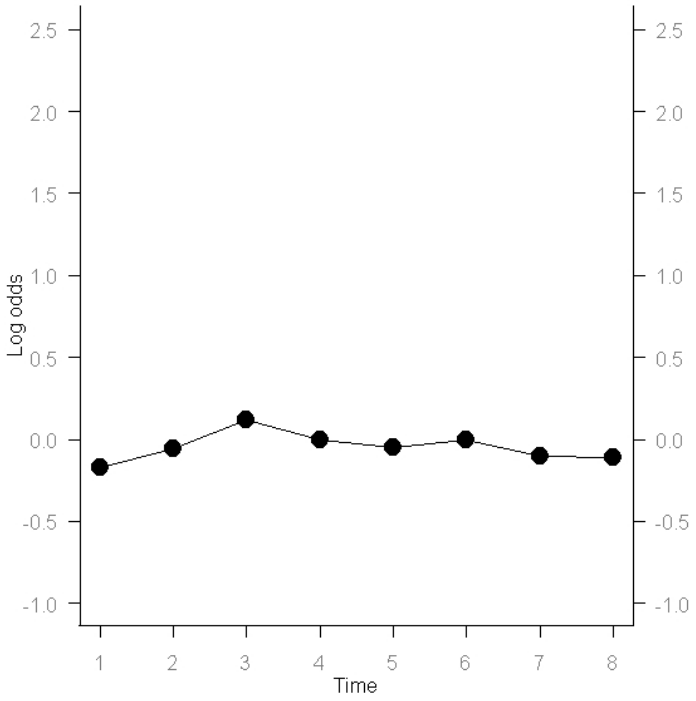

Figure 5.21: Log odds of looks to NP2 and NP1 in the SVO + demonstrative condition in Experiment 7

Test Score and Object, such that at low proficiency levels, there is an NP2 preference, which switches to an NP1 preference at high proficiency levels (Table 5.19). Where a significant interaction of Proficiency or Time spent living in a German speaking country was obtained, these are indicated. Where an effect of proficiency was obtained, in the OVS + demonstrative condition, the estimates for three proficiency levels are shown on the graph (Figure 5.28, these levels correspond to the upper and lower bounds of the data, and the mean proficiency as indicated by test score. No additional graph is plotted for the SVO + pronoun condition, as the main effect of Object remains essentially the same.

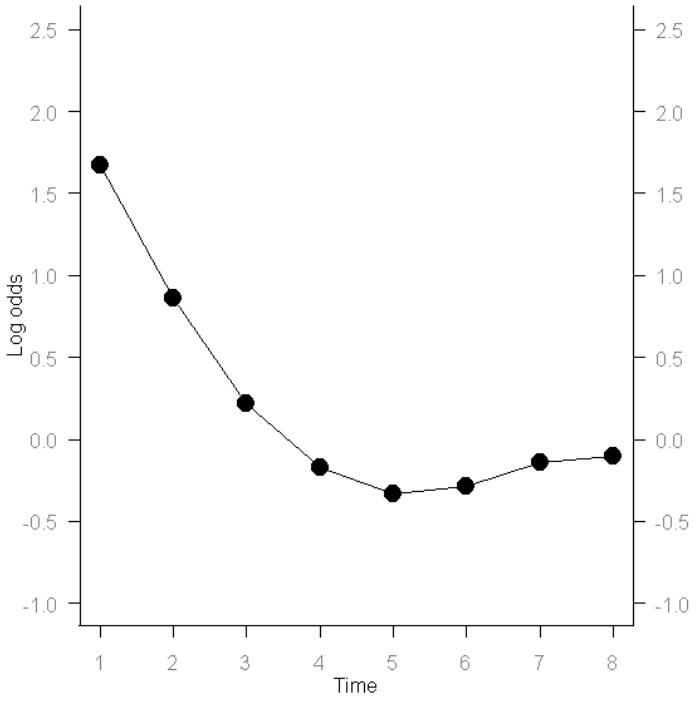

Figure 5.22: Log odds of looks to NP2 and NP1 in the OVS + pronoun condition in Experiment 7

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.40	0.12	***
Object	-0.40	0.09	***
Time	0.17	0.019	***

Table 5.14: Fixed effects for SVO + pronoun condition in Experiment 7

Discussion

It is immediately clear that L2 learners do not share the same antecedent preferences for anaphoric demonstratives and pronouns as native German speakers. In the SVO + pronoun condition there was a preference for the pre-verbal NP, while in the OVS + pronoun condition and initial NP2 preference switches over time. In the SVO and OVS demonstrative conditions there was no preference. However, in two conditions, SVO + Pronoun and OVS + demonstrative there were significant effects relating to different measures

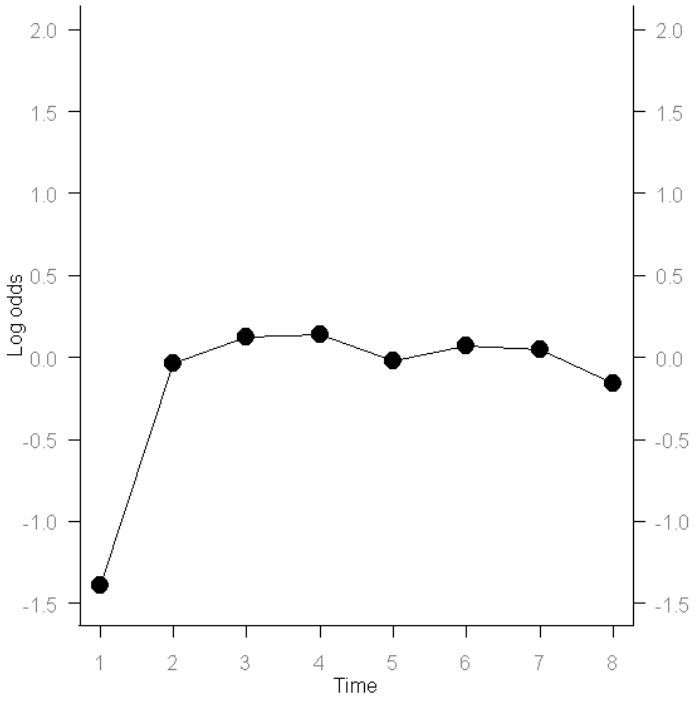

Figure 5.23: Log odds of looks to NP2 and NP1 in the OVS + demonstrative condition in Experiment 7

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.83	0.13	***
Object	-0.04	0.09	
Time	0.19	0.02	***

Table 5.15: Fixed effects for SVO + demonstrative condition in Experiment 7

of proficiency. The main effect of Time spent living in a German speaking country is difficult to interpret, since it is not clear why increased exposure to German would cause an overall decrease in looks to either entity. More interesting is the interaction of Object (NP1 or NP2) with Proficiency test score in the OVS + demonstrative condition, which suggests that the higher a score participants obtained on the test, the more likely they were to interpret the

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-4.21	0.18	***
Object	0.50	0.24	*
Time	0.27	0.03	***
Object:Time	-0.12	0.04	**

Table 5.16: Fixed effects for OVS + pronoun condition in Experiment 7

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.76	0.13	***
Object	-0.08	0.14	
Time	0.19	0.02	***

Table 5.17: Fixed effects for OVS + demonstrative condition in Experiment 7

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.39	0.12	***
Object	-0.40	0.09	***
Time	0.17	0.019	***
Lived	-0.002	0.0006	***

Table 5.18: Fixed effects for SVO + pronoun condition in Experiment 7 including time spent living in Germany

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-2.85	0.34	***
Object	-1.47	0.48	**
Time	0.19	0.02	***
Testscore	-0.04	0.01	**
Object:Testscore	0.06	0.02	**

Table 5.19: Fixed effects for OVS + demonstrative condition in Experiment 7 including proficency test score

demonstrative as the post-verbal NP. However, since there were small numbers of participants at each proficiency level, this result should be treated with caution.

Overall, there is a preference for the pre-verbal NP. Since this extends across SVO and OVS conditions, it seems likely that this preference is a Topic pref-

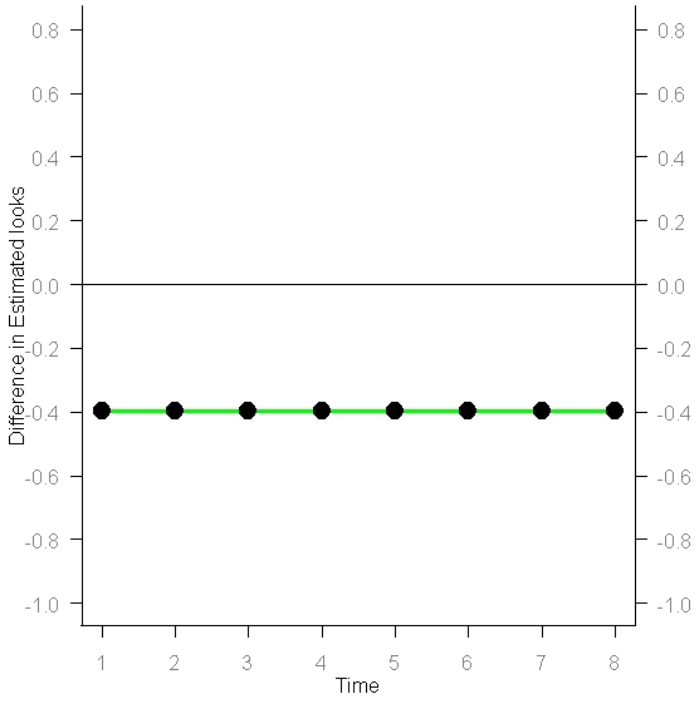

Figure 5.24: Difference in looks to NP2 and NP1 in the SVO + pronoun condition in Experiment 7

erence. This is supported by the OVS + pronoun condition, where there is initially an NP2 preference, which switches. If there is also a weaker Subject preference, then we see that the post-verbal Subject is initially preferred, but the Topic preference, which is slower to process, eventually overrules the Subject preference. An exception is the SVO + demonstrative condition, where there is no preference. It seems likely that as SVO + demonstrative is both relatively frequent in the input, and native German speakers have a strong preference for NP2 in this condition, that L2 learners are starting to be able to shift their preference away from the Topic or NP1 preference. However, the fact that neither Time spent living in Germany nor proficiency score interact with the preference for either NP1 or NP2 suggests that full acquisition of the nativelike preference does not occur, at least within the range of proficiencies in the data set.

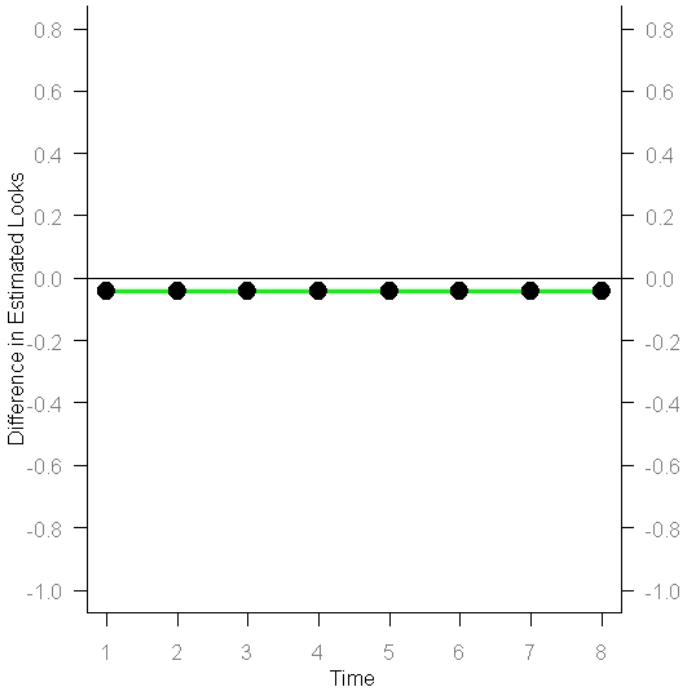

Figure 5.25: Difference in looks to NP2 and NP1 in the SVO + demonstrative condition in Experiment 7

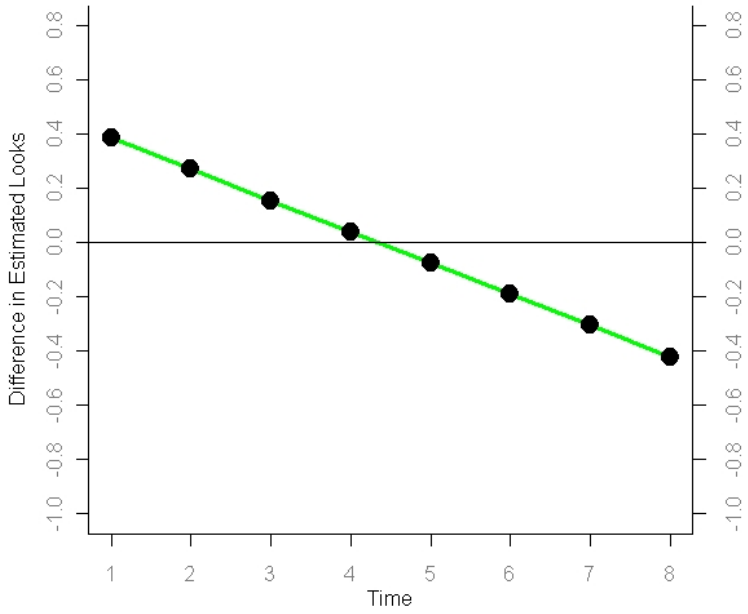

Figure 5.26: Difference in looks to NP2 and NP1 in the OVS + pronoun condition in Experiment 7

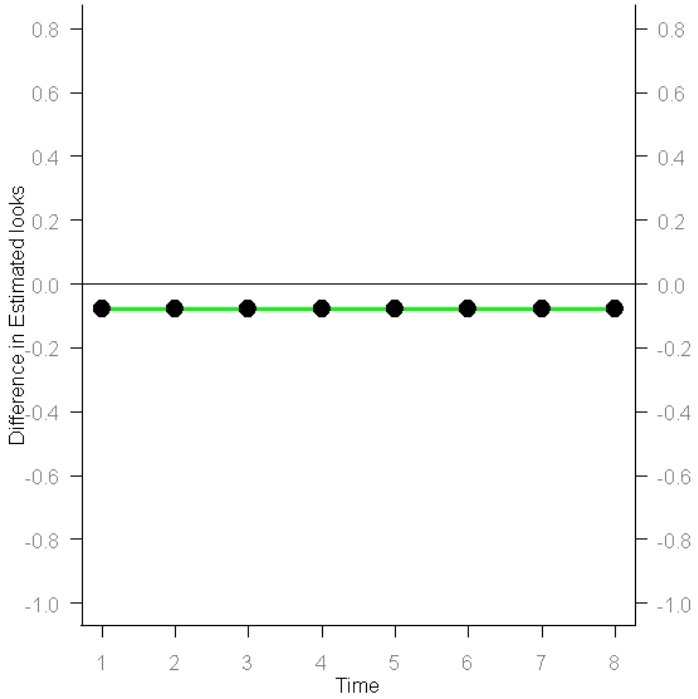

Figure 5.27: Difference in looks to NP2 and NP1 in the OVS + demonstrative condition in Experiment 7

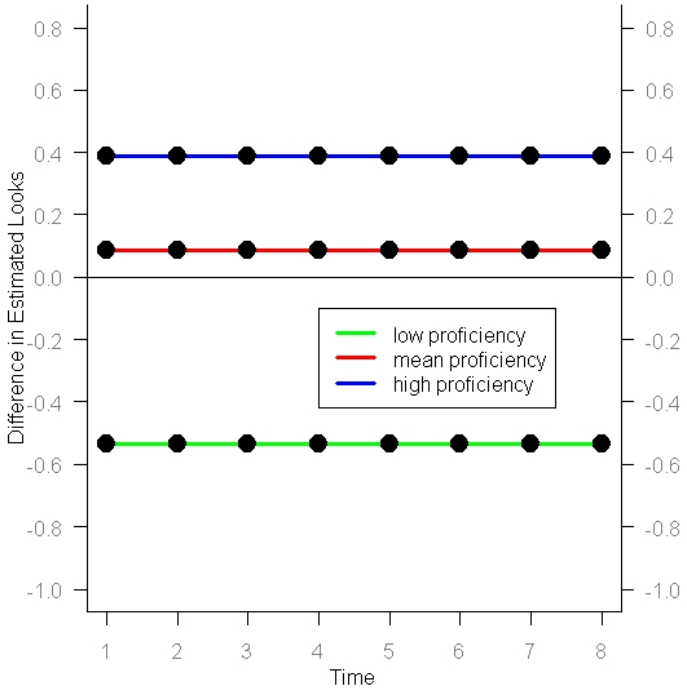

Figure 5.28: Difference in looks to NP2 and NP1 in the OVS + demonstrative condition in Experiment 7 with the factor of proficiency test score

5.5.3 Experiment 8

Experiment 8 shares the same design and materials as Experiment 6, and investigates the role of Grammatical and Thematic role in the antecedent preferences of anaphoric demonstratives and personal pronouns. This experiment extends Sorace & Filiaci's (2006) study, in that it contrasts different Thematic and grammatical role.

Participants

Twenty-four participants (18 Female, 6 Male) who had learned German after the age of 10 participated in the experiment. All participants were resident in Scotland at the time of testing, but had spent a period of 3 months or more in a German speaking environment in the two years prior to the time of testing. Participants were aged over 18 years (the precise age of participants was not recorded). Participants were rewarded £7 for participation. Table 5.20 shows the mean proficiency score and length of time spent living in Germany for participants in Experiment 8.

	Test Score	Months lived in Germany
Mean	19.09	16.57
St.Dev	5.88	20.90

Table 5.20: Mean test score and length of residence in a German speaking country for participants in Experiment 8

Materials

The materials were the same materials as used in Experiment 6.

Procedure

The procedure was identical to that in Experiment 2. No participants were excluded from the analysis due to lack of comprehension of the lexical items used in the experiment.

Analysis

The procedure for the analysis was identical to that for Experiment 1.

Results

In this experiment we are interested in looks to either the pre-verbal (NP1) or post-verbal NP (NP2). 8 time windows of 250ms, commencing 500ms before the onset of the post-verbal NP were calculated, and looks to either entity were calculated. The log odds of looks to either NP1 or NP2 are plotted in Figures 5.29, 5.30, 5.31 and 5.32. The odds of a fixation to the discourse-old entity relative to the discourse new entity were calculated, and then the natural logs taken, such that a value greater than zero can be interpreted as an overall preference for NP2, and a value of less than zero as a preference for NP1.

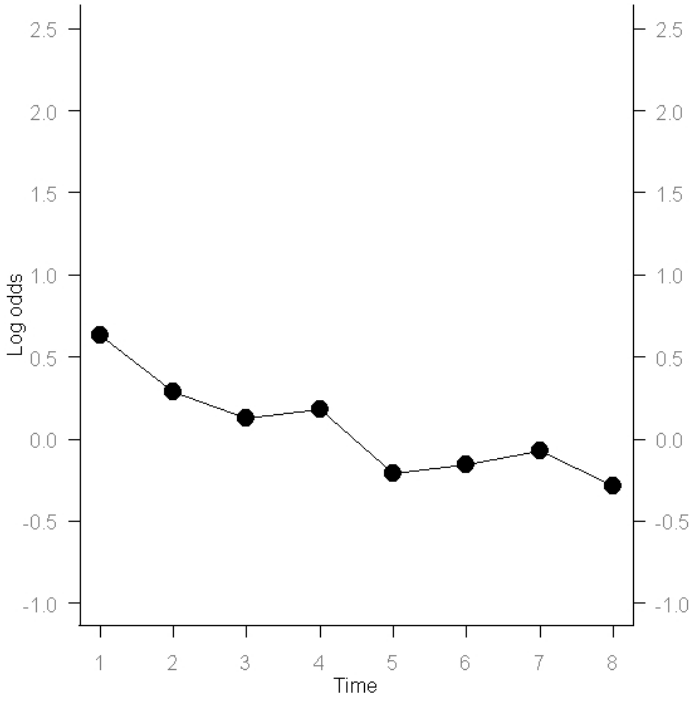

Figure 5.29: Log odds of looks to NP2 and NP1 in the Active + pronoun condition in Experiment 8

The fully specified models included the factors Time (8 regions of 250ms commencing at the onset of the pronoun), Object (looks to NP1 or NP2). Fixations

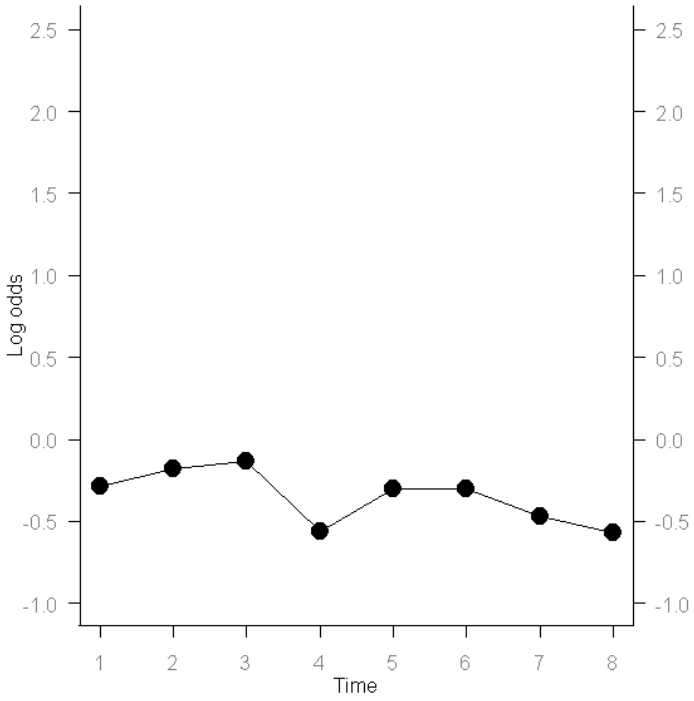

Figure 5.30: Log odds of looks to NP2 and NP1 in the Active + demonstrative condition in Experiment 8

which commenced before the onset of the pronoun were excluded from the analysis (5.91% of all fixations to either of the target objects which fell within at least one of the target time regions). Tables 5.21, 5.22, 5.23, 5.24 show the model estimates for the fixed effects, and significance levels (Significance codes: (***< 0.001) (**< 0.01) (*< 0.05) (.< 0.1))s. Figures 5.33, 5.34, 5.35 and 5.36 show the difference in model estimates of looks to the post- and pre-verbal NP (NP2-NP1) in each of the four conditions, Active + pronoun, Passive + pronoun, Active + demonstrative, Passive + demonstrative, for 8 consecutive time regions of 250 milliseconds starting from the onset of the pronoun or demonstrative. A positive value indicates a preference for NP2, and a negative value an NP1 preference. Where a significant interaction of Proficiency or Time spent living in a German speaking country was obtained, these are indicated.

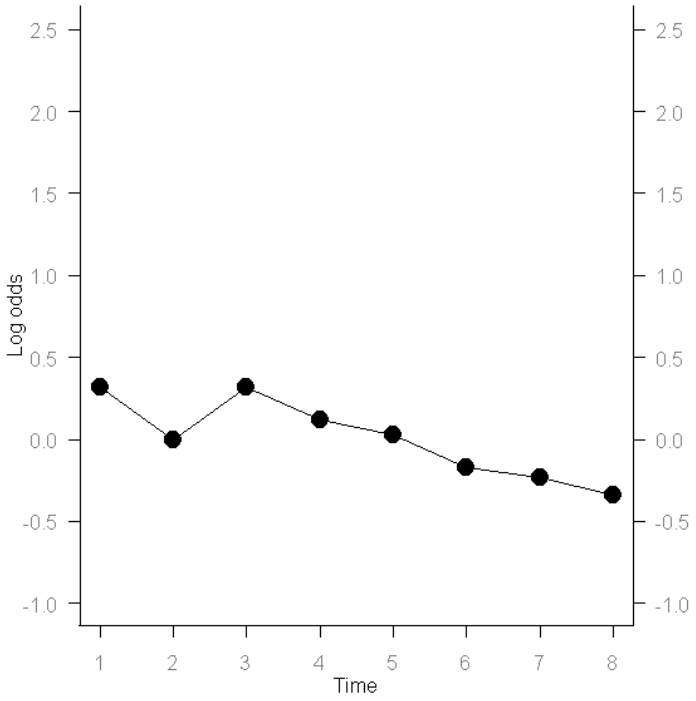

Figure 5.31: Log odds of looks to NP2 and NP1 in the Passive + pronoun condition in Experiment 8

In the Active + pro condition a significant interaction of Object and Time was obtained, such that there was an initial NP2 preference, which switched to an NP1 preference (Table 5.8). In the Active + Dem condition, we see a significant NP1 preference (Table 5.22). In the Passive + Pro condition, we obtain no significant preference for either NP. In the Passive + demonstrative condition, there was no significant preference for either NP (Table 5.24).

Additional analyses investigate the role of proficiency score and Time spent living in a German speaking country. Since these two factors typically show a high degree of colinearity, one of these factors was removed at the start, as described for Experiment 2. In the Active + pro condition a significant interaction of Object and Time was obtained, such that there was an initial NP2 preference, which switched to an NP1 preference (Table 5.25). In the Passive + Pro condition, we obtain a significant interaction of Object and Time

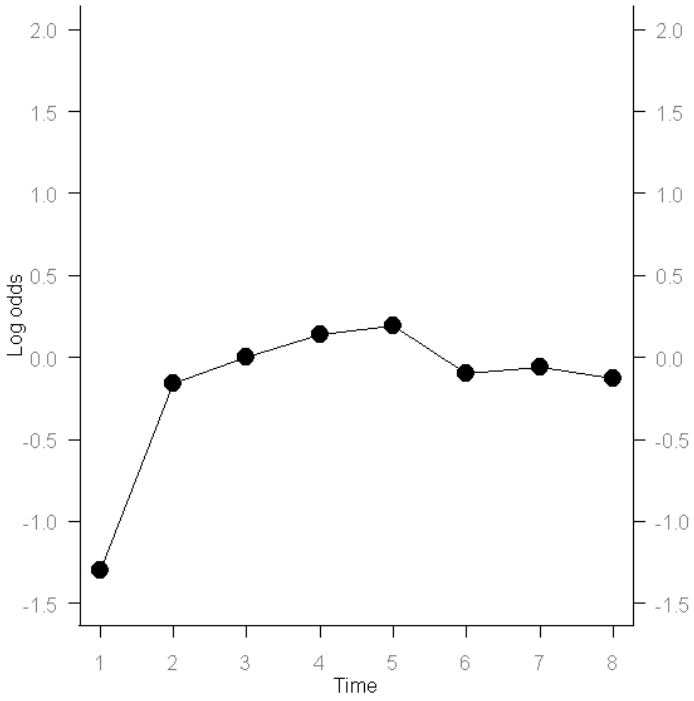

Figure 5.32: Log odds of looks to NP2 and NP1 in the Passive + demonstrative condition in Experiment 8

spent living in Germany, with an NP1 preference for those participants who had spent a short time in Germany (Table 5.26). Three different levels of time spent in Germany are plotted on the graph (Figure 5.37, corresponding to the upper and lower bounds of the data, and the mean value.

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.63	0.16	***
Object	0.27	0.23	
Time	0.20	0.03	***
Object:Time	-0.08	0.04	*

Table 5.21: Fixed effects for active + pronoun condition in Experiment 8

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.60	0.15	***
Object	-0.42	0.19	*
Time	0.17	0.02	***

Table 5.22: Fixed effects for active + demonstrative condition in Experiment 8

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.82	0.14	***
Object	-0.03	0.17	
Time	0.17	0.02	***

Table 5.23: Fixed effects for passive + pronoun condition in Experiment 8

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.41	0.14	***
Object	-0.28	0.18	
Time	0.14	0.02	***

Table 5.24: Fixed effects for passive + demonstrative condition in Experiment 8

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.70	0.16	***
Object	0.25	0.23	
Time	0.19	0.03	***
Lived	0.0053	0.0020	**
Object:Time	-0.08	0.04	*

Table 5.25: Fixed effects for active + pronoun condition in Experiment 8 including time spent living in a German speaking country

Discussion

As in Experiments 5 and 6, the SVO and Active conditions were predicted to be equivalent. However, we obtained different results in both the pronoun and demonstrative conditions. Just as with the native speaker groups, there were differences between the L2 participant groups in Experiments 7 and 8. Although there appear to be large differences in the mean length of time spent in German speaking countries, and a difference in test score on the

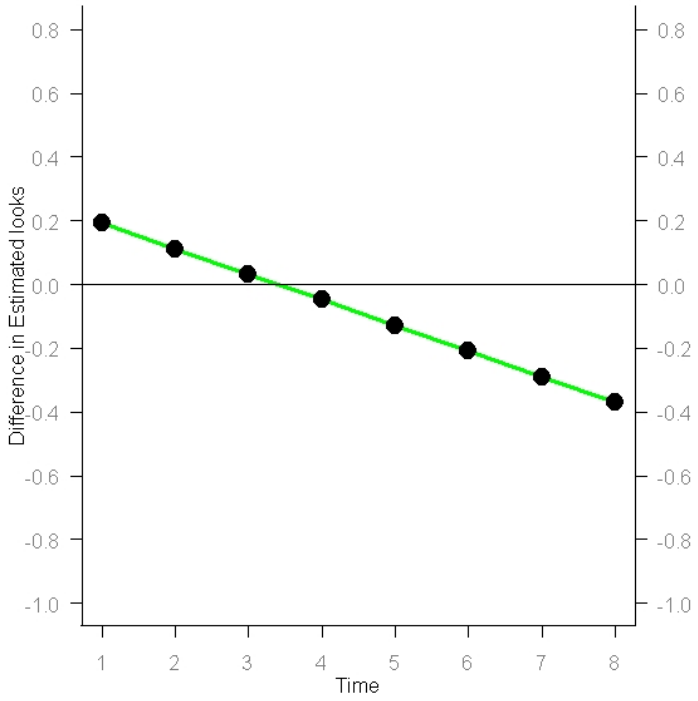

Figure 5.33: Difference in looks to NP2 and NP1 in the active + pronoun condition in Experiment 8

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-3.71	0.16	***
Object	-0.28	0.19	
Time	0.17	0.02	***
Lived	-0.006	0.005	
Object:Lived	0.01	0.005	*

Table 5.26: Fixed effects for passive + pronoun condition in Experiment 8 including time spent living in a German speaking country

proficiency test, neither of these differences were significant. The apparent large difference between the residence in a German speaking country can be attributed to two participants who were long term residents of Germany. In Experiment 7, 10 of the 24 experimental participants were resident in Germany at the time of testing, whereas none of the participants in Experiment 8 were. Furthermore, there was overlap between the participants in the two

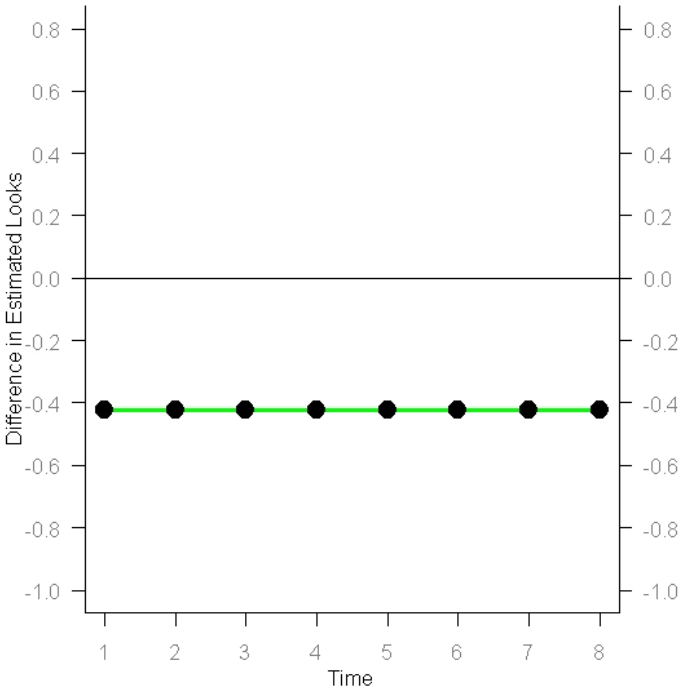

Figure 5.34: Difference in looks to NP2 and NP1 in the active + demonstrative condition in Experiment 8

experiments: 13 of the 14 participants resident in Scotland who were tested in Experiment 7 also participated in Experiment 8, 3-4 months later, and had not returned to a German speaking country between experiments. The participants in Experiment 8, therefore, had less recent exposure to high quantities of native German speaker input. Can this fact explain our results? In the SVO + dem condition (Experiment 7) we found no preference for either NP, but in Experiment 8 we found an NP1 preference. This is consistent with the overall Topic preference observed in Experiment 7. The participants in Experiment 8 who had had less recent native German exposure were less targetlike than those in Experiment 7. The results in the Active + pronoun condition do not support this argument, as they appear to be more nativelike, in that they show an NP2 preference followed by and NP1 preference. However, as the result for the Active/SVO + pronoun condition is overall less stable than that for

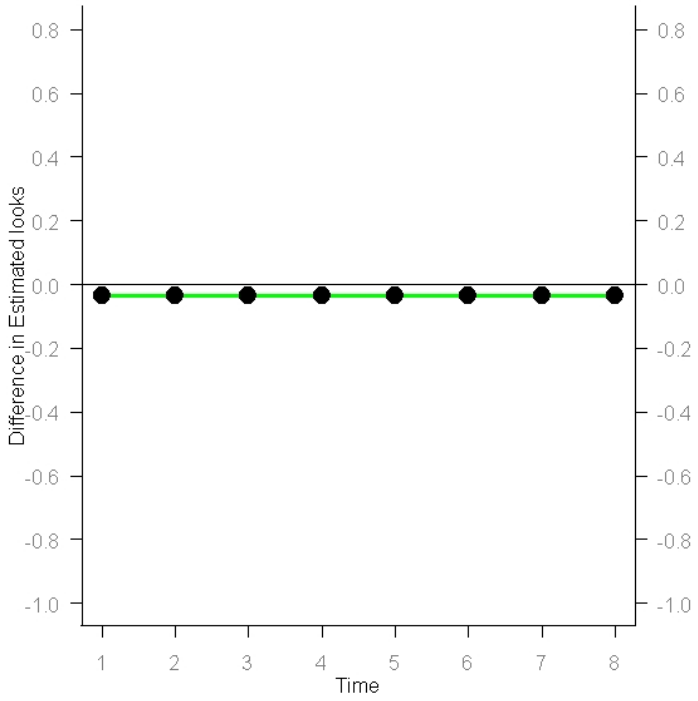

Figure 5.35: Difference in looks to NP2 and NP1 in the passive + pronoun condition in Experiment 8

the Active/SVO + demonstrative condition in native speakers, it is difficult to interpret the Active + pronoun result in Experiment 8 too strongly.

In the passive condition, native speakers of German (Experiment 6) showed no significant preference for the pre- or post-verbal NP for either pronouns or demonstratives. This pattern is repeated in the L2 learners in Experiment 8, except possibly for participants who had spent a short time living in Germany in the Passive + pronoun condition, who had an NP1 preference. It is not clear whether these preferences are due to targetlike behaviour or not. It is possible, for example that the extra lexical material in German passive sentences allows L2 learners more time to integrate different sources of information, resulting in a targetlike preference, or, indeed, lack or preference.

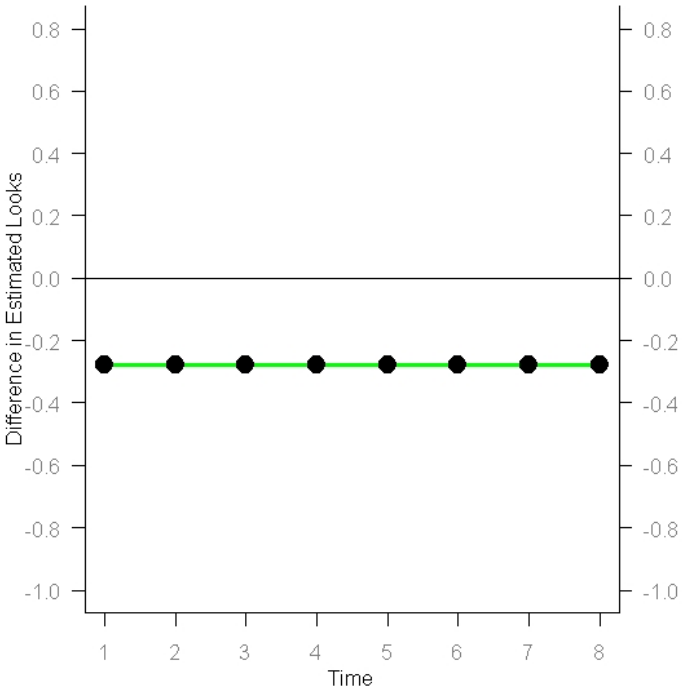

Figure 5.36: Difference in looks to NP2 and NP1 in the passive + demonstrative condition in Experiment 8

5.5.4 *Discussion: antecedent preferences of anaphoric demonstratives and personal pronouns in L2 German*

Considering the results from Experiments 7 and 8 together, we immediately have confirmation that the L2 learners are not behaving like the native speakers in their antecedent preferences for anaphoric demonstratives and pronouns. Additionally, we observe different results in the SVO and Active conditions, suggesting that there is possibly an effect of proficiency, or exposure to native speaker German. However, in order to investigate whether Topic, Thematic role or grammatical role constraints affect the antecedent preferences in L2 learners, it is necessary to consider the results from Experiments 7 and 8 together. It was predicted that if L2 learners use a grammatical role constraint, we would see the SVO/Active and Passive conditions patterning together,

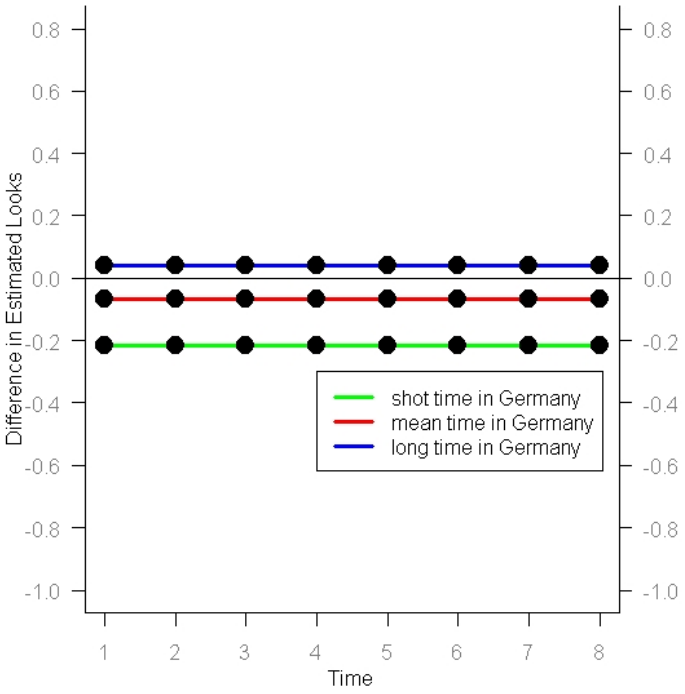

Figure 5.37: Difference in looks to NP2 and NP1 in the passive + pronoun condition in Experiment 8 including time spent living in a German speaking country

with the opposite preference in the OVS condition. If Thematic role plays a role, then we will see a contrast between the Active and Passive conditions.

If we group the results from both experiments by antecedent some striking patterns emerge. It should be noted that the patterns reported in Tables 5.27 and 5.28 are based on analyses which include a measure of proficiency. In the OVS + demonstrative condition the initial analysis without a measure of proficiency showed no preference for either NP. Similarly, in the Passive + pronoun, no significant preference for either NP was obtained in the initial analysis.

These results are striking, as the same conditions group together for both pronouns and demonstratives; however, the preferences are different.

	No preference	**NP1 preference**
Demonstrative	SVO	Active
		OVS
	Passive	(Passive (late))

Table 5.27: Patterns of results for the demonstrative conditions in Experiments 7 and 8

	NP1 preference	**NP2 to NP1 preference**
Pronoun	SVO	Active
		OVS
	Passive (no pref for those who have lived longer in Germany.	

Table 5.28: Patterns of results for the pronoun conditions in Experiments 7 and 8

Starting with the pronouns, we can see that overall, L2 learners are more likely to show a preference for one of the two potential antecedents than with demonstratives: in most of the conditions learners do have a preference for either NP1 or NP2. As the SVO and Passive condition group together with an NP1 preference, this suggests that grammatical role, in this case expressed as a Subject preference, is a constraint, at least for lower levels of time spent living in Germany for the Passive+pronoun condition. In the OVS condition, we initially observe a Subject preference, which switches, suggesting that topicalisation also plays a role, however, the grammatical role information is processed faster and is eventually overridden. This leaves the question of the Active condition: why does it not pattern with the SVO (and Passive) condition? This could be due to some sort of L2 attrition effect, which causes processing to become less automatic and slower. This effect is not evident in the Passive condition, possibly because the passive makes either the topicalisation or the grammatical role more salient. Additionally, the Passive condition is slightly longer (*Der Mechaniker wird vom Fotograf gesehen*, (the mechanic is seen by the photographer)), with *wird vom* (becomes by) giving extra processing time.

However, since little is known about L2 attrition, which would be hypothesized to occur under similar conditions to L1 attrition, namely when exposure to the target language has been reduced for a period of time, this remains purely speculative. The fact that participants who have lived in Germany for longer do not have the same preference for NP1 could be related to their additional use of thematic role information, which less experienced learners are not able to use in online processing.

As for the demonstratives, in the SVO and Passive conditions we observe no preference, whereas in the Active and OVS conditions we obtain an NP1 preference. In the SVO and Passive conditions, this lack of preference could result from the conflict of two constraints: an anti-Subject (or an Object preference) preference conflicting with a preference for Topics. This is supported to some extent by the OVS condition, which has an NP1 preference, in which both the anti-Subject and Topic preference coincide. However, since this NP1 preference is only significant in an analysis including proficiency test scores, it should be treated cautiously due to the low numbers of participants at each level. Where there are conflicting constraints we see one difference between the pronouns and demonstratives: for the demonstratives we initially observe no preference, whereas with the pronouns a preference first for NP2 and then NP1 is apparent. It is possible that for the pronouns we obtain a preference for Subjects, which is faster to process, resulting in an early preference, but for the demonstratives we observe a preference against Subjects, which is perhaps weaker, or just slower to process.

However, again we are left with the question of the Active condition: what could explain the NP1 preference? Again, it seems likely that this is due to the fact that the participants in Experiment 2 were not living in Germany at the time, and were less able to use the Grammatical role information. However, research on L1 attrition (see e.g. Sorace & Filiaci (2006) for discussion) has shown that syntactic information is less vulnerable to L1 attrition than discourse information, for example, in Italian, the antecedent preferences of null pronouns, which are subject to syntactic dependencies are less vulnerable to attrition than overt pronouns, which form a discourse based dependency. However, as mentioned previously, since research on L1 attrition is currently limited, and research on L2 attrition even more so, it would be premature to

assume that L1 and L2 attrition would be directly parallel. For example, it is possible that L2 learners' ability to use syntactic constraints may be more vulnerable than in native speakers.

Considering the results from Experiments 7 and 8, it seems as though L2 learners are using different constraints compared to the native speakers, in that they seem to apply a preference for Topics across both pronouns and demonstratives, but pronouns seem to prefer Subject antecedents, and demonstratives Object antecedents. Native speakers showed a non-Topic preference for demonstratives and not pronouns, which persisted even in the group based in Edinburgh. L2 learners only seem to be able to distinguish the two types of anaphor based on grammatical role information, and not Topic information, suggesting that grammatical role information may be more accessible, and be easier to process. The use of the grammatical role for both pronouns and demonstratives is quasi-targetlike. The most frequent word order in German is SVO (Weber & Müller 2004); typically, then, the pre-verbal NP is a both a Subject and Topic, and the post-verbal NP is both an Object and Non-Topic. The fact that L2 learners over extend a grammatical role preference to demonstratives is therefore mostly consistent with the input, and suggests that grammatical role information is easier to process. The Topic preference across both types of anaphor and conditions seems to be a default processing strategy, evidence for which is clearly not available in the native speaker input. This suggests that L2 learners are unable to integrate all sources of information when processing anaphors, indeed, the Topic preference seems to be used late in processing, after grammatical role information has been used. It is not clear whether the L2 learners are interpreting the pre-verbal NP as a discourse Topic, or find it salient because it is the first-mentioned entity, without attaching a discourse interpretation (e.g. discourse-old information) to the pre-verbal NP. It could further be argued, that the Topic preference is merely a first-mention preference, which could be considered easier to process than a Topic preference. Approaches to processing such as MacDonald (1993), which consider processing in terms of competing constraints can explain these results: it is possible that L2 learners do acquire the nativelike anti-Topic preference, however, this is outranked by the Topic or first mention preference,

possibly because extensive exposure to English has increased the activation level of this constraint.

The data from Experiments 7 and 8 are compatible with the data from near-native speakers of Italian presented by Sorace & Filiaci (2006). Their near-native speaker of Italian participants also seemed to behave in a more target-like manner with respect to processing grammatical dependencies compared to discourse based dependencies. However, the L2 learners of German overextended the use of grammatical role information to demonstratives. It could be that the L2 learners of German in Experiments 7 and 8 were of a lower proficiency level, and near-native speakers of German would not overextend the use of grammatical role information, although the fact that score on a proficiency test and the time spent living in a German speaking country were not effective predictors of antecedent preferences speaks against this. It could also be the case that overextending the use of grammatical role constraints is less inconsistent with the input in German compared to Italian, so that the use of this constraint is a residual processing strategy for learners of L2 German.

Taken together, the Italian and German data suggest that syntactic dependencies are easier for L2 learners to process than dependencies which require a wider range of information sources to be integrated. The data presented in Experiments 7 and 8 therefore show that while L2 learners do treat pronouns and demonstratives differently, they are not able to acquire the appropriate constraints, and may misanalyse the input to use non-targetlike processing strategies. Furthermore, the role of different measures of proficiency requires further investigation: only in some conditions did either proficiency test score or time spent living in German show significant effects. Further research using larger sample sizes at each level is required to confirm the conclusions discussed in this section, and clarify the role of proficiency.

5.6 General Discussion and Conclusions

Experiments 4-6 have extended support for the Form Specific Multiple Constraint approach to anaphor resolution. Native speakers of German were shown to apply different constraints to personal pronouns and anaphoric demonstrative pronouns: personal pronouns being sensitive to both grammatical

role and topicality, whereas anaphoric demonstrative pronouns consistently preferred non-Topics. Overall it could be argued that anaphoric demonstrative pronouns prefer less salient referents than personal pronouns: crucially, however, these anaphors are sensitive to different means by which salience is encoded (i.e. by grammatical role or topicality) in the previous discourse. Furthermore, Experiments 4-6 show clear evidence of cross-linguistic variation: German personal pronouns and anaphoric demonstratives seem to have different antecedent preferences from the parallel phenomena previously reported for Finnish.

Future work on anaphoric demonstratives and personal pronouns in native speaker German could take three main directions: by investigating the role of extra-linguistic context, by adding additional discourse context to the antecedent sentences and by varying the nature of the antecedent sentences. Examining the extent to which extra-linguistic, situational context affects the preferred referent of both types of pronoun, it would be hypothesized that overall less salient referents would be preferred by anaphoric demonstratives, while more salient referents would be preferred by personal pronouns. Just as in a linguistic context, there are different means of increasing or decreasing the salience of referents in context, such as by pointing, eye-gaze etc (for further discussion see Skarabela (2007), Skarabela & Allen (2002)), and it is not clear the extent to which these extra-linguistic features are linked to specific anaphors. Secondly, the use of an OVS or passive sentence in isolation, without prior discourse context is pragmatically marked in German. By adding a licensing context for OVS sentences, the processing of these sentences may be made easier, although it should be noted that Wilson (2005) found that native speakers were able to process OVS sentences in isolation in a similar experimental situation without problems. Probably the most significant role of an additional prior discourse context would be to manipulate the information structure status (discourse-old or new information) of one of the referents, thus allowing information structure to be distinguished from topicality and grammatical role. Finally, the experiments reported in this chapter use a very limited range of antecedent sentences: SVO, OVS and passive. By manipulating, for example, the nature of the element in the pre-verbal Topic position, it

would be possible to determine whether a preference for the pre-verbal entity were really a Topic preference or a first mention entity.

The data from Experiments 5-8 are suggestive that like other syntax-discourse interface phenomena, the antecedent preferences of anaphoric demonstratives and pronouns are susceptible to attrition. The (native speaker) participants in Experiment 5 were all resident in Germany, and showed different results across the SVO conditions compared to those participants in Experiment 6. Similarly, in Experiment 7, all participants were either resident in Germany, or had lived in Germany more recently than those in Experiment 8; in the SVO conditions we see differences across the two experiments. It could be argued that these differences might be a result of differences in experimental stimuli, however, Experiment 9 used the stimuli from Experiments 5 (and 7) on participants based in Scotland, and found that measures of potential attrition such as time spent living in Great Britain and the proportion of input in German were significant predictors of antecedent preference. Furthermore, the data from Experiment 9 (Experiment 9 simulated the L2 antecedent preferences of demonstratives and pronouns in native speakers experiencing L1 attrition by increasing processing load by adding a secondary task) followed the same pattern of antecedent preferences in native speakers experiencing L1 attrition as found in the L2 learners in Experiments 7 and 8, suggesting that L2 learners were affected by L2 attrition.

The fact that native speakers have been shown to use different constraints when processing anaphoric demonstratives and personal pronouns allows more detailed understanding of the difficulties which L2 learners show at the syntax-discourse interface. Overall, the L2 learners seemed to be able to use syntactic information to a greater extent than discourse information, such that they over-extended the use of a grammatical role constraint to demonstrative pronouns. L2 learners however used a non-targetlike discourse constraint, for which there is no evidence in the input: a preference for the Topic as antecedent interacted with the grammatical role constraint. Although it seems likely that this is a Topic preference, being processed slower than the grammatical role constraint, further work is needed to confirm this. A first mention preference, for example is not ruled out, nor is transfer from the L1 (English), which also shows a first mention and Topic preference. Investigating the

antecedent preferences for L2 learners of a language which does not show this Topic preference and manipulating the experimental stimuli such that the Topic position is filled with an element which could not be an antecedent would be able to confirm this hypothesis. Although the data from Experiments 7 and 8 are suggestive of a processing difficulty, the experiments were not designed to probe the nature of any potential difficulties. This question is addressed in the next chapter.

To conclude, the processing of anaphoric demonstratives and personal pronouns in German sheds light on important issues in both native and L2 processing. However, it is clear that work on this phenomenon is still at an early stage, with many questions outstanding. The data presented in Experiment 9 will address one of these issues in detail: the nature of the difficulty which L2 learners have when processing personal pronouns and anaphoric demonstrative pronouns.

CHAPTER 6

Simulating L2 Learners' Difficulties in Native Speakers

6.1 Introduction

In Chapters 4 and 5 I have examined two different, but related interface phenomena: the information structure implications of word order and pronominalisation, and the antecedent preferences of demonstrative and personal pronouns. A general conclusion which can be drawn from the data presented in these chapters is that L2 learners do not seem to behave in the same way as native speakers with respect to these processing phenomena. This raises the question addressed in this chapter: what could account for these differences? It is possible, as Clahsen and Felser (Clahsen & Felser 2006*b*) suggest for syntax, that L2 learners have a representational deficit which prevents them from interpreting interface phenomena in a nativelike manner, however these data are more consistent with a processing deficit which is not directly linked to a representational deficit. However, experiments presented thus far have not been designed to test the processing vs representational deficit question explicitly. In this section I present an experiment (Experiment 9) which aims to address this question. Furthermore, the results from Experiments 4-8 suggest that the processing of demonstratives and personal pronouns are vulnerable to attrition; Sorace & Filiaci's (2006) data suggest parallels between the behaviour of native speakers of Italian undergoing attrition and near-native speakers of Italian with respect to the comprehension of null and overt

pronouns in Italian which they attribute to a lack of processing resources. Experiment 9 addresses this issue by looking at the interaction of processing load with time spent away from a German speaking environment and its impact on the processing of personal and demonstrative pronouns.

In this chapter I first discuss the background to the processing versus representational deficit account, and then examine in more detail the different ways in which processing can be impaired, both from the perspective of L2 learners and native speakers undergoing L1 attrition. I then present an experiment designed to examine these issues.

6.2 A Processing or a Representational Deficit?

In the recent literature on L2 processing two diverging explanations for L2 learners' different performance (compared to native speakers) have emerged in experiments designed to investigate L2 syntactic processing: a representational deficit (Clahsen & Felser 2006*a*) or a processing deficit (Sorace & Filiaci 2006). Clahsen & Felser (2006*b*) adopt Townsend & Bever's (2001) integrated processing model, which proposes two routes for syntactic parsing: a fully specified syntactic description route and a *pseudo-syntax* route, which uses lexical and statistical information. In a review of the literature, Clahsen and Felser (2006*a*, 2006*b*) argue that L2 syntactic processing is shallow, and that L2 learners are only able to use the latter, shallow, parsing route. They propose that L2 learners are unable to compute a full syntactic representation when parsing because the underlying syntactic representations are unavailable for parsing, possibly because they are incomplete or deviant in some way. Clahsen and Felser cite evidence from a range of studies (Felser & Roberts 2007, Juffs 2004, Juffs 2005, Sato & Felser 2005) which investigate the role of working memory in L2 learners. They reason that if L2 learners have a processing deficit, then we would expect that L2 learners with low working memory spans to be less nativelike because they have even fewer processing resources than high span L2 learners. Since these studies do not find significant differences between high and low span L2 learners, they argue that L2 learners are unlikely to have a processing deficit. However, as discussed in Section 6.3, these studies are limited in that they take an individual differences approach.

Individual differences approaches are limited in two main ways. Firstly, it is not clear exactly what different measures of working memory actually measure: Felser and Roberts used reading span, which has been shown by Juffs (2004) not to be a reliable predictor of L2 processing, unlike word span. A further problem with Felser and Roberts' study relates to the fact that their task (cross-modal priming) relied on auditory presentation of experimental stimuli while their measurement of working memory span used a reading span task. It is quite possible that L2 learners show a great deal of variance in their familiarity to written and auditory modalities in the L2, a factor which is likely to affect their reading span and their performance on the experimental task. Secondly, there may not be sufficient individual differences among the participants in an experiment for any effects to be apparent.

Sorace & Filiaci (2006) take a different approach. They argue that L2 learners "may not have the necessary processing resources to integrate multiple sources of information consistently" (Sorace & Filiaci 2006, p361) specifically showing difficulty at the interface of syntax with other cognitive domains. As Almor et al. (1999) point out, anaphoric reference places demands on working memory, as Topics have to be stored across several utterances. Sorace and Filiaci present evidence from near-native speakers of Italian processing null and overt pronouns in Italian. Native speakers of Italian follow Carminati's (2002) Position of Antecedent Strategy, preferring null pronouns to have an antecedent in the specifier of IP, and for overt pronouns to be subject to more discourse based constraints, near-native speakers behave in a nativelike manner with respect to the comprehension of null pronouns, but not overt pronouns. They argue that these data suggest that L2 learners are able to process full syntactic dependencies, as the near-native speakers were able to process the syntactic dependency in a targetlike manner. However, the more discourse based dependency, for the overt pronouns, was problematic, because it requires more processing resources as discourse based dependencies are subject to a wider range of constraints than the relatively closed syntactic system. This account is compatible with Burkhardt's (2005) Syntax-Discourse Model, which predicts that syntactic dependencies are processed more quickly than discourse dependencies.

6.2.1 Beyond the processing vs representational deficit debate

Although Clahsen and Felser (2006*b*, 2006*a*) and Sorace & Filiaci (2006) come to different conclusions regarding the likely source of difficulty for L2 learners, their accounts both take a very similar view of the nature of processing deficits which may affect L2 learners. They characterize a processing deficit in terms of a limitation on processing resources (Here we follow Levy (2008) and term this the resource limitation account). Clahsen and Felser cite studies looking at working memory and L2 processing, the implication being that potentially, at least, L2 learners with low working memory spans may process their L2 in a less nativelike manner because they do not have sufficient resources with which to do so. The lack of evidence for differences between high and low span learners is taken as supportive of the idea that L2 learners do not have a processing deficit. Similarly, Sorace and Filiaci take the fact that they find near-native speakers of Italian are able to process a syntactic dependency, argued to require fewer resources, but not a more discourse based dependency in a nativelike manner as evidence that L2 learners do not have sufficient resources.

The resource limitation account is not the only possibility, however. Considering models of native speaker processing, Levy (2008) discusses an alternative approach. Rather than processing resources being limited, as such, it may be a question of resource allocation. Traditionally, theories of native speaker processing which emphasize the limitations of language processing resources emphasize the primacy of syntactic processing, and how, in the face of ambiguity, the parser reduces processing cost by choosing a simpler alternative. Early examples of theories which take this approach include Late Closure (Frazier & Fodor 1978) and Minimal Attachment (Frazier 1979), and more recently the Active Filler Hypothesis; (Clifton & Frazier 1989); and the Dependency Locality Theory (Gibson 1998, Gibson 2000). Resource allocation accounts consider processing in terms of competing constraints, and emphasize the role of lexical and semantic constraints, such as MacDonald (1993). These models propose that processing is parallel, such that there is a ranking of possible structural constructions for a given sentence, and that these rankings are based on many factors. This account is termed resource allocation because the parser assigns different levels of resources to different possible interpretations or constraints.

How might a resource allocation deficit be manifested in L2 processing? If we consider Sorace and Filiaci's data, it seems plausible that rather than their near-native speakers having insufficient resources to process overt pronouns appropriately, instead, different processing constraints (such as a preference for a non-Topic antecedent) are ranked inappropriately. For example, if L1 constraints conflict with L2 constraints, these could out-compete the L2 constraints, causing non-nativelike behaviour. However, data from Spanish native speakers learning Italian would seem to contradict this hypothesis: Bini (1993), cited in Sorace & Filiaci (2006) found that native Spanish speaking learners of L2 Italian overused overt pronouns. Since the syntax of pro drop in Spanish and Italian appears to be almost identical, we would not expect competing constraints to cause difficulty. This result could possibly be explained by Filiaci's (2008) findings that even though the syntax of Spanish and Italian appear to be the same, the discourse constraints relating to the antecedent preferences of overt pronouns are not, leading to the discrepancies observed by Bini. It is also not necessarily the case that all competing constraints are a result of the L1. Learners may rank constraints such as a preference for the first-mentioned NP to be the referent of an antecedent, as first-mentioned entities are often considered to be more salient. A conflicting constraint would be a preference for the most recently mentioned entity. Rather than just simple competition between languages, it could be the case that there is a difficulty ranking constraints appropriately.

Despite the fact that a resource allocation deficit is a plausible deficit, a resource limitation effect in L2 learners is by no means ruled out. Indeed, it is possible that both deficits affect L2 processing, although different parts of the syntax-discourse interface may be affected differently. For example, with respect to null and overt pronouns in Italian, while the interpretation of overt pronouns may be affected by a resource allocation deficit, the null pronouns, constrained by syntactic dependencies may be more vulnerable to a resource limitation. If there are insufficient processing resources to construct and maintain the syntactic dependency, then we would expect some sort of processing collapse. However, given that these participants were of very high proficiency level, we would not necessarily expect this to occur in a task such as a picture verification task, where there are no time constraints.

Furthermore, a resource limitation could lead to a resource allocation deficit, if resource limitation has the consequence that all appropriate constraints cannot be stored for processing, and so an inappropriate constraint is applied.

6.2.2 Resource limitation/allocation deficits in L1 attrition

A resource allocation/limitation account is supported by other bilingual populations. We now consider the resource allocation/limitation accounts in the light of data from attriting populations. The patterns observed in the literature on L1 attrition are striking in that they are remarkably similar to the results found by Sorace & Filiaci (2006). Tsimpli et al. (2004) found that native speakers of Italian and Greek who are highly proficient in English and undergoing L1 attrition, were more likely to interpret overt pronouns as the matrix Subject compared to monolingual native speakers, however, there were no differences with respect to the interpretation of null Subjects. Although Tsimpli et al give a representational deficit account, arguing that exposure to English *erodes* the feature [+topic shift], leading to divergence from monolingual native speakers, this phenomenon could also be explained in terms of a resource allocation deficit in the same way as Sorace and Filiaci's near-native speakers of Italian. Increased exposure to English introduces competition from English constraints leading to non-targetlike behaviour. Whereas Tsimpli et al. (2004) describe the [+topic shift] feature as being *eroded*, it could be the case that the feature has a reduced resting activation level, as it is used less frequently, so it is outcompeted by the English feature. Indeed, it is not entirely clear what it means for a feature to be *eroded*, as it could be either a matter of activation level, or that something about the representation itself which is altered in some way. I will consider the former to be a result of a processing deficit, and the latter to be a representational deficit. A further cause of a resource allocation deficit could be that the resting activation level is unaffected, but the English feature's activation level has increased, causing competition.

Why does syntax appear to be less affected by resource allocation in L2 learners and attriting native speakers? Comparing the differences between syntactic and discourse processing under typical native speaker processing conditions can shed light on this issue. Although proponents of competition models of syntactic processing (e.g. MacDonald (1993)) would argue that syntactic

processing is a matter of resolving competing constraints, in comparison to discourse processing, syntactic processing is a relatively closed system, with non-syntactic constraints, such as lexical semantic constraints informing the competition. Discourse processing, on the other hand requires the integration and ranking of constraints from many domains to determine salience. The data presented in Experiments 4-6 are suggestive that native speakers of German may be undergoing attrition: participants in Experiment 5 were all resident in Saarbrücken, whereas in Experiment 6 they were all resident in Edinburgh, in Experiment 5 we observed a strong NP2 preference in the SVO demonstratives condition, which was reduced in Experiment 6.

6.2.3 Resource limitation/allocation deficits in the L2 processing of demonstratives and pronouns

The data relating to L2 learners in Experiments 7 and 8 show a similar pattern to that of the native speaker data with respect to attrition. L2 learners show either no preference for either NP in the SVO condition in Experiment 7, or a preference for NP1 in the SVO condition in Experiment 8. Since the participants in Experiment 8 were all tested in Edinburgh, whereas nearly half of those in Experiment 7 were resident in Germany at the time of testing, we would expect participants in Experiment 8 to be less nativelike, as the NP2 preference constraint would be out-competed by an NP1 preference due to the extra exposure to English. The situation with pronouns is less straightforward. Pronouns seem to be constrained by both syntactic and discourse based constraints, so it is less clear whether L2 learners' preferences are a result of a resource limitation, or a resource allocation.

6.3 Methodology: Experiment 9

Results from Experiments 1-8 suggest that L2 learners have difficulty processing at the syntax-discourse interface. However, although the data from these experiments are suggestive of a processing deficit, since they were not designed to test the nature of any difficulties at the syntax-discourse interface we cannot draw any firm conclusions. Experiment 9 aims to tease apart the different hypotheses discussed above. Firstly, it is important to examine

whether the differences in L2 learner behaviour and native speaker behaviour can be attributed to a representational deficit, or to a processing deficit. As discussed above, however, processing deficits can be caused by either a resource allocation or a resource limitation deficit. If a limitation of processing resources affects processing, by controlling the processing resources of participants, we would expect to see differences between processing with fewer available resources and more available resources. If resource allocation affects processing, then we would expect that competition with another language would affect processing. If the deficit is representational, then we would expect that controlling for processing resources and exposure to another language would have no effect on processing, because if the underlying deficit is representational, varying processing load and exposure to another language would have no impact on the representations. Experiment 9 additionally aims to investigate the effect of L1 attrition on processing at the syntax-discourse interface. Experiment 9 used a dual task methodology which is an adaptation of a standard visual-world paradigm experiment to explore these issues in the processing of demonstrative and personal pronouns. For part of the experiment participants were placed under additional processing load; participants' antecedent preferences for pronouns and demonstratives were compared across the additional load and no additional load conditions. In this section we discuss the motivation for choosing this particular methodology.

6.3.1 Summary of aims

Experiment 9 aims to investigate the nature of the difficulties observed in L2 learners at the syntax-discourse interface by investigating the following questions:

1. Is there evidence for a distinction between a resource allocation and resource limitation deficit? Since we hypothesize that pronouns are subject to a syntactic dependency, we would expect that pronouns would be more susceptible to a lack of processing resources, whereas demonstratives would be more susceptible to a resource allocation deficit.
2. Do native speakers of German under attrition and/or processing load behave like L2 learners with respect to their antecedent preferences for anaphoric demonstratives and pronouns? If it is possible to simulate the

patterns observed in L2 learners in native German speakers, we can determine likely causes for L2 learners' difficulties at the syntax-discourse interface.

3. Can we attribute L2 learners' difficulties at the L2 interface to a representational deficit, or a processing deficit resulting from a resource allocation or resource limitation deficit? If L2 learners' difficulties at the syntax-discourse interface are largely due to a lack of processing resources, then we would expect that native speakers who have a lack of processing resources would behave more like L2 learners; a resource allocation deficit in L2 learners would lead to similarities with native speakers who have little native German input.

6.3.2 Investigating a resource limitation and resource allocation deficit

Previous work investigating the role of working memory in L2 processing has taken a resource limitation approach (see e.g. Felser & Roberts (2007)), and compared L2 learners of low and high span. I take a different approach, which aims to tease apart the resource limitation and resource allocation accounts, and compare these to the representational deficit account. Rather than testing L2 learners, Experiment 9 aims to simulate the results obtained in L2 learners by controlling processing resources and exposure to English in native speakers of German. Simulating one population in another is a technique which has been used for several populations. Hayiou-Thomas, Bishop & Plunkett (2004) modelled Specific Language Impairment (SLI) in 6-year old children with typically developing language, by compressing the speech rate of normal speech by 50%, to simulate a processor with reduced processing speed, and found similar patterns to errors as found in children with SLI, concluding that children with SLI have some form of processing deficit. Similarly, Kilborn (1991) masked stimulus sentences with low level noise in healthy native speakers of German, and found that in the noise condition native German speakers were less likely to use grammatical morphology and rely more on word order, a trend found in some patients with aphasia. Blackwell & Bates (1995) administered a secondary task to healthy adult native speakers of English and showed that adding "global stress" induced similar patterns of behaviours as seen in patients with receptive agrammatism. They

were able to conclude that at least some cases of receptive agrammatism are not due to damage to a "closed-class module". One major advantage of this technique is the ability to isolate factors which are hypothesized to be different between two populations to determine their precise effect, although it could also be argued that one major disadvantage is that it is sometimes difficult to precisely identify the role that a secondary task, or measurement of one aspect of working memory plays. Therefore it is essential to choose factors whose role can be clearly identified. It is also possible that a difference in performance is due to an interaction of factors, which may not be identified in this type of experiment.

6.3.3 Two approaches: individual differences vs external load

In the literature (see, e.g. Caplan & Waters (1999) for a review), generally two main approaches to investigating the effect of working memory on processing have been used: firstly, an individual differences approach, focussing on correlations between individuals' working memory capacity and linguistic processing, secondly external load approaches, where extra burden is placed on working memory by including an additional task, or by increasing the complexity of the material to be processed. Work on processing deficits in other populations, such as in patients with aphasia (Kilborn 1991), agrammatism (Blackwell & Bates 1995), and children with SLI (Hayiou-Thomas et al. 2004) have generally taken one of these two approaches. We will turn first to the individual differences approach.

Individual differences approach

The individual differences approach relies on the ability to measure working memory capacity, and use this as a predictor of performance on a processing task. Much of the rather sparse literature on working memory and L2 acquisition has taken this approach. Juffs (2004, 2005) found that reading span, as measured using Daneman & Caprenter's (1980) reading span test was not a predictor of L2 performance. However, Juffs (2004) did find an effect of word span in L2 learners. Similarly, as discussed in Section 6.2, Felser and Roberts failed to find an effect of reading span on L2 processing. There is still considerable debate in the literature (Caplan & Waters (1999)), Bayliss, Jarrold,

Baddeley, Gunn & Leigh (2005) regarding exactly which aspects of working memory different working memory tests measure: it seems likely that the lack of results could be due to using an inappropriate measure of working memory for the task. Indeed, Caplan & Waters (1999) report an inability to find differences between high and low span adult native speakers on similar sentence types. A further potential issue relates to the range of working memory spans, irrespective of how this is measured among the participants in an experiment. If participants are drawn from a university population, as is frequently the case, then we would not expect to see the full range of working memory spans seen across the population as a whole among the participants in the study. This was indeed the case for the participants in Experiment 9, who had had an average of 18.75 years of education (SD=4.16), and showed a range of digit span scores ranging from 6 to 8 (mean = 6.38). A post hoc analysis of the data from Experiment 9 (in the no load condition only), including digit span, NP (pre- or post-verbal NP), time and type of anaphor as fixed factors found no significant effect of digit span, whereas there were strong effects of processing load across the experiment.

External load

Rather than measuring the participants' working memory, another option is to artificially add processing load, and compare participants' performance across the load and no additional load conditions. This approach allows much more flexibility, as a range of additional tasks which clearly increase the processing load can be chosen. For example, the speech signal can be manipulated by compression (Hayiou-Thomas et al. 2004), or by the addition of "pink noise"(random noise restricted to the speech band) (Kilborn 1991). Participants can be asked to remember lists during presentation of experimental items, such as lists of digits (Blackwell & Bates 1995), or lists of words. Gordon, Hendrick & Levine (2002) for example, asked participants to remember series of words while reading, and found that lists of words semantically similar to the sentences caused more processing difficulty. Manipulating the syntactic complexity of the experimental stimuli is also possible: Gibson (1998) used Object versus Subject extracted relative clauses as a measure of

complexity, as Object extracted relative clauses were found to be more difficult to process. However, one drawback with this method for the purposes of investigating processing at the syntax-discourse interface would be that altering the syntactic construction used would impact on the relative salience of the NPs, potentially altering antecedent preferences for reasons of salience induced by the different syntactic construction.

Individual differences vs external load: summary and conclusions

One clear advantage of using an external load technique is that the extra load is measurable, and can be manipulated to give a clear distinction between the load and no extra load condition, increasing the likelihood than any changes caused by processing load would not be masked by lack of differences among participants. However, one difficulty with this approach is choosing an appropriate means of adding additional load, as each method may affect different aspects of processing, and it is crucial to be clear which aspects of processing are affected in order to be able to draw meaningful conclusions. Resource sharing accounts of working memory (see e.g. Daneman & Caprenter (1980), Just & Carpenter (1992) propose a trade-off between processing and storage; if more items need to be stored, then processing would be impaired, and vice-versa. Requiring participants to recall words, as Gordon et al. (2002) did, as well as causing storage demands, may require semantic processing, and so cause additional load in that domain. Adding pink noise, as Kilborn (1991) did, would not load any specific area of processing, although it may affect the speed of processing, causing extra storage demands, as each item must be stored for longer in working memory until it can be processed. Although a case could be made for most of the methods of adding processing load, Blackwell & Bates's (1995) technique of requiring participants to remember digits has the advantage of simplicity: it is clear that the task requires storage, and minimal semantic processing, allowing the data to be analysed with respect to a well defined task. Therefore digit recall was chosen as the additional task to add processing load for Experiment 9. Following Logie (R. Logie, personal communication, 12/02/2008), participants' digit spans were assessed at the start of the experiment, to allow the additional load to be relative to each participant's span. This technique has the advantage of allowing all participants

to be tested at the limit of their span, maximising the difference between the additional load and no load conditions without overloading some participants beyond their working memory span.

6.3.4 Measures of possible sources of attrition

It is hypothesized that attrition may cause similar effects in native speakers of German compared to those observed in L2 learners; in particular in native speakers who are resident in a non-German speaking country due to the reduced levels of native input in German. In this experiment we examine native German speakers who have been resident in Great Britain for a range of periods of time, in order to investigate the effect of reduced levels of input over time. However, as there is great individual variance in the amount of German used when away from a German speaking country, we also recorded what percentage of participants' language use they estimated to be in German. A questionnaire conducted after the experiment sought to investigate in more detail the nature of the German input which people were receiving while in the UK.

6.3.5 The visual-world paradigm and dual task methodologies

Previous experiments presented in this thesis have used the visual-world paradigm, as this technique allows a detailed insight into the unfolding interpretation of utterances. As discussed in Chapter 3, this paradigm has the advantage of being relatively close to natural language processing, with few additional task-related demands on participants. We would therefore expect that incorporating the visual-world paradigm with a secondary task would allow the examination of participants' processing under two conditions of maximal contrast: with no load and additional load. Other methodologies, such as self-paced reading are associated with very task specific demands, perhaps reducing the contrast between the dual-task and single task conditions. Combining the visual-world paradigm with a secondary task allows an insight into the effect of additional load on the interpretation of utterances over time. To the best of our knowledge, the use of the visual-world paradigm with a secondary task of this nature is a novel use of the paradigm, although the effect of cognitive load on the link between eye-movements and language

comprehension has been examined by Bailey, Siebold, Zork & Groves (2008), who moderated the paradigm by introducing disfluencies into the stimuli, and requiring participants to recall the final word of each of six utterances at the end of each of 12 blocks of utterances. They found that under high cognitive load, participants spent less time looking at the target region, and concluded that the link between eye-movements and language may be attenuated by cognitive load. Does this result suggest that the visual-world paradigm is unsuitable for a dual task methodology, because if the link between eye-movements and language is weakened, eye-movements could be considered to be a poor indication of the interpretation of language? In the current study, this could attenuate the link between the different interpretations of pronouns and demonstratives. However, the cognitive load placed on participants in Bailey et al's experiment was very high, and was not modulated to individual participants' working memory spans. The current experiment places a processing load on participants relative to, and one digit less than their digit span, ensuring that participants are not overloaded, reducing the risk of attenuating the link between eye-movements and language. Furthermore, we are primarily concerned with the relative preference for two potential antecedents, so even if there is some attenuation of the link, the relative preferences for each antecedent would be apparent. However, if all participants showed no preference for either antecedent in the additional processing load condition, while showing a preference in the no additional load, then this would indicate that the link between eye-movements and language might have been impaired.

6.3.6 Materials

As discussed above, the processing of demonstrative and personal pronouns provides a suitable domain for investigating the underlying nature of L2 learners' deficits at the syntax-discourse interface. In this experiment we investigate the antecedent preferences of anaphoric demonstratives and personal pronouns with SVO antecedent sentences, as seen in (6.1).

(6.1) a. *Der Kellner erkennt den Detektiv als das Bier*
the-nom waiter recognises the-acc detective as the beer
umgekippt wird. Er ist offensichtlich sehr
tipped.over is. he.pron is clearly very
fleißig.
hard.working.
The waiter recognises the detective as the beer is tipped over. He is clearly very hard working.

b. *Der Kellner erkennt den Detektiv als das Bier*
the-nom waiter recognises the-acc detective as the beer
umgekippt wird. Der ist offensichtlich sehr
tipped.over is. he.dem is clearly very
fleißig.
hard.working.
The waiter recognises the detective as the beer is tipped over. He is clearly very hard working.

Figure 6.1: Picture corresponding with Example (6.1)

SVO antecedent sentences were chosen as they are more frequent in the input than other antecedent structures which we have investigated thus far (OVS and passives). We predict that demonstrative pronouns will be most sensitive to a resource allocation deficit, caused by exposure to English, whereas pronouns may be affected by both resource allocation and resource limitation,

because under processing load participants may not be able to form the appropriate syntactic dependency.

We re-used the experimental items used in Experiment 5. Twelve experimental items were used for the no load condition, which was a standard visual-world experiment, in which participants viewed semi-realistic scenes such as Figure 6.1 while hearing sentences such as 6.1. After each picture participants were asked a comprehension question. The processing load condition used additional 12 experimental items similar to those in the no load condition. Before each item participants heard a list of digits which they were instructed to remember; they then repeated the digits after answering the comprehension question. Each participant was exposed to six examples of each condition.

The experiment therefore had 4 conditions as shown in Table 6.1

Pronoun condition	No load	Extra load
Demonstrative condition	No load	Extra load

Table 6.1: Experimental conditions in Experiment 9

The sentences were recorded by an adult female native speaker of German. The digits used in the lists of digits were recorded by an adult male native speaker of German, and then spliced together such that participants heard one digit every 800ms. The lists were generated using a random number generator (random.org, 2008).

6.3.7 Participants

There were 24 participants (13 Female, 11 Male). Participants were adult native speakers of German resident in Edinburgh, and were rewarded £7 for participation. Table 6.2 shows participants' biographical details and recorded digit span.

6.3.8 Procedure

The experiment was conducted in four stages. Firstly, participants filled in a questionnaire about their language and educational background. Secondly,

	Mean	S.D
Years of education	18.75	4.16
Time spent living in Great Britain in months	36.54	35.77
% use of German	25.88	19.59
Digit span	6.4	2.78
Age	26.9	6.4

Table 6.2: Biographical details of participants in Experiment 9

participants' digit span was assessed by playing prerecorded lists of digits in German (e.g. 2, 4, 1, 7, 5), starting from a list two digits in length, with three lists for each length (3 lists of 2 digits, followed by 3 lists of 3 digits), and increasing by one digit every three lists. Each participant heard the same lists of digits. Participants were asked to repeat each list back immediately after hearing it; this continued as long as participants were able to repeat at least two out of the three lists correctly. Participants' digit span was defined as the longest set of three lists for which they were able to repeat at least two out of three correctly. The third and fourth stages of the experiment were both eye-tracking stages, one of which was a standard visual-world set up, the other was a dual task set up. Half of the participants did the dual task first, half did the standard visual-world set up first.

Both eye-tracking sections used EyeTrack software in conjunction with an SMI EyeLink II headmounted eye-tracker. Participants wore a swimming hat and an SMI EyeLinkII headmounted eyetracker, sampling at 500Hz. (The swimming hat prevented the eyetracker from slipping.) Their eyes were approximately 25" from the display, which is a 21" colour display. A simple test before the eye-tracking sessions determined each participant's dominant eye; the movement from this eye was tracked. Viewing was binocular, and head movements unrestricted. The eyetracker was calibrated using a 9-point fixation stimulus. The calibration was validated using EyeLink software. Sentences were played through speakers attached to the display monitor.

Each item was viewed only once, in one of the four conditions by each participant. Each participant viewed the same number of items in each condition.

The questions were presented as text on screen, and answered using a game pad. At the start of the experiment there was a short practice phase, consisting of 3 filler items, and including one item which had a question following it to familiarize participants with the task. The experiment lasted approximately 40 minutes.

The standard visual-world set up consisted of 12 experimental items and 12 fillers, with a practice session of 3 items at the start. After each item, participants responded to a yes/no answer comprehension question using a game pad. Example 6.2 shows two examples of experimental stimuli (Examples 6.2a and 6.2c presented auditorily), and the corresponding comprehension question (Examples 6.2b and 6.2d presented as text).

(6.2) a. *Der Tennisspieler nervt den Fussballspieler als*
the.nom tennisplayer annoys the.acc footbalplayer as
die Brille zerbrochen wird. Der scheint offensichtlich
the glasses broken are. he.dem seems apparently
sehr egozentrisch zu sein.
very egocentric to be.
The tennisplayer annoys the football player as the glasses are broken. He seems, apparently, to be very egocentric.

b. *Nervt der Tennisspieler den Fussballspieler?*
annoys the.nom tennisplayer the.acc footballplayer?
Does the tennis player annoy the football player?

c. *Der Schwimmer sieht den Trainer als das Badetuch*
the.nom swimmer sees the.acc trainer as the towel
nass wird. Der ist offensichtlich aktiv.
wet becomes. he.dem is apparently active.
The swimmer sees the trainer as the towel gets wet. He is apparently active.

d. *Wird der Trainer nass?*
becomes the trainer wet?
Does the trainer get wet?

The dual task set up was identical, except that before each item, participants were played a list of digits and asked to remember this list. The length of the list of digits was one digit shorter than participants' digit span. Participants

were asked to repeat back each list after answering the comprehension question. Participants' voices were recorded during this section using a clip-on microphone. Their responses were transcribed after the experiment. Participants were instructed that it was important to pay attention to both the digit lists and the visual-world stimuli, and motivated to do so by the promise of a prize for the participant with the greatest number of digit lists and correct comprehension questions.

6.3.9 Data transcription

Although participants were motivated to remember both the digit lists and to pay attention to the visual-world stimuli, there was considerable variation among participants with respect to the number of digit lists correctly recalled, with some participants recalling less than 17% of lists correctly, and some recalling all lists correctly. Performance on the comprehension questions was less variable, with all participants achieving at least 75% accuracy. It is crucial to the design of the experiment that participants pay attention to both the lists and the stimuli, so any participants who achieved less than 75% accuracy on either task were eliminated from the analysis. Six extra participants were tested to replace those excluded from tha analysis. An accurate response for recall of the digit lists was defined as follows:

1. the correct number of digits, and the correct digits in the correct order
2. only one digit too few or one digit too many, all other digits in the correct order, i.e. with a target list of 4 6 8 3 1, participant produces e.g. either 4 8 3 1 or 4 6 7 8 3 1
3. two digits swapped with each other, all other digits in the correct order, with a target list of 4 6 8 3 1, e.g. 8 6 4 3 1
4. one digit replaced with another, i.e. for a target list of 4 6 8 3 1, 4 6 8 3 2

The near misses described in (2)-(4) were treated as accurate to prevent excessive data loss, as it is clear that participants were trying to recall the digit list, and are therefore under processing load.

6.4 Results

The data were analysed according to the procedure outlined in Chapter 3. Fixations which commenced before the onset of the pronoun were excluded from the analysis (6.50% of all fixations to either of the target objects which fell within at least one of the target time regions).

In this experiment we are interested in looks to either the pre-verbal (NP1) or post-verbal NP (NP2). 8 time windows of 250ms, commencing 500ms before the onset of the post-verbal NP were calculated, and looks to either entity were calculated. The log odds of looks to either NP1 or NP2 are plotted in Figures 6.2 and 6.3. The odds of a fixation to the discourse-old entity relative to the discourse new entity were calculated, and then the natural logs taken, such that a value greater than zero can be interpreted as an overall preference for NP2, and a value of less than zero as a preference for NP1. The pronoun conditions show an early NP1 preference in the no additional load condition which switches over time, and the reverse trend (NP2 to NP1) in the load condition. The demonstratives conditions both show an overall preference for NP2, although this does seem to reduce around Time 6 (1250-1500ms) in the no additional load condition, however, this reverses such that there is ultimately an NP2 preference.

A separate model was run for the pronouns and demonstratives. The following fixed factors were included in the fully specified model:

- Time (in 250ms chunks, starting from the onset of the pronoun)
- Object (looks to NP1 (base level) or NP2)
- Load (processing load condition or no load condition (base level))
- Time lived in Great Britain (in months)
- Percentage of language use which is German

The final demonstratives model obtained had a signficant four-way interaction Time, Load, Time lived in Great Britain, and Percentage of language use which is German. Table 6.3 shows the fixed effects (Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)), the model estimates are plotted in Figure 6.4. The demonstratives data are more straightforward than the pronoun data.

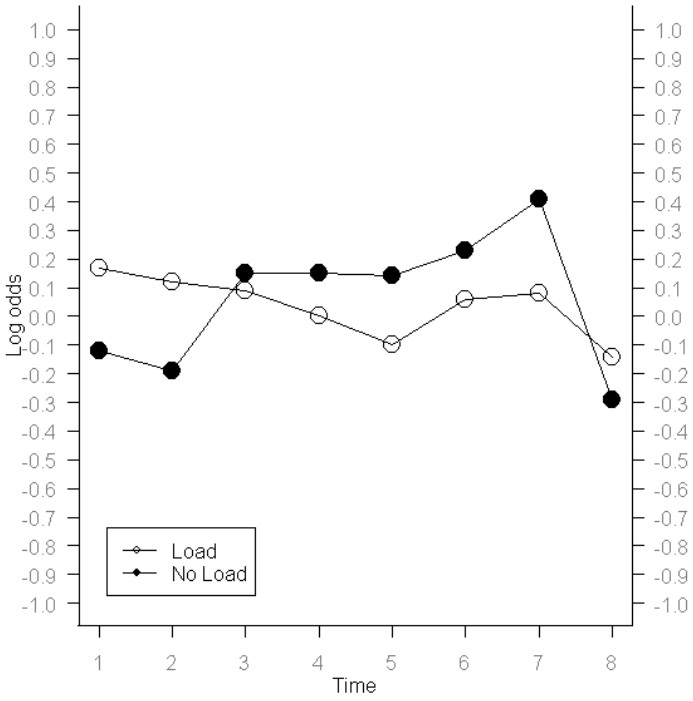

Figure 6.2: Log odds of looks to NP2 and NP1 in the pronoun condition in Experiment 9

For the demonstratives, at low levels of time spent in Great Britain, we observe an NP2 preference for those people who use German the most, which lessens as use of German decreases. Additional processing load either switches the preference (low use) or reduces it (medium use). At medium levels of time spent in Great Britain, there is little preference for either NP at all levels of use of German, processing load has little impact. At high levels of time spent in Great Britain, we observe a slight NP2 preference for low levels of use of German, a slight NP1 preference at medium levels of use of German, and a strong NP1 preference at high levels of use of German. The results of the mixed modelling reflect those seen in Figures 6.2and 6.3, however, inclusion of the additional factors of time spent living in Great Britain and use of German show that it is important to consider the data in the light of these additional factors.

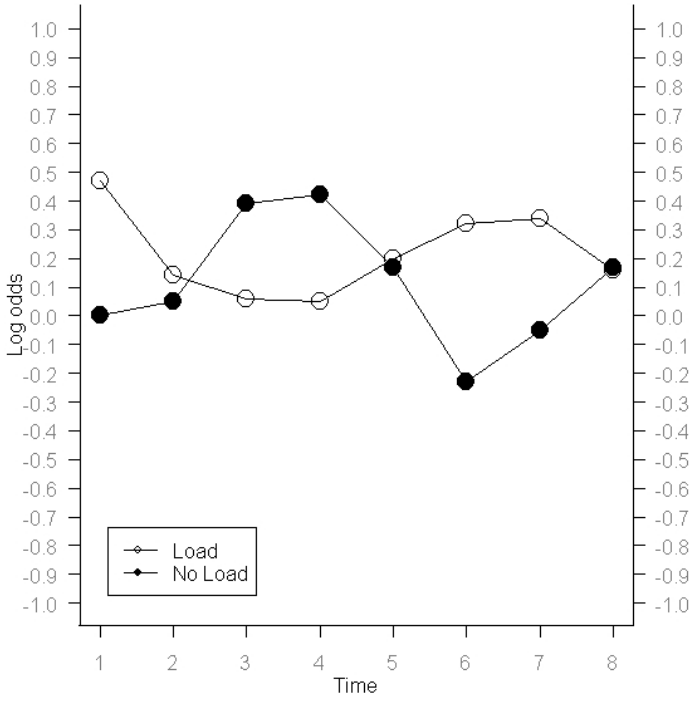

Figure 6.3: Log odds of looks to NP2 and NP1 in the demonstratives condition in Experiment 9

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-4.39	0.47	***
Object	0.21	.57	
Time	.19	0.08	*
Load	1.38	0.60	*
Time lived in GB	0.006	0.008	
Use of German	0.02	0.01	
Object : Time	0.08	0.10	
Object : Load	-0.99	0.51	*
Time : Load	-0.11	0.10	
object : Time lived in GB	0.01	0.009	
Time : Timelived in GB	-7.80e-05	0.0014	
Load : Time lived in GB	-0.02	0.009	*
Object : Use of German	0.02	0.01	
Time : Use of German	-0.001	0.002	
Load : Use of German	-0.07	0.02	***
Time lived in GB : Use of German	-1.32e-05	3.21e-04	
Object : Time : Load	0.02	0.069	
Object : Time : Time lived in GB	-0.003	0.002	.
Object : Load : Time lived in GB	0.01	0.004	**
Time : Load : Time lived in GB	0.002	0.002	
Object : Time : Use of German	-0.005	0.003	.
Object : Load : Use of German	0.02	0.009	*
Time : Load : Use of German	0.008	0.003	**
Object : Time lived in GB : Use of German	-9.128e-04	3.849e-04	*
Time: Time lived in GB: Use of German	4.093e-06	5.599e-05	
Load : Time lived in GB : Use of German	9.641e-04	3.987e-04	*
Object: Time: Time lived in GB: Use of German	1.662e-04	6.636e-05	**
Time : Load : Time lived in GB : Use of German	-1.543e-04	6.824e-05	**

Table 6.3: Model estimates and significance levels for the demonstratives condition in Experiment 9

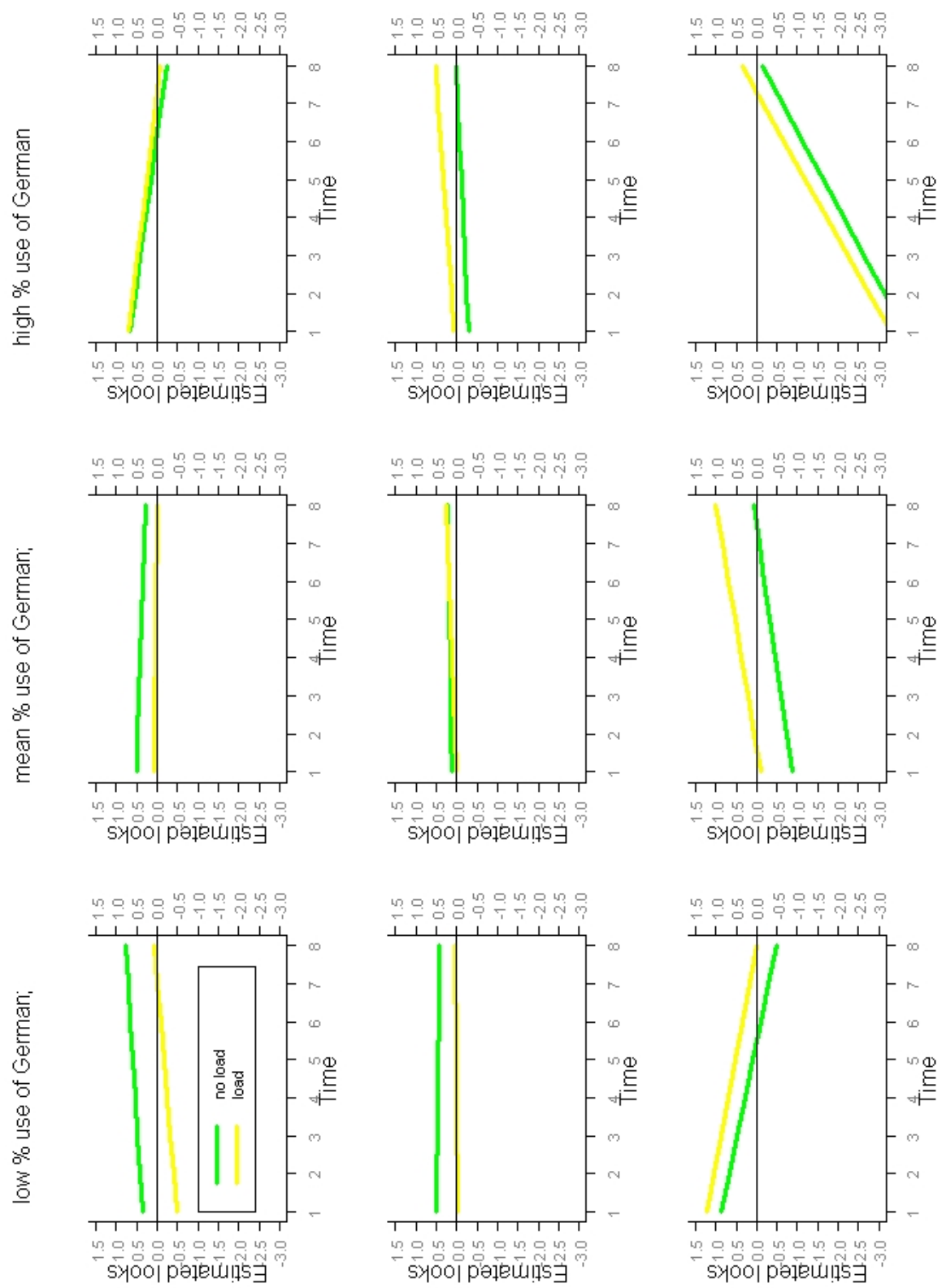

Figure 6.4: Difference between looks to NP2 and NP1 in the demonstratives condition in Experiment 9

The final pronoun model obtained had a significant five-way interaction of all fixed factors. Table 6.4 shows the fixed effects (Significance codes: (***$<$ 0.001) (**$<$ 0.01) (*$<$ 0.05) (.$<$ 0.1)), the model estimates are plotted in Figure 6.5. The pronoun data are more complex than the demonstratives data. Taking the low levels of time spent in GB, and high use of German as a starting point, in both the processing load and no load conditions we observe almost no preference for either NP. For low and medium levels of time spent in GB, with low and medium use of German, we observe an NP2 preference, which is generally similar in both load and no load conditions. For the high levels of time spent in GB conditions in the no load condition (all levels of use of German) we observe either no preference, or a slight NP1 preference, suggesting that for pronouns, use of German is less important than for demonstratives, possibly because demonstratives are more permeable to input factors. However this is not the case for the processing load condition in the high levels of time spent in GB at medium and high levels of use, and for medium levels of time spent in GB at high levels of use. In these conditions we observe a very dramatic NP2 to NP1 switch, with a strong initial preference for NP2 followed by a very strong preference for NP1.

	Estimate	Std. Error	$Pr(>\|z\|)$
(Intercept)	-5.22	0.54	***
Object	1.56	0.68	*
Time	0.31	0.09	***
Load	1.36	0.72	.
Time lived in GB	0.02	0.009	**
Use of German	0.04	0.01	**
Object : Time	-0.06	0.12	
Object: Load	-0.93	0.93	
Time : Load	-0.14	0.12	
Object : Time lived in GB	-0.02	0.012	
Time : Time lived in GB	-0.002	0.002	
Load : Time lived in GB	-0.003	0.012	
Object : Use of German	-0.02	0.02	
Time : Use of German	-0.004	0.002	.
Load : Use of German	-0.02	0.02	
Time lived in GB : Use of German	-5.814e-04	3.493e-04	.
Object : Time : Load	-0.03	0.16	
Object : Time : Time lived in GB	0.001	0.002	
Object : Load : Time lived in GB	0.002	0.02	
Time : Load: Time lived in GB	8.427e-05	0.002	
Object : Time : Use of German	-3.588e-04	0.003	
Object : Load : Use of German	-0.005	0.02	
Time : Load : Use of German	9.621e-04	0.003	
Object : Time lived in GB : Use of German	7.538e-05	5.405e-04	
Time : Time lived in GB: Use of German	7.252e-05	6.208e-05	
Load : Time lived in GB : Use of German	-9.525e-04	6.541e-04	
Object : Time : Load : Time lived in GB	0.002	0.003	
Object : Time : Load : Use of German	0.007	0.004	
Object : Time : Time lived in GB : Use of German	1.617e-05	9.490e-05	
Object : Load : Time lived in GB : Use of German	0.002	9.626e-04	.
Time : Load : Time lived in GB: Use of German	1.782e-04	1.084e-04	.
Object : Time : Load : Time lived in GB : Use of German	-5.012e-04	1.762e-04	**

Table 6.4: Model estimates and significance levels for the pronoun condition in Experiment 9

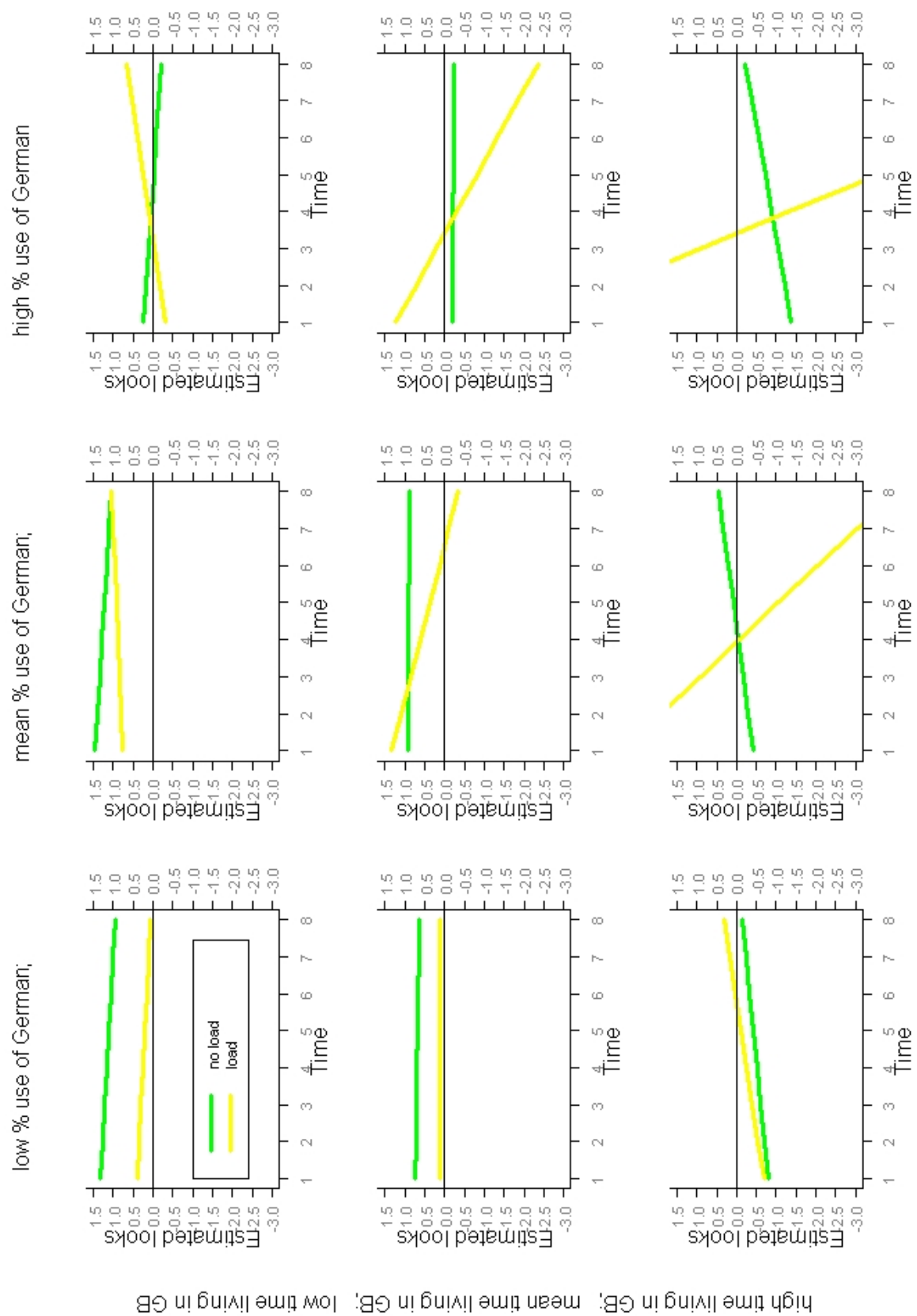

Figure 6.5: Difference between looks to NP2 and NP1 in the pronoun condition in Experiment 9

The data presented here are illustrated by graphs showing participants NP preferences for both demonstratives (Figure 6.4) and pronouns (Figure 6.5) at three levels of German usage (low: 4%, the mean for the data: 25.88%, and high: 50%, and three levels of time spent living in Great Britain (low: 5 months, the mean for the data: 36.54 months, and high: 120 months) These levels show the spread of the data, allowing trends across the range of the data to be identified. The graphs show the difference in estimated looks to each potential antecedent, either the pre-verbal NP (NP1), or the post-verbal NP (NP2), represented as looks to NP2 minus looks to NP1. Data points above zero on the y-axis therefore indicate an NP2 preference, data points below zero, an NP1 preference.

Figures 6.4 and 6.5 show the differences in looks to NP2 and NP1, a positive value shows a preference for NP2, a negative value a preference for NP1, for participants at low, mean and high levels of time spent in Great Britain and estimated percentage use of German, resulting in nine plots for pronouns (6.5) and nine plots for demonstratives (6.4) .

After the experiment, a questionnaire was sent to all participants from Experiment 9 to determine in more detail the nature of the input which participants were exposed to. Due to a low response rate (16 responses from 24), these data were combined with an equivalent questionnaire sent to participants who participated in Experiment 6, bringing the total responses to 26. There was a particularly low response rate for participants who had been resident in Great Britain for less than the mean number of months; this is probably due to the fact that many of these participants were visiting exchange students, who are likely to have returned to their home country, and not use the University of Edinburgh email addresses which were used as the main contact for recruitment. Although these data only partly correspond to the participants tested in Experiment 9, these data give an overview of the overall patterns of the source of German input for German native speakers in Edinburgh.

Participants were asked their predominant source of German input, from the options of Non-native German speakers, native German speakers resident in Great Britain, but for less than one year, native German speakers resident in Great Britain for longer than one year, and native German originating from

a German speaking country, such as friends and family or media output. Table 6.5 shows the pattern of responses, grouping respondents into groups according to whether they have been resident in Great Britain for shorter or longer than the mean for the Group, and whether they reported a lesser or a higher % of German use than the mean.

Predominant source of German input		Non-native speakers	Native German speakers who have been resident in GB for < 1 year	Native German speakers who have been resident in GB for > 1 year	Native German originating from a German speaking country
Shorter than average time spent in GB	Low % use	0	2	1	2
Shorter than average time spent in GB	High % use	1	3	1	1
Longer than average time spent in GB	Low % use	0	0	6	4
Longer than average time spent in GB	High % use	0	0	5	0

Table 6.5: Sources of input for native German speakers

Some clear patterns emerge from the data. Firstly, participants who have been resident in Great Britain for a short time are more likely than participants who have been resident in Great Britain for a longer time, to receive input from native German speakers who have also been resident in Great Britain for a short time. However, participants who have been resident in Great Britain are also report receiving input from native German speakers who have been in Great Britain for more than one year, and native German originating from a German speaking country. Participants who have been resident in Great Britain show a very different pattern. Those who use German less than average report input from both native German speakers who have been resident in Great Britain for longer than average and sources originating in a German speaking country, whereas those who use German more than average report that their main source of German input is other native German speakers who have been resident in Great Britain for longer than one year.

6.5 Discussion

Experiment 9 aimed to investigate the nature of the difficulties observed in L2 learners at the syntax-discourse interface by simulating the processing of L2 learners in native speakers of German. Three main questions were addressed:

1. Is there evidence for a distinction between a resource allocation and resource allocation deficit?
2. How do native speakers of German under attrition and/or processing load behave with respect to their antecedent preferences for anaphoric demonstratives and pronouns?
3. Is this like L2 learners' behaviour? Can we attribute L2 learners' difficulties at the L2 interface to a representational deficit, or a processing deficit resulting from a resource allocation or resource limitation deficit?

Firstly we examine the antecedent preferences of native German speakers under processing load and conditions leading to attrition, namely the time spent in Great Britain and the percentage of use of German at the time of testing. Subsequently we look at how these data relate to the notions of a resource allocation versus a resource limitation account, and whether there

is evidence for a processing deficit in native speakers of German undergoing attrition. Finally, we link these data to the data obtained from L2 learners in Experiments 7 and 8, and discuss the nature of the deficit observed in L2 processing at the syntax-discourse interface.

6.5.1 Implications for theories of L1 attrition

The demonstratives data show that overall, the longer the time spent in Great Britain, that is, away from high levels of native speaker German input, the weaker the preference for the post-verbal NP becomes, and finally switches to a preference for the pre-verbal noun phrase (see Figure 6.4). However, processing load does not seem to have a strong effect on antecedent preferences for demonstrative pronouns. Competition from English gradually becomes stronger, overriding the native German post-verbal preference for demonstratives. It is not clear, however, whether this results from lower activations for the German constraint, or a strengthening of the English constraint due to additional exposure.

It might be hypothesized that those native German speakers who have lived in Great Britain for a long time but still use German frequently would behave more like native Germans who have not been living in Great Britain for very long. However, the shift to an NP1 preference seem strongest in this group. On the one hand, this seems paradoxical, however, when we consider that participants who had spent more time in Great Britain typically speak to other long-term residents Great Britain (see Table 6.5), it seems likely that the effect is compounded by impoverished input: the German input which these participants are receiving is affected by attrition; it seems likely that the fact that this input is in German would cause it to have a greater effect because it is from the same language in comparison to competition from English constraints.

Processing load, however, does not have a clear and consistent effect on the antecedent preferences for demonstratives overall. However, processing load does seem to interact with use of German and time spent living in Great Britain, though the effect sizes are small. For participants who have been resident in Great Britain for a short period of time (the graphs on the top row show the model estimates for participants who have been resident in Great

Britain for 5 months in Figures 6.5 and 6.4), the less German used by participants, the stronger the effect of processing load, with almost no difference for those who use German a great deal, to a near switch of preference for those who use German the least. The participants in this group (resident in Great Britain for short periods of time) typically speak German with other native German speakers in a similar situation; as they have been in Great Britain for a short time, it is hypothesized that their German is relatively unaffected by competing constraints from English. This group suggests that processing load, or indeed a reduction of processing resources may attenuate the ability to allocate processing resources effectively, as there appears to be a switch in preference for those participants who use German the least, and who have been in Great Britain for a short period of time. However, the effect sizes are very small. The model estimates for those participants who have been in Great Britain for an average amount of time (mean = 36.54 months) are less clear; those who use German very little have a stronger NP2 preference in the no load condition, and no preference in the additional load condition, whereas those who use German a lot show the opposite preference: in the no load condition there is little preference for either NP, whereas in the additional load condition an NP2 preference develops over time. This latter result could be explained by the relatively high levels of impoverished input which participants who have been resident in Great Britain for longer who use German a great deal are receiving, as we see a similar pattern in those participants who had been living in Great Britain for a long time, and use an average amount of German.

These data are consistent with the hypothesis that the antecedent preferences of demonstratives are subject to discourse based constraints, which are greatly affected by a resource allocation deficit. Even though, overall the quantity and quality of German input has the effect of making participants' interpretation of demonstratives less targetlike, processing does not seem to break down, as we might expect if there were a resource limitation. It is of course possible, that a resource limitation may play a role as well, by preventing the parser from storing the different constraints, reducing their availability to compete with the prevailing preference. It is plausible that this is the case for the participants who have a high level of German use and who have been in Great

Britain for a long time: in this case there is a strong preference for the preverbal NP, which could be a result of the unavailability of the native German-like NP2 preference for demonstratives to be considered, both because it is so weak relative to the English constraints and because the parser is unable to store the additional, weaker constraint.

The pronoun data (Figure 6.5) show that the processing of pronouns is sensitive to both levels of input and processing load. Participants who have spent a low level of time in Great Britain and use German frequently show a similar pattern of antecedent preference to native speakers in Experiment 5, with an initial NP2 preference followed by a slight NP1 preference. In the additional load condition, this tendency was reversed, suggesting that a resource limitation could be affecting processing of pronouns even in a population relatively unaffected by attrition. However, this hypothesis is not clearly supported by those participants who have also spent a short or an average length of time in Great Britain, but use only an average or low level of German. For these participants there is a strong NP2 preference in the no load condition. What could explain this shift in preference? It does not appear to be caused by competition from English constraints, as we would expect a shift towards an NP1 preference. Additionally, it does not seem to be a result of a resource limitation, because there is a less strong shift towards an NP2 preference in the additional load condition. In previous experiments we have generally observed an overall preference for pronouns and demonstratives to refer to the post-verbal NP. It could be the case that the SVO order followed by a pronoun is rather ambiguous, and so under reduced levels of input, the default preference of an NP2 preference becomes stronger. However, this hypothesis clearly requires further investigation. For those participants who have spent a long time away from Germany, we start to see a shift towards an NP1 preference in the no load condition, suggesting that competition with English constraints is starting to have an impact. This shift occurs at much lower levels of time spent living in Great Britain for demonstrative pronouns, suggesting that pronouns are much less sensitive to a resource allocation deficit.

Additional processing load, which causes a limitation of available processing resources, does seem to have a much greater on pronouns than demonstra-

tives in certain conditions. Participants who have spent a long time in Great Britain who use an average or high amount of German, and participants who have spent an average amount of time in Great Britain but use a high amount of German (represented by the graphs in the bottom right of Figure 6.5) show very strong effects of processing load: in the additional processing load condition there is a very strong initial preference for NP2, followed by a strong preference for NP1 after about 1000 ms. Data from Experiments 4-6 suggest that pronouns form a syntactic dependency (which is also modulated by discourse constraints) with their antecedents. A syntactic dependency is more likely to be vulnerable to a resource limitation deficit, in that if the parser is unable to form the syntactic dependency, there would be a catastrophic processing failure, leading to the patterns we observe. Why do we see this only in those who have been in Great Britain for longer periods of time and who use German frequently? It is possible that just as for the demonstratives, these native speakers are exposed to impoverished input, leading to the acquisition of a non-nativelike preference for NP1, formed by a syntactic dependency. Under processing load, the parser is unable to form either syntactic dependency due to storage costs of considering both representations for processing, leading to a total breakdown of parsing. The pattern of preferences observed could be due to the competing discourse constraints, with the native German NP2 constraint initially out-competing an NP1 preference, but this then switches. Clearly, further research is needed to investigate the underlying cause of the direction of this switch in preference in more detail.

To summarize, it seems that pronouns are more susceptible to the effects of processing load than demonstratives, though the effect of processing load on pronouns also interacts with exposure to English. Demonstratives do not show a clear effect of processing load, but rather show a systematic effect of exposure to English. These data are consistent with the hypothesis that native speakers undergoing attrition suffer from a processing deficit, and that rather than thinking about a processing deficit purely in terms of resource limitation, that we also need to consider the ability to allocate resources effectively. If the changes in antecedent preference observed in the current study in native speakers of German resident in Great Britain were due to impaired representations, we would not expect to see an interaction between

time spent in Great Britain, use of German and additional processing load; although this interaction is stronger for the pronouns, this interaction is also evident for the demonstratives. We can further qualify the nature of the processing deficit. The demonstratives show a gradual shift towards an NP1 preference the longer they have been resident in Great Britain, consistent with the hypothesis that the NP2 preference is becomes outcompeted, and that participants are showing a resource allocation deficit. The pronouns also show evidence of a resource allocation deficit, however, this is much more restricted than in the demonstratives. A resource allocation deficit for participants who have been living in Great Britain for longest, and who use German a lot is evident; processing seems to break down under processing load.

Tsimpli et al.'s (2004) data on native speakers of Greek and Italian undergoing attrition show similar patterns. The interpretation of overt pronouns by these populations is parallel to the interpretation of demonstratives by the native German speakers in this study, as both phenomena can be attributed to a resource allocation deficit. Although Tsimpli et al found that the interpretation of null pronouns seemed to be unaffected by attrition, and the current study found that the processing of personal pronouns in German is affected by attrition, this can be attributed to the fact that personal pronouns in German are subject to both syntactic and discourse constraints. Given that there are certain parallels between the processing of null and overt pronouns in Italian, and pronouns and demonstratives in German, it would be informative to examine the effect of additional processing load on native speakers of Greek and Italian undergoing attrition to determine whether the syntactic dependency formed when processing null pronouns in these languages breaks down under processing load; this result would add further evidence to the resource limitation versus resource allocation account of processing difficulties at the syntax-discourse interface.

These data contribute to the wider literature on working memory. Baddeley's model of working memory (for the more recent versions of the model see Baddeley (2000)) splits working memory into a phonological loop, a visuospatial sketchpad and an episodic buffer, all controlled by a central executive. There is debate about the extent to which the central executive contains specialized

components for separate tasks, such as components for visual and verbal processing, or are domain general. Caplan and Waters (1999) propose components which are even more specific: that even within the verbal domain, the domain of "interpretative processing", the extraction of an interpretation by constructing a syntactic representation is a separate component of the central executive. In a review of the literature, Caplan & Waters (1999) discuss the fact that studies in which participants are presented with a list of digits to recall, then presented with an experimental stimulus (such as a sentence), and immediately asked to recall the digits, as in the current study, typically do not find an effect of digit load. Only when the sentence is interrupted was an effect of concurrent digit load obtained. Caplan & Waters (1999) suggest that digit span may relate to a "specialized auditory-to-articulatory information transfer mechanism" (Caplan & Waters 1999, p86), and that the effects seen due to additional load caused by storing digits during processing could be attributed to attentional shifts, rather than evidence for a shared working memory resource. The fact that processing load was demonstrated to affect the processing and interpretation of pronouns without any interruption to the experimental sentence, albeit by native speakers undergoing attrition, suggests that this is not the case, and that concurrent digit load does impact on language processing, providing evidence that the verbal component of the central executive (if indeed the central executive is split into domain specific components), is not further specialized. It is therefore possible to conclude that "interpretative processing" does not rely on a specific working memory resource. It is interesting, however, that these effects were only clear in native speakers of German who had been in Great Britain for longer periods of time, indicating that the study of populations other than typical native speaker populations can be helpful as a tool for understanding the architecture of the language processing mechanisms of typical native speakers.

6.5.2 Implications for L2 processing

Experiment 9 aimed to simulate the differences observed between native speakers and L2 learners in the processing of demonstratives and pronouns in Experiments 4 -8. Table 6.6 shows a summary of the results obtained in Experiments 7 and 8 in the conditions shared with Experiment 9.

Preferences	Population	SVO + Pronoun	SVO + Demonstrative
Experiment 7	10 resident in Germany, 14 in Scotland	NP1	No Preference
Experiment 8	24 resident in Scotland	NP2 to NP1	NP1

Table 6.6: Summary of antecedent preferences for anaphoric demonstratives and personal pronouns for L2 learners in Experiments 7 and 8

As discussed in Chapter 5, in Experiments 7 and 8 we did not replicate the results across the shared conditions, as might have been expected. This was speculatively attributed to differences between the participant groups. In Experiment 7, 10 participants were resident in Germany at the time of testing, of the remaining 14 participants who were resident in Great Britain, in Experiment 8 all participants were resident in Great Britain at the time of testing. Twelve were tested for both Experiments 7 and 8, at an interval of about 3-4 months, during which time they had all been resident in Great Britain. It is therefore likely that differences in the groups can be attributed to L2 attrition effects, with those participants in Experiment 8 having suffered a greater degree of L2 attrition.

Do the results from the L2 learners in Experiments 7 and 8 show similar patterns to the data obtained in Experiment 9? Overall, the native speakers of German in Experiment 9 show a shift from an NP2 preference, through no preference to an NP1 preference, as participants had spent more time living in Great Britain. The L2 group in Experiment 7 show no preference, and those in Experiment 8 show an NP1 preference, the same pattern as we see in the native speaker group. This is suggestive of the fact that the L2 learners do seem to be able to acquire the appropriate constraint, since those L2 learners in Experiment 7 have moved away from an NP1 preference, but that the competing L1 constraint prevents unattrited nativelike processing.

The data from the L2 learners in Experiment 7 and 8 for pronouns also follow a similar pattern to the data from attriting native speakers in Experiment 9.

The L2 learners in Experiment 7 had an NP1 preference, those in Experiment 8 had an NP2 preference switching over time to an NP1 preference. These results pattern with native speakers who have been in Great Britain for a long time, and use German a lot, in the no load condition (NP1 preference) and the load condition (NP2 preference switching to NP1). This pattern suggests that L2 learners are subject to a processing load deficit, because processing seems to break down similarly to native speakers under processing load, i.e., with extremely limited processing resources. Crucially, however, these similarities are only manifest in native German speakers who have been in Great Britain for a long time, and who use a lot of German.

6.6 Conclusions and Future work

In this study I aimed to simulate the antecedent preferences for pronouns and demonstratives in L2 learners of German, in native speakers of German who are undergoing L1 attrition, and who have been placed under additional processing load.

The data presented in this chapter show that both resource allocation and resource limitation affect the processing at the syntax-discourse interface in native speakers of German experiencing L1 attrition. The processing of demonstratives seems to be subject to discourse constraints, and as expected we saw a shift in antecedent preference as participants had been resident in Great Britain for longer, consistent with a resource allocation deficit. The antecedent preferences for pronouns, which we had hypothesized to be subject to both discourse and syntactic constraints were affected by the amount of time participants had been resident in Great Britain, how much German they used, and additional processing load. The processing of pronouns seemed to break down for native speakers who have been resident in Great Britain for longer periods of time, who report high levels of German use and are under additional processing load, suggesting that a resource limitation deficit affects processing in this group. This study also aimed to simulate L2 processing of pronouns and demonstratives. We found that L2 learners behaved like native speakers of German experiencing attrition with respect to the processing of demonstrative pronouns, indicating a resource allocation deficit. For

pronouns, L2 learners demonstrate the same processing patterns as native speakers of German who have been resident in Great Britain for a long time, and report high levels of German use and are under additional processing load, suggestive of the fact that processing of syntactic dependencies in L2 learners can be subject to a resource limitation deficit.

This study successfully demonstrated a novel way of using the visual-world paradigm, as part of a dual-task paradigm, a technique which shows many opportunities for future work. Using a concurrent digit load as a secondary task was chosen due to its transparency: concurrent digit load can be easily manipulated to match individual participants' digit spans, and the task itself requires storage, but little processing, in that participants are not required to manipulate the digit list in any way. Manipulating the nature of the secondary task would allow further investigation into the precise nature of processing deficits in different populations. For example, rather than asking participants to repeat the list of digits in the order of presentation, it would be possible to ask them to order the digits from lowest to highest. Almor (1999) argues that a digit ordering test is closer to natural language processing, as it involves both the storage and processing elements of working memory. A secondary task which involves processing might have a greater effect on the processing of syntactic dependencies, for example, as required for the processing of pronouns. Rather than using concurrent digit load, it is also possible to use word span, requiring participants to recall lists of words rather than digits could require more semantic processing, depending on the semantic relatedness of the words in the list to both each other and in the experimental stimuli. It is not clear what effect additional load caused by word span might have on the processing of pronouns and demonstratives, potentially we might expect the processing of demonstratives to be affected more strongly than pronouns, however, it is difficult to make precise predictions.

The current experiment has found effects of resource allocation and limitation in native speakers of German affected by attrition, which simulate L2 processing of pronouns and demonstratives. Since the attrition of L1 Italian and near-native speakers of Italian is hypothesized to follow the same patterns of resource allocation and resource limitation, with respect to the processing

of overt and null pronouns respectively, future work would ideally seek to confirm the findings of this study in these populations.

CHAPTER 7

Discussion and Conclusions

7.1 Introduction

In this chapter I summarize the findings of the thesis. First, I present a chapter by chapter summary, stating the main aims and findings of each chapter. I then discuss these results as a whole. Finally, I discuss directions for future work in the light of the conclusions drawn.

7.2 Summary of Chapters

In this section I summarize each of the chapters presented in this thesis.

7.2.1 Chapter 2: the syntax-discourse interface

In this chapter the literature on the syntax-discourse interface in both native speaker and L2 acquisition is discussed. I adopt the Form Specific Multiple Constraint (FSMC) approach (Kaiser & Trueswell 2008) to the syntax-discourse interface: since the FSMC is relatively recent, this thesis contributes to the evidence supporting this approach. Much of the research on L2 acquisition and the syntax-discourse interface reveals that L2 learners show difficulties at the syntax-discourse interface, however, these difficulties are not uniform. Furthermore, the underlying cause of these difficulties remained unclear. From a methodological perspective, research on the syntax-discourse interface has typically used off-line techniques; those that have used online

methodologies have only investigated the interpretation of interface phenomena indirectly. Finally in this chapter, comparisons between L2 learners and other developmental populations at the syntax-discourse interface were drawn, highlighting the possibility that the difficulties observed in L2 learners could be a result of a limitation of processing resources, or due to competition from another language.

7.2.2 Chapter 3: Methodology

In this chapter I presented a rationale for the choice of methodology used in the thesis, and describe the statistical method used to analyse the data. The visual-world paradigm was chosen as it allows an insight into the incremental interpretation of sentences, which is crucial to the study of the syntax-discourse interface. It is particularly suitable for research into L2 acquisition, as it places relatively low task demands on participants; L2 learners may be particularly susceptible to additional processing load. Previous research conducted using the visual-world paradigm has typically used an analysis of variance (ANOVA), with separate analyses conducted on individual time slices to analyse the data. However, this technique is not very suitable for visual-world type data, since these data are longitudinal and categorical. Mixed modelling is an appropriate tool for analysing categorical data which is able to take the lack of independence between different time regions into account. Furthermore, mixed modelling is able to allow a more sophisticated treatment of unwanted variance in the data, such as inter-subject and item variance; particularly important in L2 research, as we expect a high degree of inter-subject variance in L2 learners.

7.2.3 Chapter 4: The role of pronominalisation and word order with respect to information structure

In Chapter 4 I presented three visual-world experiments examining the role of pronominalisation and word order with respect to information structure. In Experiments 1 and 2, participants saw a picture depicting one stereotypically male entity, e.g. a boss, and two stereotypically female entities, e.g. two secretaries. In a context sentence, the boss and one of the secretaries were mentioned. In the target sentence, which always had the order of boss then

secretary, the pre-verbal element was either a lexical NP or a pronoun, and the word order was SVO or OVS. The experiment aimed to investigate whether the choice of a pronoun or lexical NP, or SVO or OVS word order would influence participants' anticipation and interpretation of the post-verbal NP being discourse-new (the unmentioned secretary) or discourse-old (the secretary mentioned in the context sentence). Experiment 1 found that native speakers of German showed no effect of word order, but that the use of a repeated lexical NP seemed to disrupt processing. Experiment 2 found an interaction of proficiency with word order and pronominalisation with respect to the interpretation of the post-verbal NP in L2 learners of German. This result showed that L2 learner's processing was disrupted by use of a pronoun, and by OVS word order. Experiment 3 investigated whether L2 learners' behaviour in Experiment 2 could be attributed to transfer effects by examining the behaviour of native speakers of English on parallel stimuli in English (Active was contrasted with Passive rather than SVO and OVS). The results of Experiment 3 indicated that L2 learners of German are not strongly affected by transfer of representations. Since the effects observed in L2 learners in Experiment 2 are similar to those seen in patients with Alzheimer's (Almor et al. 1999), these data suggest that L2 learners have a processing difficulty.

7.2.4 Chapter 5: Demonstratives

The antecedent preferences of anaphoric demonstratives and personal pronouns are a fruitful phenomenon for investigating the FSMC approach to the syntax-discourse interface. In German both demonstrative and personal pronouns can be used anaphorically, though native speakers of German typically suggest that they have different antecedent preferences, with demonstratives typically referring to less salient antecedents. Experiments 4-6 investigated the constraints governing the antecedent preferences of anaphoric demonstratives and pronouns, and showed that pronouns are more sensitive to grammatical role information, preferring Subject antecedents, while demonstratives are more sensitive to discourse based constraints, preferring non-topic antecedents. This indicates that pronouns form a dependency which is more syntactic in nature, while demonstrative pronouns form a more discourse based dependency. Data from Experiments 4-6 further suggested that anaphor

resolution is strongly affected by attrition; this result was confirmed in Chapter 6.

Previous work on anaphor resolution in L2 acquisition (Sorace & Filiaci 2006) suggests that L2 learners are able to form syntactic dependencies, but show greater difficulty on discourse dependencies. Data from Experiments 7 and 8 show that although L2 learners were able to distinguish between pronouns and demonstratives, that they did not use the appropriate constraints, and were over-extending the use of a grammatical role constraint, such that pronouns preferred Subject antecedents, while demonstratives preferred Object antecedents. However, the use of a grammatical role constraint interacted with a Topic or possibly first-mention preference, suggesting that L2 learners have difficulty using the appropriate constraints in online processing.

7.2.5 Chapter 6: Simulating L2 learners' difficulties in native speakers

This chapter presented an experiment designed to investigate the underlying cause of L2 learners' difficulties at the syntax-discourse interface by simulating L2 learners' antecedent preferences for pronouns and demonstratives in native speakers of German, by adding processing load and controlling for attrition. In this chapter I outlined an alternative framework for considering the difficulties shown by L2 learners at the syntax-discourse interface. Previously, these difficulties have been considered in terms of a representational deficit, or a processing deficit caused by a lack of processing resources. However, there is another possibility: a resource allocation difficulty: where there are competing constraints possibly resulting from each of a bilingual's two languages, an inappropriate constraint may out-compete the appropriate constraint, causing non-targetlike behaviour. Experiment 9 used a novel methodology to investigate these different accounts, by comparing behaviour in a visual-world paradigm set up in a dual-task condition, where the secondary task added additional processing load, with a standard visual-world set up. Participants in Experiment 9 were native German speakers resident in Great Britain for varying lengths of time, who, at the time of testing, reported different levels of German input in their daily lives. The antecedent preferences of demonstratives were predominantly determined by exposure to German, both in quality and quantity, while the antecedent preferences of pronouns were affected by

both processing load and exposure to German. This suggests that syntactic dependencies are more subject to resource limitations, while discourse dependencies are more subject to resource allocation difficulties. The results obtained in Chapter 5 for L2 learners were replicated, suggesting that L2 learners show resource allocation and limitation difficulties for discourse and syntactic dependencies respectively.

7.3 Contribution

In this section I summarize and briefly discuss the findings of the thesis thematically, starting with a discussion of methodology, then considering the contribution made to theories of native speaker processing at the syntax-discourse interface, L1 attrition and L2 processing.

7.3.1 Methodological

This thesis presents several methodological innovations. Firstly, the use of mixed-modelling to analyse visual-world data is a relatively recent technique which is currently the subject of debate in the field. I present a method of using mixed-modelling to analyse visual-world data. The visual-world paradigm has been widely used to investigate native speaker processing. However, despite the advantages of the technique for research into L2 acquisition, it remains underused in this domain. In the thesis I extend the use of the visual-world paradigm in L2 acquisition research to work on the syntax-discourse interface, allowing an understanding of the incremental interpretation of interface phenomena for the first time. Finally, in Experiment 9, the visual-world paradigm was used in a novel way as part of a dual task experiment. Additional processing load was added by requiring participants to remember lists of digits while being presented with conventional visual-world stimuli. This technique has significant potential for future research: not only by using the technique as presented in this thesis to simulate the processing difficulties of one population in another, but also to contribute to work on working memory. By varying the nature of the secondary task it would be possible to further investigate the role of working memory with respect to language processing.

7.3.2 Theories of native speaker processing

This thesis contributes to theories of native speaker processing of the syntax-discourse interface. I adopted a Form Specific Multiple Constraints (FSMC) approach (Kaiser & Trueswell 2008), which proposes that different forms, e.g. personal pronouns or demonstrative pronouns are subject to different constraints. This approach is relatively recent. The data presented in this thesis support the FSMC approach, by demonstrating that in native German, personal pronouns and demonstratives form different types of dependency with their antecedents. Furthermore, these data show that there are cross-linguistic differences: even though personal pronouns and demonstratives in German and Finnish appear to be similar, they are subject to different constraints (see Kaiser & Trueswell (2008) for details of Finnish), although in both Finnish and German, demonstratives have less salient antecedents than pronouns: it is the means of encoding salience which differs. The data from Experiment 9 further support the FSMC approach: the antecedent preferences for pronouns and demonstratives were affected differently by additional processing load and exposure to English, suggesting that different types of constraint (syntactic versus discourse) are used when processing pronouns and demonstratives: a syntactic dependency (for pronouns) is more vulnerable to processing load, as under too much load, processing breaks down, whereas for a discourse dependency (for demonstratives), exposure to English changes the relative activation levels of each constraint, causing a gradual shift in antecedent preference. In summary, this thesis provides further evidence consistent with the FSMC approach to the interface.

7.3.3 L1 attrition

Experiment 9 provided further evidence supporting the similarities between the behaviour of L2 learners and native speakers experiencing attrition at the syntax-discourse interface. Although further work is needed to explore the underlying nature of these similarities in more detail, the fact that increased levels of attrition (as measured in time spent living in Great Britain) simulated L2 learners antecedent preferences for demonstratives is striking. Furthermore, for pronouns, at higher levels of attrition, processing seemed to break down under additional processing load, and showed similar patterns to

those observed in L2 learners. Sorace & Filiaci (2006) found that near-native speakers were able to form the syntactic dependencies generated between a null pronoun and its antecedent in Italian: it is possible that very high proficiency L2 learners do not suffer from a resource limitation, in the same way as native speakers who experience low levels of attrition. In summary, this thesis contributes to the literature on L1 attrition, by providing evidence for underlying cause of the differences observed between native speakers undergoing attrition and other native speakers.

7.3.4 L2 processing

The starting point for this thesis was Sorace & Filiaci's (2006) Interface Hypothesis, which states that L2 learners show residual difficulty at interface of syntax with other cognitive domains, such as discourse, and do not show converging behaviour with native speakers. The data presented in this thesis show that L2 learners do seem to show difficulty with the syntax-discourse phenomena presented in this thesis. However, although these L2 learners were not near-native, and thus could potentially have achieved convergence with native speakers at a later stage in acquisition, this thesis contributes to our understanding of the nature of L2 learners' difficulties at the syntax-discourse interface. Previously these difficulties have been considered in terms of either a representational or a processing deficit. A representation deficit would entail that the underlying representations were unavailable for processing (Clahsen & Felser 2006*b*), while a processing deficit is typically discussed in terms of a limitation on processing resources (Sorace & Filiaci 2006). However, these are not the only options: a resource allocation deficit is also possible, caused when there are competing constraints, for example from each of an L2 learner's languages. The constraint which does not have sufficient activation, perhaps due to lack of exposure to input supporting that constraint, is outcompeted by the other constraint, resulting in non-targetlike behaviour. The behaviour of L2 learners with respect to the antecedent preference of pronouns, which form a syntactic dependency with their antecedents suggests a resource limitation is causing non-targetlike behaviour, while their behaviour with respect to demonstratives is suggestive of a resource allocation deficit.

The results observed in Experiment 2, where L2 learners appeared to show difficulty maintaining a mental representation of discourse participants in certain conditions is suggestive of a processing limitation: in the conditions with OVS word order (processed with more difficulty by L2 learners at lower proficiency levels (Wilson 2005)) and a pronoun, processing was disrupted. Since the increased difficulty observed by L2 learners when processing pronouns is similar to that observed in patients with Alzheimer's disease (Almor et al. 1999), a population which has a well documented working memory difficulty, it seems plausible that L2 learners' behaviour with respect to this phenomenon is a result of a resource limitation. Interestingly, in Experiment 2 participants showed a clear effect of proficiency; it is possible that as proficiency increases that processing would become more automatic, such that the resource limitation would diminish, resulting in greater, if not complete convergence with native speakers.

Do L2 learners really have a deficit?

Throughout the thesis L2 learners' behaviour with respect to the syntax-discourse interface has been discussed in terms of convergence with native speakers (targetlike behaviour), and a lack of convergence is described in terms of *difficulty* or a *deficit*. This follows the traditional view of second language acquisition, where success is equated with nativelike behaviour (Lardiere 2006). However, comparing L2 learners to monolingual native speakers is questionable for several reasons.

Traditionally, the target for L2 acquisition has been taken to be an adult monolingual speaker of the language in question, an idea based on Chomsky's (1965) ideal-speaker hearer, who exists in a homogenous speech community. However it is not clear that this is a meaningful comparison; rather than monolingualism being the norm, bilingualism is more common in many parts of the world; even in relatively monolingual societies such as in England, many people have had at least some exposure to another language. Furthermore, there are languages, such as Welsh (Welsh Assembly Government 2003), where are now very few monolingual native speakers, with the vast majority having extensive knowledge of English, so a comparison with a monolingual speaker can hardly be said to be representative of Welsh speakers in general.

Conversely, Graddol (2007) reports that there are more non-native speakers of English than native speakers, so the traditional comparison of L2 learners of English to native speakers is debatable. The extent to which L2 learners' behaviour converges on monolingual native speakers' behaviour is a question not only of the limits of acquisition post-critical period, but the extent to which a bilingual's two languages influence each other.

The native speaker data presented in this thesis highlight this issue: in Chapters 5 and 6 attrition effects in native speaker who had been resident in Great Britain for relative short periods of time were observed, which interacted with the amount of German input which they were receiving. Native speaker behaviour, therefore, is not as stable as has perhaps previously been assumed, so a careful consideration of the characteristics of the native speaker control group is necessary.

If comparing L2 learners to monolingual native speakers is questionable, what should we use as a comparison? The resource allocation/limitation account provides a starting point. If one apparent difficulty, or difference from monolingual native speakers which L2 learners show is resource allocation, caused at least in part by competition from another language, comparison with adult early bilinguals who also have competition with other languages would allow a better comparison, as only one feature, namely the age of acquisition of one of their two languages would be different. Of course, it would also be necessary to control the amount and quality of input from each language, as this was also shown to be a factor. Table 7.1 shows a summary of the features of a selection of different population. Although this summary is clearly a simplification, it highlights the nature of the comparisons which are commonly made in the literature. For example, monolingual and bilingual children are frequently compared (e.g. Müller & Hulk (2001)), however, as noted by Argyri (2006) and Argyri & Sorace (2007), levels of input are also important, so this factor should be taken into account in such research. As regards L2 acquisition, when comparing L2 learners with adult monolinguals, all of the factors listed are different: age of acquisition, competition from another language, developing language system, and potentially level of input. Comparison with adult early bilinguals would reveal the effect of age of acquisition. A comparison with native speakers undergoing attrition is more

controversial: although both L2 learners and native speakers undergoing attrition can both be said to have a developing language system, the direction of the development is generally considered to be in opposite directions. The effect of competition from another language may differ depending on the age of acquisition of that language. However, it is perhaps no less problematic than comparing L2 learners with monolingual native speakers, as the external, environmental conditions are more similar for these two groups. Table 7.1 also highlights the importance of research on near-native speakers in L2 acquisition, because they show the differences between developing L2 learners, and the ultimate attainment which is possible in L2 acquisition (see Sorace (2003) for further discussion of the role of near-natives in L2 acquisition research). To summarize, this thesis highlights the fact that native speaker competence is not as stable as has previously been thought, and that comparing L2 learners' behaviour to monolingual native speakers is not necessarily the most appropriate comparison.

	pre-critical period acquisition	competion from another language	developing language system	quantity of input
monolingual children	Yes	No	Yes	High
bilingual children	Yes	Yes	Yes	High/Low
developing L2 acquisition	No	Yes	Yes	High/Low
L2 (near-native)	No	Yes	No	High/Low
adult early bilinguals	Yes	Yes	No	High/Low
adult monolinguals	Yes	No	No	High
L1 attrition	Yes	Yes	Yes	Low

Table 7.1: Features of different populations of language users

To summarize then, this thesis has provided further evidence of the nature of L2 processing at the syntax-discourse interface, and proposed a framework for considering the underlying cause of the behaviour seen in L2 learners.

7.4 Future Work

Each of the three experimental strands of this thesis raises further research questions. The following sections examine each experimental strand and discuss avenues for future research which stem from the results presented in the thesis. Overall however, since none of the L2 learners who participated in the experiments presented in the thesis could be placed at the near-native level, future work could examine the extent to which near-natives show the same behaviour as lower proficiency L2 learners, to determine whether the observed effects could be attributed, in part at least, to the developing L2 system.

7.4.1 The role of word order and pronominalisation with respect to information structure

Chapter 4 provided evidence that L2 learners find lexical NPs easier to process than pronouns. Future work in this area could investigate the lack of a repeated name penalty in L2 learners, and compare the extent to which different types of anaphors cause processing difficulty.

Experiment 1 did not find an informational structure effect of word order in native speakers of German, contrary to predictions. Future work could examine the role of other factors, such as prosody, in combination with word order as it is possible that certain syntactic options are associated with particular prosodic patterns, and the lack of appropriate prosody obscures any information structural effects.

7.4.2 Antecedent properties of anaphoric demonstratives and pronouns

In Chapter 5 the role of three factors in determining the antecedent preferences of anaphoric demonstratives and pronouns were examined: grammatical role, topicalisation and thematic role. However, it is possible that other factors, such as animacy and the discourse status (i.e. discourse-new or old) could play a role. Future work in this area could examine these factors. Similarly, it

seems as though L2 learners do not use the same constraints as native speakers, however, it is not clear to what extent the use of different constraints is a feature of input levels or a consequence of bilingualism.

7.4.3 Simulating L2 learners' difficulties in native speakers

Chapter 6 presented a novel use of the visual-world paradigm as part of a dual task experimental paradigm. Future work in this area could explore the effect of different additional tasks on language processing, and the link between language and eye-movements. This would contribute to theories of language comprehension, working memory and visual processing.

The effect of additional processing load on language processing in different developmental and bilingual populations can contribute to our understanding of the nature of language processing in these populations, by exploring the role of processing resource limitations in language processing. A comparison of early bilinguals with L2 learners, native speakers undergoing attrition, and monolinguals would enable a more detailed picture of the nature of the differences between these groups to emerge. The resource allocation/limitation framework provides a clear framework for understanding these differences.

7.5 Conclusion

In this final chapter I have summarized the major findings of the thesis, chapter by chapter and thematically, and discussed possibilities for future work. This thesis contributes to our understanding of both native speaker processing and L2 processing, as well as providing a framework for future work in the area of bilingual processing at the syntax-discourse interface.

APPENDIX A

Experimental Materials for Experiments 1-3

A.1 Experiments 1-3

The same images were used for Experiments 1-3. Experiments 1 and 2 used the same sentences, Experiment 3 used an English translation of these sentences.

A.1.1 Experiments 1-3 Images

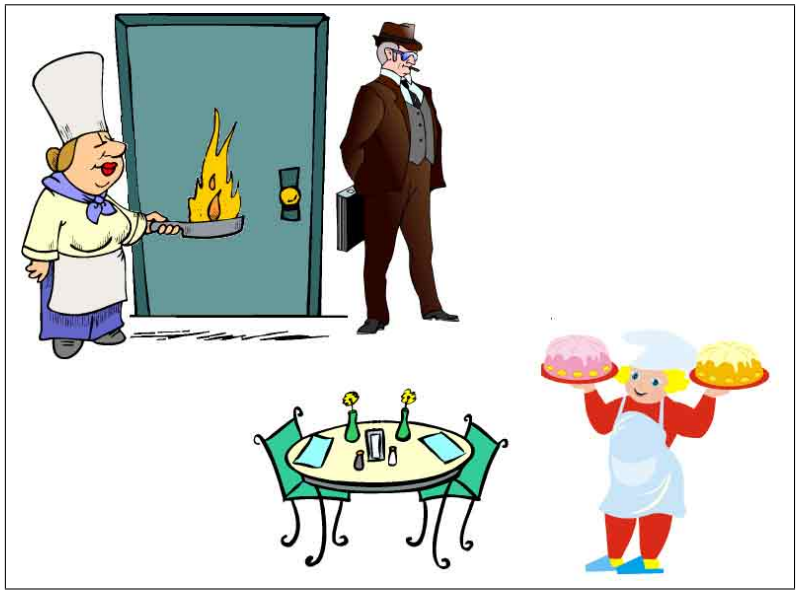

Figure A.1: Item 1

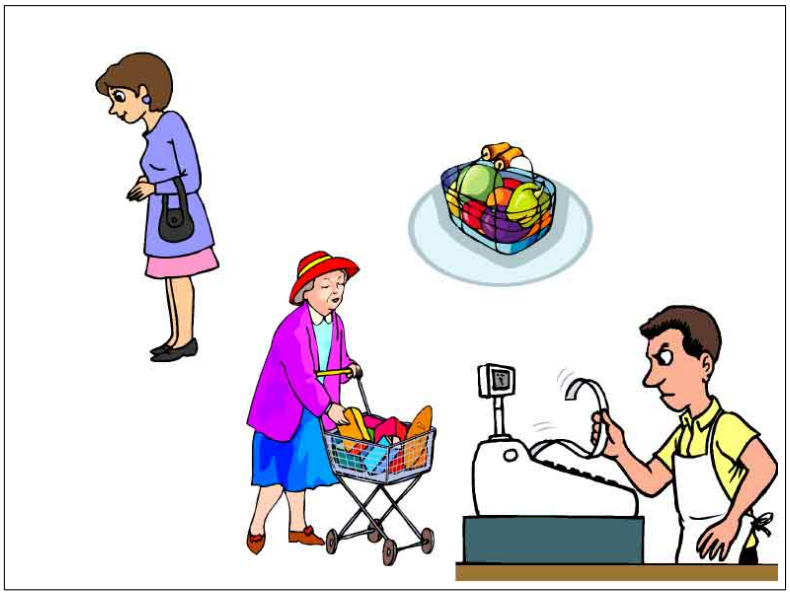

Figure A.2: Item 2

Figure A.3: Item 3

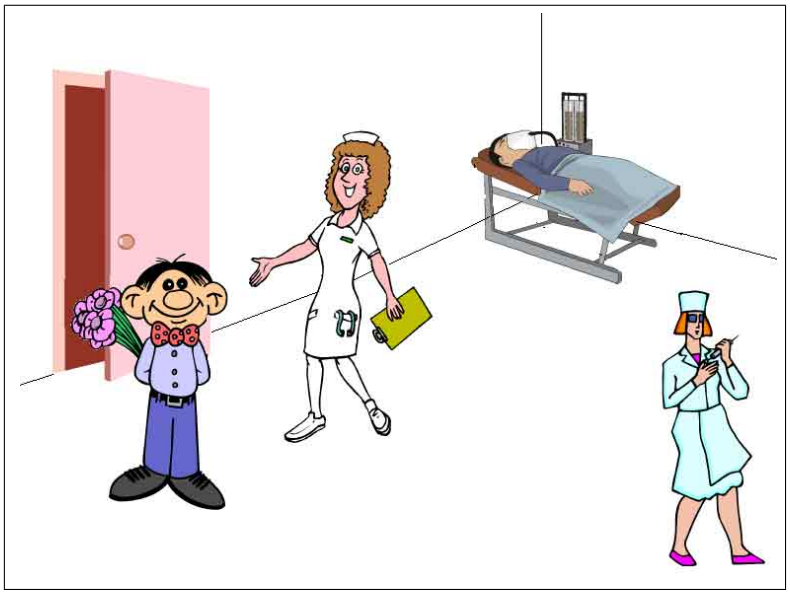

Figure A.4: Item 4

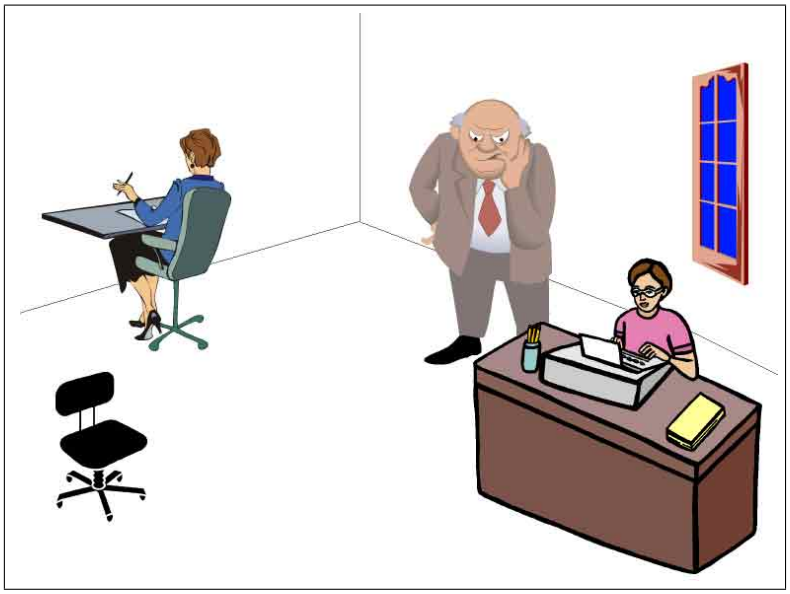

Figure A.5: Item 5

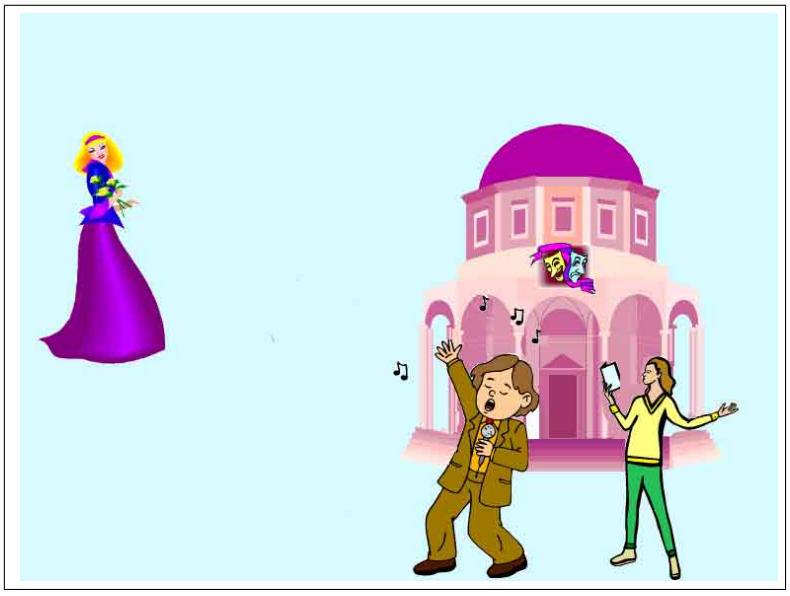

Figure A.6: Item 6

Figure A.7: Item 7

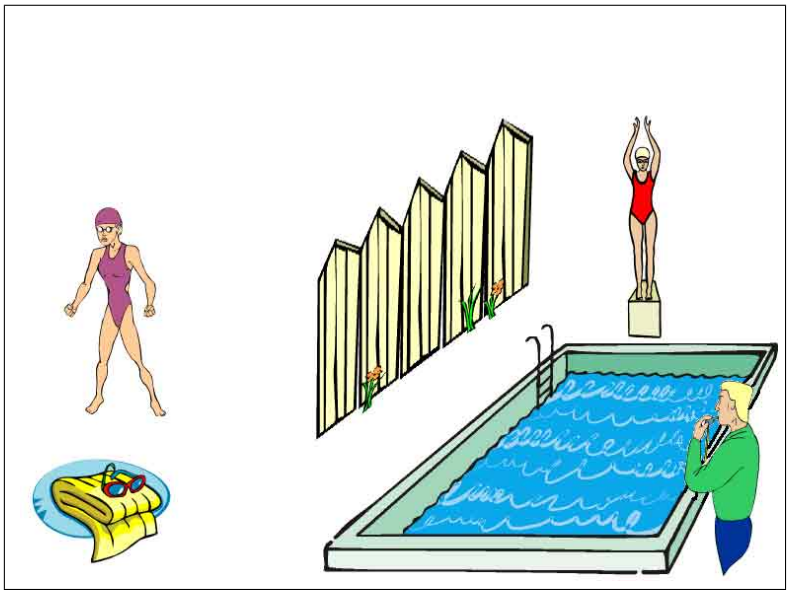

Figure A.8: Item 8

Figure A.9: Item 9

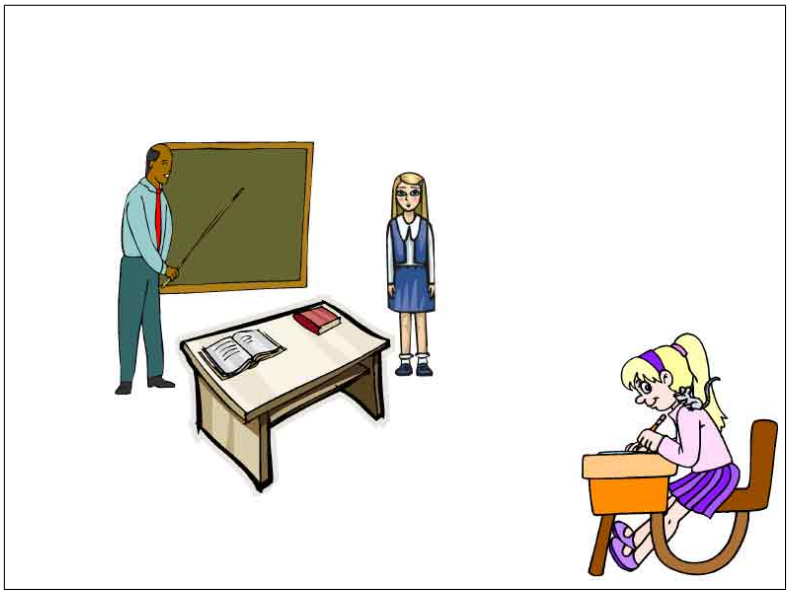

Figure A.10: Item 10

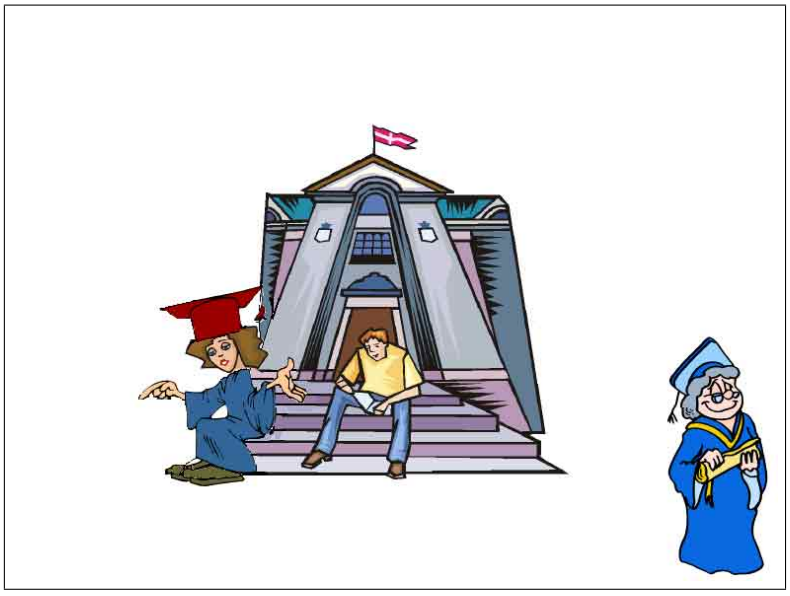

Figure A.11: Item 11

Figure A.12: Item 12

Figure A.13: Item 13

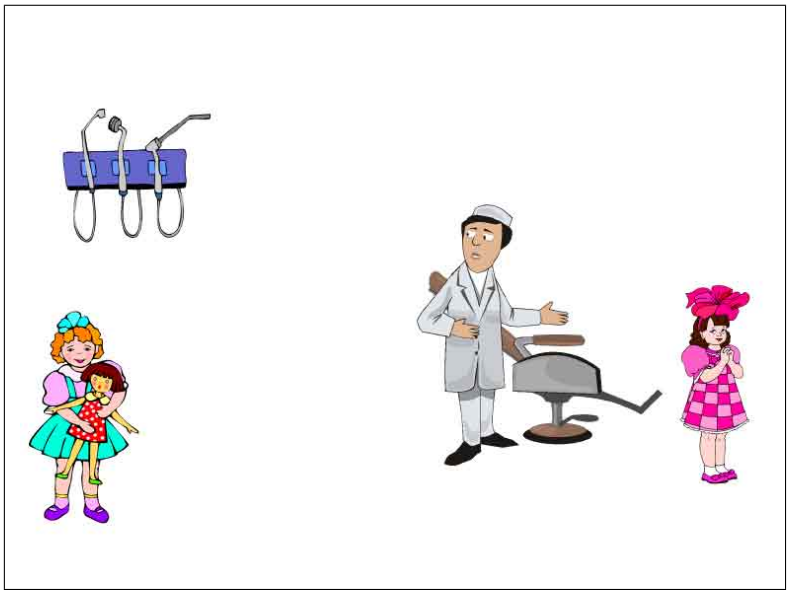

Figure A.14: Item 14

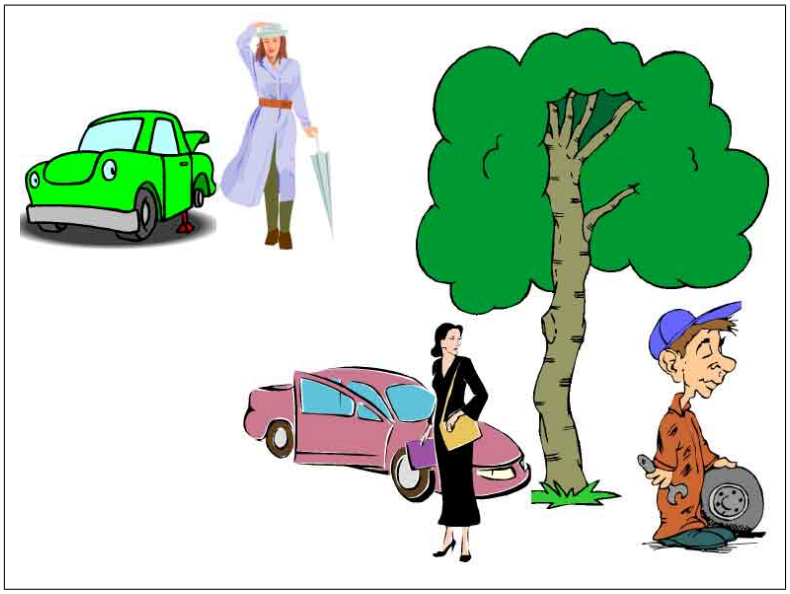

Figure A.15: Item 15

Figure A.16: Item 16

Figure A.17: Item 17

Figure A.18: Item 18

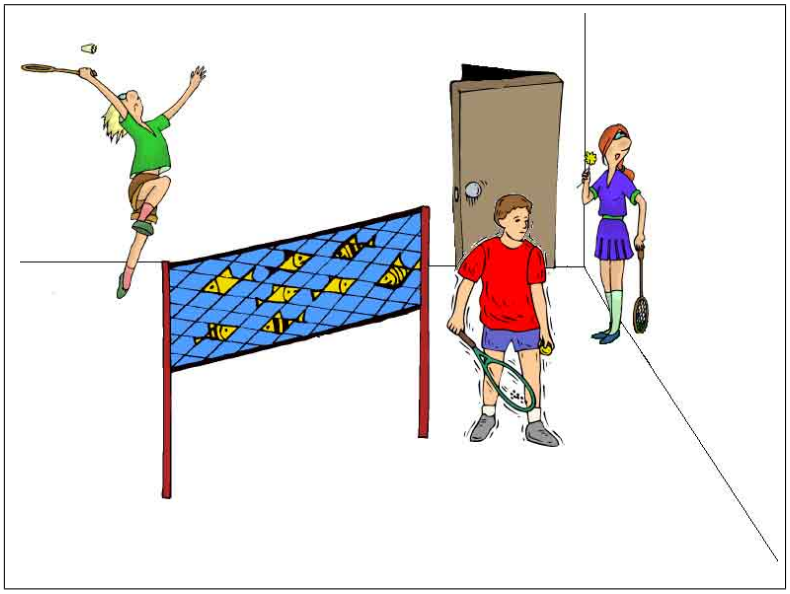

Figure A.19: Item 19

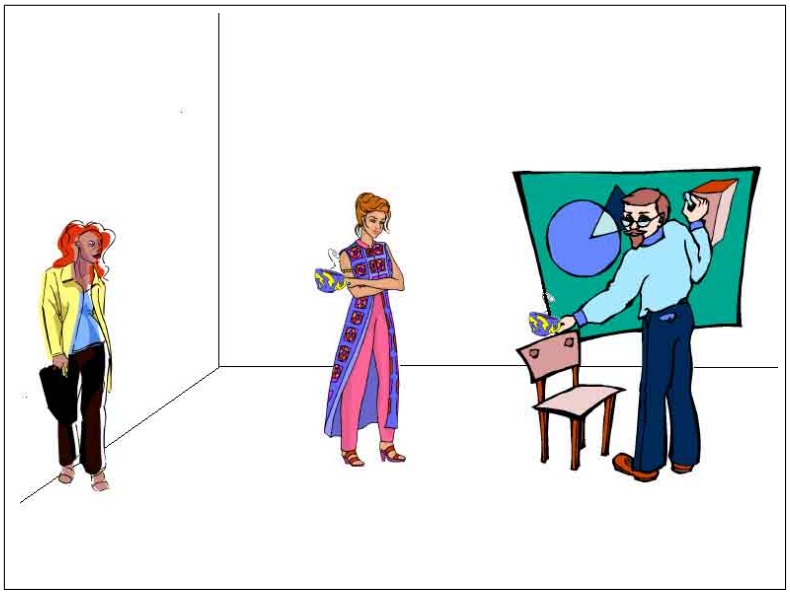

Figure A.20: Item 20

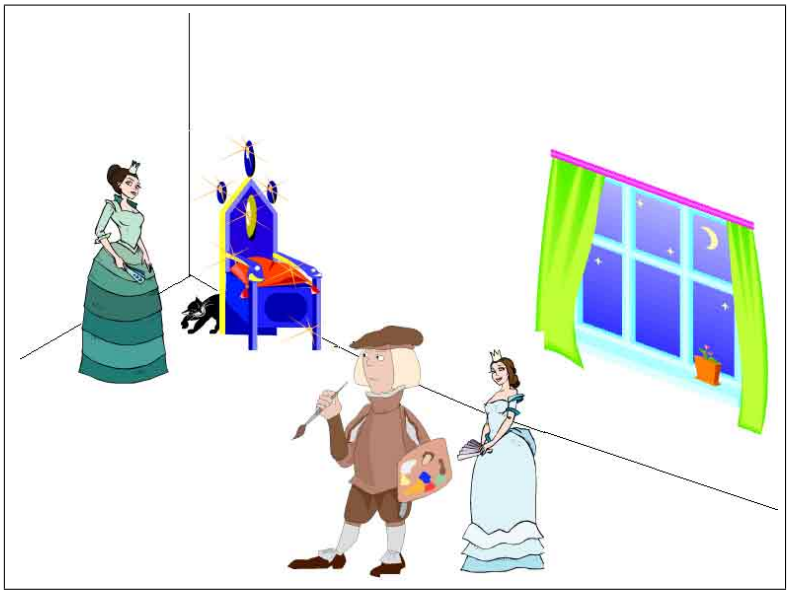

Figure A.21: Item 21

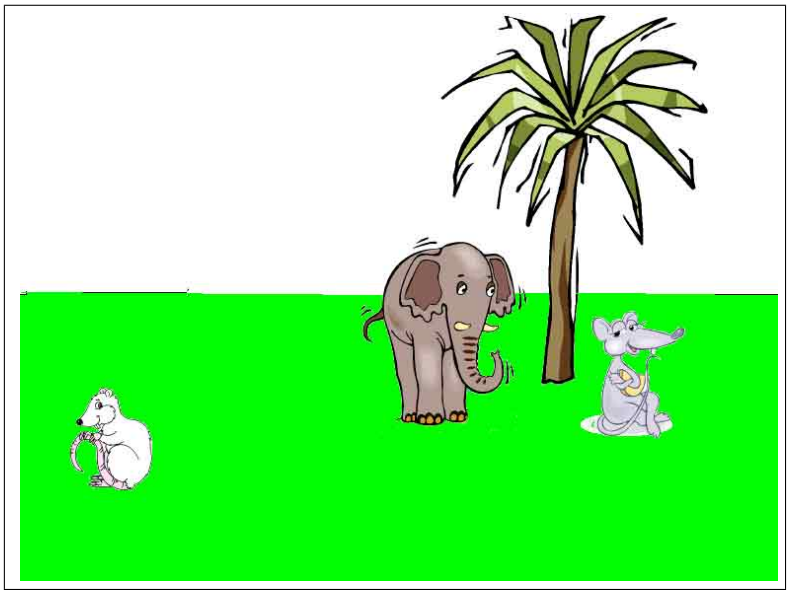

Figure A.22: Item 22

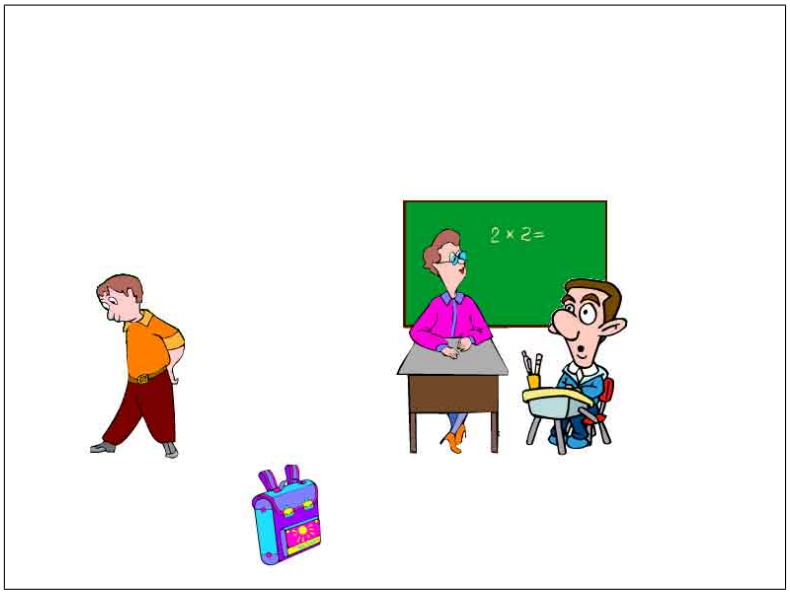

Figure A.23: Item 23

Figure A.24: Item 24

Figure A.25: Item 25

Figure A.26: Item 26

Figure A.27: Item 27

Figure A.28: Item 28

A.1.2 Sentences used in Experiments 1 and 2

The first item listed shows all experimental conditions.

(A.1) a. *Es ist Mittagszeit in einem Restaurant. Ein Geschäftsmann*
it is lunch.time in a restaurant. a businessman
und eine Köchin stehen neben der Tür.
and a cook stand next.to the door
It is lunch time in a restaurant. A businessman and a cook are standing next to the door.

b. *Der Geschäftsmann begrüβt möglicherweise die Köchin.*
the.nom businessman greets probably the cook
The business man greets probably the cook.

c. *Den Geschäftsmann begrüβt möglicherweise die Köchin.*
the.acc businessman greets probably the cook
The businessman is prbably greeted by the cook.

d. *Er begrüβt möglicherweise die Köchin.*
he greets probably the cook
He greets prbably the cook.

e. *Ihn begrüβt möglicherweise die Köchin.*
him greets probably the cook.
He is probably greeted by the cook.

(A.2) a. *Es ist Samstag morgen im Geschäft. Ein Kassierer*
it is Saturday morning in.the shop. a cashier
und eine Frau sprechen miteinander.
and a woman speak with.each.other
It is Saturday morning in the ship. A cashier and a woman speak with each other.

b. *Der Kassierer mag offensichtlich die Frau.*
the.nom cashier likes apparently the woman
The cashier likes apparently the woman.

(A.3) a. *Es ist nachmittag im Krankenhaus. Ein Patient und*
it is afternoon in.the hospital. a patient and
eine Ärztin sitzen auf einem Bett.
a doctor sit on a bed
It is afternoon in the hsopital. A patient and a doctor sit on a bed.

b. *Der Patient ruft natürlich die Ärztin.*
the.nom patient calls naturally the doctor
Naturally the patient calls the doctor.

(A.4) a. *Es ist Montag nachmittag im Krankenhaus. Ein Besucher und eine Krankenschwester stehen an der Tür.*
it is Monday afternoon in.the hospital. A visitor and a nurse stand at the door
It is Monday afternoon in the hospital. A visitor and a nurse stand at the door.

b. *Der Besucher ruft offensichtlich die Krankenschwester.*
the.nom visitor calls apparently the nurse
The visitor calls apparently the nurse.

(A.5) a. *Es ist 5 Uhr abends im Büro. Ein Chef und eine Sekretärin arbeiten am Fenster.*
it is 5 o'clock evening in.the office. a boss and a secretary work at.the window
It is 5 o'clock in the evening in the office. A boss and a secretary work at the window.

b. *Der Chef liebt offensichtlich die Sekretärin.*
the.nom boss loves apparently the secretary
The boss loves apparently the secretary.

(A.6) a. *Es ist Freitag abend. Ein Sänger und eine Schauspielerin stehen vor dem Theater.*
it is Friday evening. a singer and an actress stand before the theatre
It is Friday evening. A singer and an actress stand in front of the theatre.

b. *Der Sänger kennt wahrscheinlich die Schauspielerin.*
the.nom singer knows probably the actress
The singer knows probably the actress.

(A.7) a. *Es ist Mittag. Ein Taxifahrer und eine Japanerin warten neben der Bushaltestelle.*
it is noon. a taxidriver and a japanese.lady wait next.to the bus.stop
It is noon. A taxidriver and a Japanese lady wait next to the bus stop.

b. *Der Taxifahrer mag offensichtlich die Japanerin.*
the.nom taxidriver likes apparently the Japanese.lady
The taxidriver likes apparently the Japanese lady.

(A.8) a. *Es ist 6 Uhr früh im Sportzentrum. Ein Trainer*
it is 6 o'clock early in.the sport.centre. a trainer
und eine Sportlerin sind im Schwimmbad.
and a sportswoman are in.the swimming.pool
It is 6 o'clock in the morning in the sports centre. A trainer and a sportswoman are in the swimming pool.

b. *Der Trainer sieht wahrscheinlich die Sportlerin.*
the.nom trainer sees probably the sportswoman
The trainer sees probably the sportswoman.

(A.9) a. *Es ist Samstag nachmittag im Sportzentrum. Ein*
it is Saturday afternoon in.the sport.centre. a
Schwimmer und eine Tennisspielerin sitzen auf einer Bank.
swimmer and a tennis.player sit on a bench
It is Saturday afternoon in the sports centre. A swimmer and a tennis player sit on a bench.

b. *Der Schwimmer mag offensichtlich die Tennisspielerin.*
the.nom swimmer likes apparently the tennis.player
The swimmer likes apparently the tennis player.

(A.10) a. *Es ist Mittagspause in der Schule. Ein Lehrer und eine*
it is lunch.break in the school. a teacher and a
Schülerin stehen am Tisch.
pupil sit at.the table
It is lunch.break in the school. A teacher and a pupil sit at the table.

b. *Der Lehrer ruft natürlich die Schülerin.*
the.nom teacher calls naturally the pupil
The teacher calls naturally the pupil.

(A.11) a. *Es ist 9.00 morgens in der Uni. Ein Student und eine*
it is 9.00 morning in the uni. a student and a
Professorin sitzen vor der Tür.
professor sit before the door
It is 9.00 in the morning in the uni. A student and a professor sit in front of the door.

b. *Der Student informiert sicherlich die Professorin.*
the.nom student informs surely the professor
Surely the student informs the professor.

(A.12) a. *Es ist nachmittag im Konzertsaal. Ein Komponist und*
it is afternoon in.the concert.hall. a composer and
eine Musikerin stehen auf der Bühne.
a musician stand on the stage
It is afternoon in the concert hall. A composer and a musician stand on the stage.

b. *Der Komponist liebt offensichtlich die Musikerin.*
the.nom composer loves apparently the musician
The composer loves apparently the musician.

(A.13) a. *Es ist Mitternacht. Ein Polizist und eine Diebin stehen*
it is midnight. a policeman and a thief stand
neben der Tür.
near the door
It is midnight. A policeman and a thief stand near the door.

b. *Der Polizist kennt offensichtlich die Diebin.*
the.nom policeman knows apparently the thief
The policeman knows apparently the thief.

(A.14) a. *Es ist Mittwoch früh beim Zahnarzt. Ein Zahnarzt*
it is Wednesday early at.the dentist. a dentist
und ein Kind warten neben dem Stuhl.
and a child wait near the chair.
It is Wednesday morning at the dentist's. A dentist and a child wait near the chair.

b. *Der Zahnarzt begrüßt selbstverständlich das Kind.*
the.nom dentist greets of.course the child.
Of course the dentist greets the child.

(A.15) a. *Es ist Montag nachmittag. Ein Mechaniker und eine*
it is Monday afternoon. a mechanic and a
Autofahrerin warten unter dem Baum.
car.driver wait under the tree
It is Monday afternoon. A mechanic and a car driver wait under the tree.

b. *Der Mechaniker fragt natürlich die Autofahrerin.*
the.nom mechanic asks naturally the car.driver
The mechanic asks naturally the car.driver.

(A.16) a. *Es ist Freitag früh im Postamt. Ein Rentner und*
it is Friday early in.the post.office. a pensioner and
eine Briefträgerin warten neben dem Tisch.
a post.woman wait near the table
It is Friday morning in the post office. A pensioner and a postwoman wait near the table.

b. *Der Rentner ruft wahrscheinlich die Briefträgerin.*
the.nom pensioner calls probably the post.woman
The pensioner calls probably the post.woman.

(A.17) a. *Es ist 16.30 im Flughafen. Ein Pilot und eine Reisende*
it is 16.30 in.the airport. a pilot and a traveller
warten an der Passkontrolle.
wait at the passport.control
It is 16.30 in the airport. A pilot and a traveller wait at passport control.

b. *Der Pilot informiert sicherlich die Reisende.*
the.nom pilot informs surely the traveller
The pilot surely informs the traveller.

(A.18) a. *Es ist Freitag abend im Theater. Ein Schauspieler*
it is Friday evening in.the theatre. an actress
und eine Sängerin warten unter der Uhr.
and a singer wait under the clock
It is Friday evening in the theatre. An actress and a singer wait under the clock.

b. *Der Schauspieler liebt offensichtlich die*
the.actor loves apparently the singer
Sängerin.

The actor loves apparently the singer.

(A.19) a. *Es ist Montag abend im Sportzentrum. Ein*
it is Monday evening in.the sport.centre. a
Tennisspieler und eine Badmintonspielerin warten neben der
tennis.player and a badminton.player wait near the
Tür.
door.
It is Monday evening in the sports centre. A tennisplayer and a badminton player wait near the door.

b. *Der Tennisspieler mag offensichtlich die*
the.nom tennis.player likes apparently the
Badmintonspielerin.
badminton.player
The tennisplayer likes apparently the badminton player.

(A.20) a. *Es ist 9.00 in der Universität. Ein Mathematiker und*
it is 9.00 in the university. a mathematician and
eine Studentin trinken einen Kaffee.
a student drink a coffee
It is 9.00 in the university. A mathematician and a student drink a coffee.

b. *Der Mathematiker informiert möglicherweise die*
the.nom mathematician informs probably the
Studentin.
student
The mathematician informs probably the student.

(A.21) a. *Es ist Dienstag nachmittag im Palast. Ein Maler und*
it is Tuesday afternoon in.the palace. a painter and
eine Prinzessin warten neben dem Fenster.
a princess wait near the window.
It is Tuesday afternoon in.the palace. A painter and a princess wait near the window.

b. *Der Maler liebt offensichtlich die Prinzessin.*
the.nom painter loves apparently the princess
The painter loves apparently the princess.

(A.22) a. *Es ist Donnerstag nachmittag im Garten. Ein Hund*
it is Thursday afternoon in.the garden. a dog
und eine Maus sitzen neben dem Haus.
and a mouse sit near the house.

It is Thursday afternoon in the garden. A dog and a mouse sit near the hour.

b. *Der Hund sieht offensichtlich die Maus.*
the.nom dog sees apparently the mouse
The dog sees apparently the mouse.

(A.23) a. *Es ist Dienstag nachmittag in der Schule. Ein Schüler*
it is Tuesday afternoon in the school. a pupil and
und eine Lehrerin sitzen am Fenster.
a teacher sit at the window.
It is Tuesday afternoon in the school. A pupil and a teacher sit at the window.

b. *Der Schüler begrüßt sicherlich die Lehrerin.*
the.nom pupil greets surely the teacher
The pupil surely greets the teacher.

(A.24) a. *Es ist Samstag nachmittag am See. Ein Fischer*
it is Saturday afternoon at.the lake. a fisherman
und eine alte Frau stehen unter einem Baum.
and an old lady stand under a tree
It is Saturday afternoon at the lake. A fisherman and an old lady stand under a tree.

b. *Der Fischer sieht wahrscheinlich die alte Frau.*
the.nom fisherman sees probably the old lady.
The fisherman sees probably the old lady.

(A.25) a. *Es ist 11 Uhr morgens im Stadtzentrum. Ein*
it is 11 o'clock morning in.the city.centre. a
Tourist und eine Polizistin stehen vor der Kirche.
tourist and a policewoman stand before the church
It is 11 o'clock in the morning in the city centre. A tourist and a policewoman stand in front of the church.

b. *Der Tourist begrüßt möglicherweise die Polizistin.*
the.nom tourist greets probably the policewoman
The tourist greets probably the policewoman.

(A.26) a. *Es ist Montag früh im Garten. Ein Briefträger und*
it is Monday early in.the garden. a postman and
eine Gärtnerin stehen neben den Rosen.
a gardener stand near the roses

It is Monday morning in the garden. A postman and a gardner stand near the roses.

b. *Der Briefträger kennt bestimmt die Gärtnerin.*
the.nom postman knows definitely the gardener.
The postman definitely knows the gardener.

(A.27) a. *Es ist Freitag nachmittag beim Metzger. Ein Metzger und eine Frau stehen an der Theke.*
it is Friday afternoon at.the butcher. a butcher and a woman stand at the counter
It is Friday afternoon at the butcher's. A butcher and a woman stand at the counter.

b. *Der Metzger kennt wahrscheinlich die Frau.*
the.nom butcher knows probably the woman.

(A.28) a. *Es ist Mittwoch nachmittag im Sportzentrum. Ein Fussballspieler und eine Basketballspielerin laufen auf dem Sportplatz.*
it is Wednesday afternoon in.the sport.centre. a football.player and a basketball.player run on the sports.field
It is Wednesday afternoon in the sports centre. A football player and a basketball player run on the sports field.

b. *Der Fussballspieler begrüβt möglicherweise die Basketballspielerin.*
the.nom football.player greets probably the basketball.player
The football player greets probably the basketball player.

A.1.3 Sentences used in Experiment 3

The first item listed shows all experimental conditions.

(A.29) a. It is lunchtime in a restaurant. A business man and a cook are standing near the door.

b. The businessman greets unsurprisingly the cook.

c. He greets unsurprisingly the cook

d. The businessman is greeted unsurprisingly by the cook

e. He is greeted unsurprisingly by the cook

(A.30) a. It is Saturday morning in a shop. A cashier and a woman are talking to each other.
b. The cashier likes apparently the woman.

(A.31) a. It is afternoon in a hospital. A patient and a doctor are sitting on a bed.
b. The patient calls seemingly the doctor.

(A.32) a. It is Monday afternoon in a hospital. A visitor and a nurse are standing by the door.
b. The visitor calls unsurprisingly the nurse.

(A.33) a. It is 5 o'clock in an office. A manager and a secretary are working by the window.
b. The manager loves seemingly the secretary.

(A.34) a. It is Friday evening. A singer and an actress are standing in front of the theatre.
b. The singer knows unsurprisingly the actress.

(A.35) a. It is noon. A taxidriver and a Japanese lady are waiting near the bus stop.
b. The taxidriver likes apparently the Japanese lady.

(A.36) a. It is 6 o'clock in a sports centre. A coach and a sportswoman are in the swimming pool.
b. The coach sees undoubtedly the sportswoman.

(A.37) a. It is Saturday afternoon in a sports centre. A swimmer and a tennisplayer are sitting on a bench.
b. The swimmer likes apparently the tennisplayer.

(A.38) a. It is the lunch break in a school. A teacher and a pupil are standing at a table.
b. The teacher calls unsurprisingly the pupil.

(A.39) a. It is 9 o'clock in the morning at the university. A student and a professor are sitting in front of the door.
b. The student informs seemingly the professor.

(A.40) a. It is afternoon in the concert hall. A composer and a musician are standing on the stage.
b. The composer loves apparently the musician.

(A.41) a. It is midnight. A policeman and a thief are standing near the door.
b. The policeman knows surely the thief.

(A.42) a. It is Wednesday morning at the dentist's. A dentist and a child are waiting near the chair.
b. The dentist greets undoubtedly the child.

(A.43) a. It is Monday afternoon. A mechanic and a car driver are waiting under the tree.
b. The mechanic questions unsurprisingly the cardriver.

(A.44) a. It is Friday morning in the Post Office. A pension and a postwoman are waiting next to a table.
b. The pensioner calls undoubtedly the postwoman.

(A.45) a. It is half past four in an airport. A pilor and a traveller are waiting at passport control
b. The pilot informs seemingly the traveller.

(A.46) a. It is Friday evening in the theatre. An actor and a singer are waiting under the clock.
b. The actor loves apparently the singer.

(A.47) a. It is Monday afternoon in the sports centre. A tennis player and a badminton player are waiting next to the door.
b. The tennis player loves surely the badminton player.

(A.48) a. It is 9 o'clock in the university. A mathematician and a student are drinking coffee.
b. The mathematician informs seemingly the student.

(A.49) a. It is Tuesday afternoon in the palace. A painter and a princess are waiting next to the window.
b. The painter loves unsurprisingly the princess.

(A.50) a. It is four o'clock in the railway station. A train driver and a traveller are standing next to the train.
b. The train driver calls undoubtedly the traveller.

(A.51) a. It is Tuesday afternoon in a school A pupil and a teacher are sitting by the window.
b. The pupil greets seemingly the teacher.

(A.52) a. It is Saturday afternoon by the lake. A fisherman and an old lady are standing under a tree.
b. The fisherman sees surely the old lady.

(A.53) a. It is 11 o'clock in the morning in the town centre. A tourist and a policewoman are standing in front of the church.
b. The tourist greets apparently the policewoman.

(A.54) a. It is Monday morning in a garden. A postman and a gardner are standing near the roses.
b. The postman loves apparently the gardner.

(A.55) a. It is Friday afternoon at the butcher's. A butcher and a woman are standing at the counter.
b. The butcher knows seemingly the woman.

(A.56) a. It is Wednesday afternoon in the sports centre. A football player and a basketball player are running on the playing field.
b. The football player greets unsurprisingly the basketball player.

APPENDIX B

Experimental Materials for Experiments 4-9

B.1 Experiment 4

Experiment 4 was a judgement task, in which participants were asked to provide co-reference judgements for either the pre- or post-verbal NP. The first item listed shows all experimental conditions.

B.2 Experiments 5, 7 and 9

The same images and sentences were used in Experiments 5, 7 and 9. In Experiment 9, half of the items were presented as part of a dual task experiment.

B.2.1 Experiments 5,7 and 9 Images

Figure B.1: Item 1

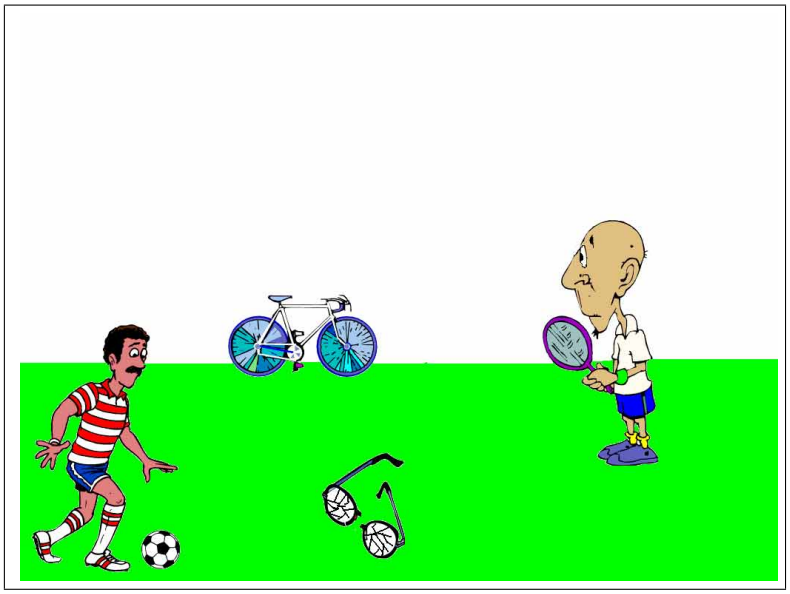

Figure B.2: Item 2

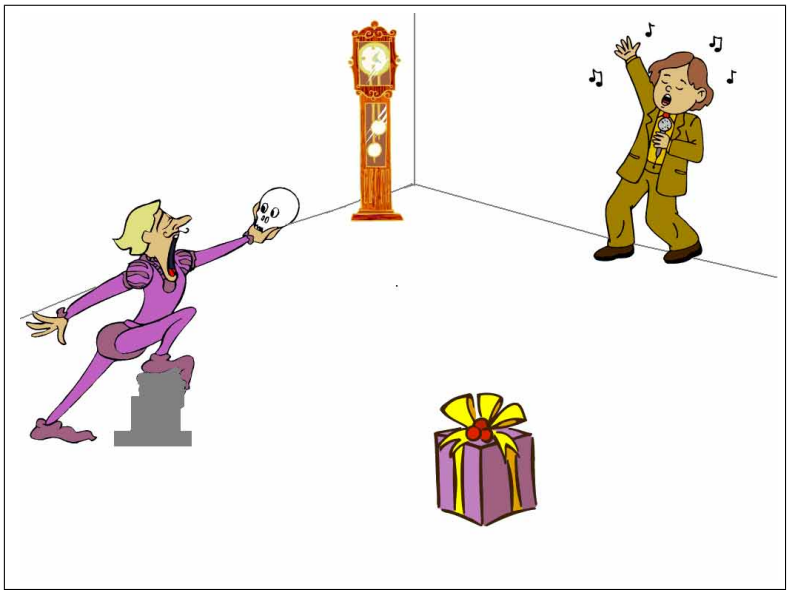

Figure B.3: Item 3

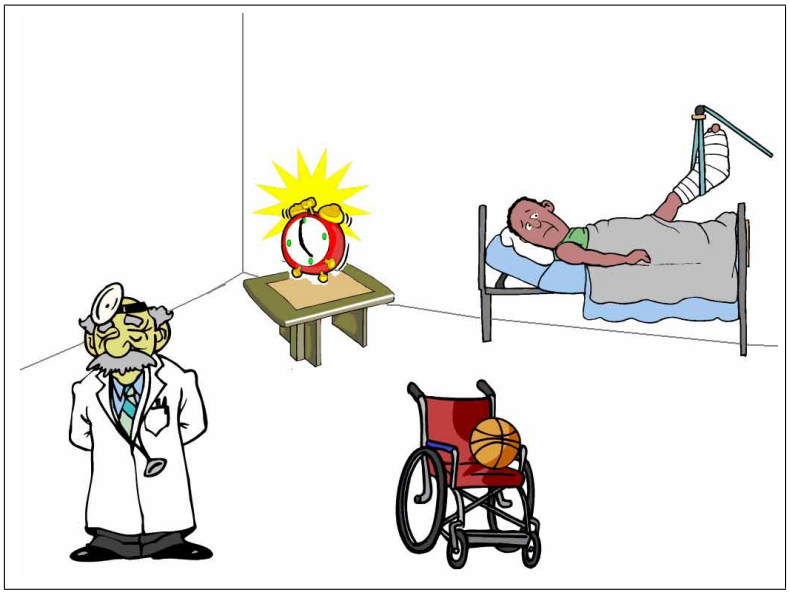

Figure B.4: Item 4

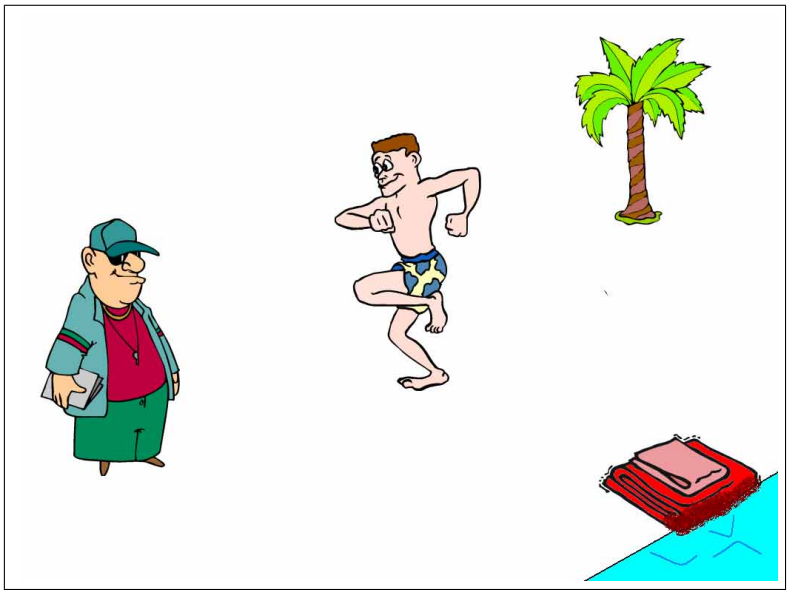

Figure B.5: Item 5

Figure B.6: Item 6

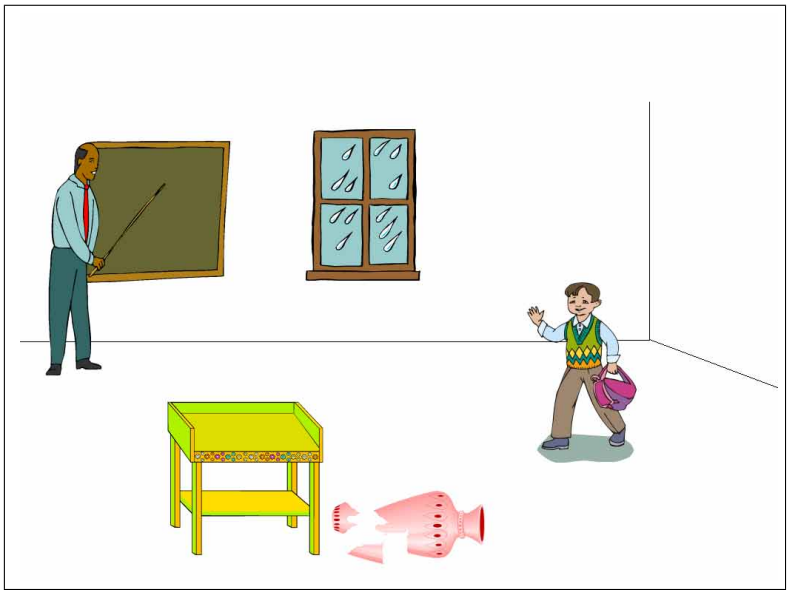

Figure B.7: Item 7

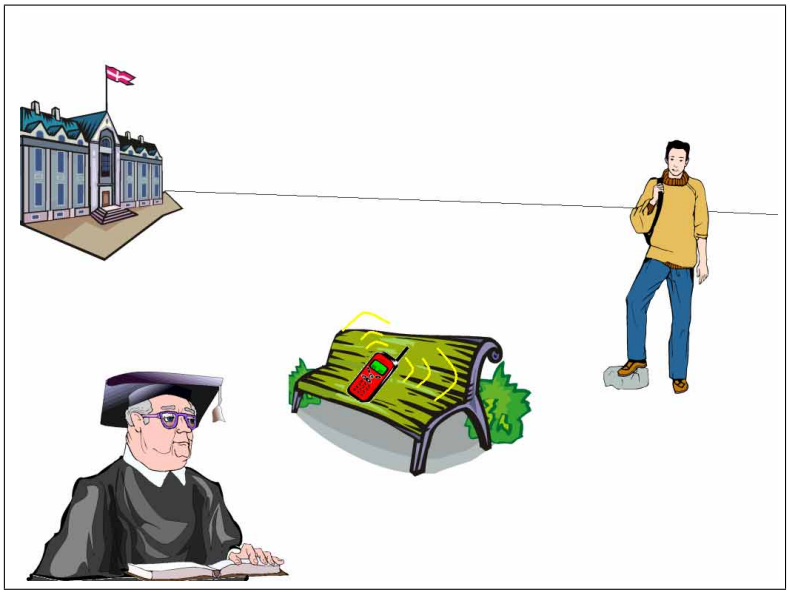

Figure B.8: Item 8

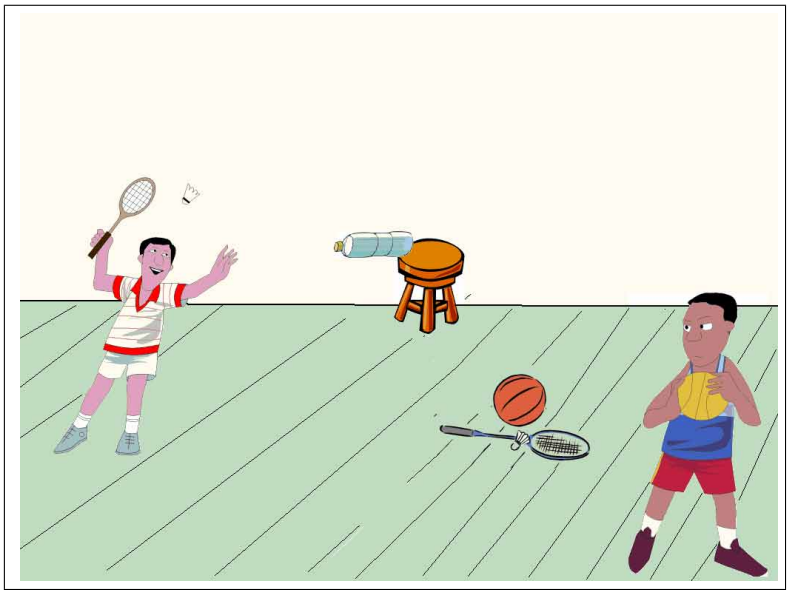

Figure B.9: Item 9

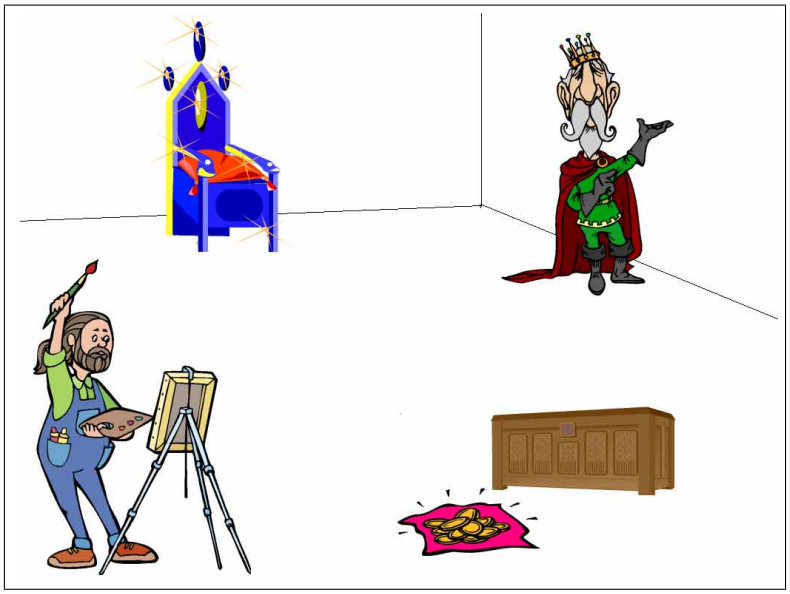

Figure B.10: Item 10

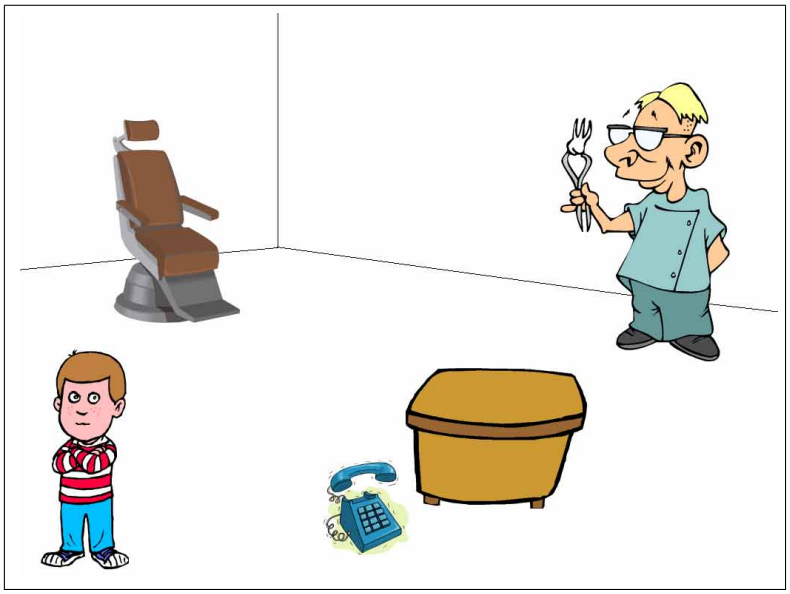

Figure B.11: Item 11

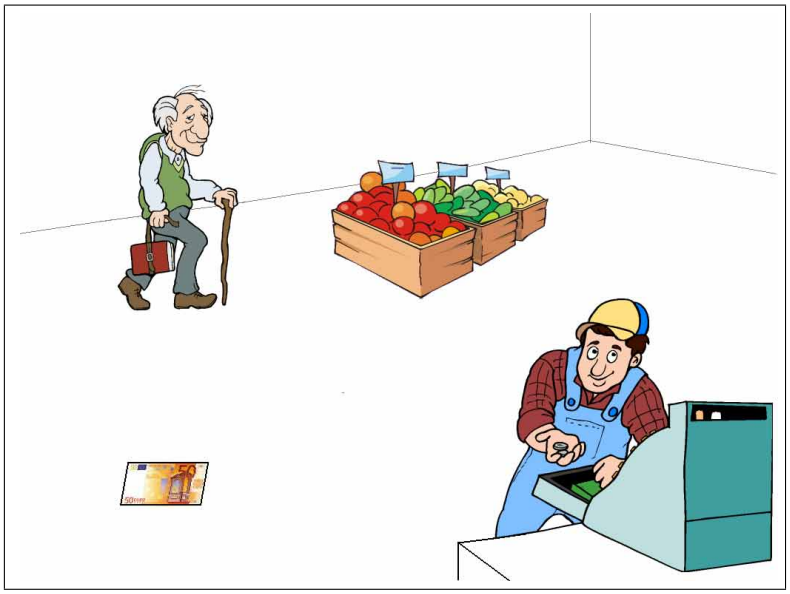

Figure B.12: Item 12

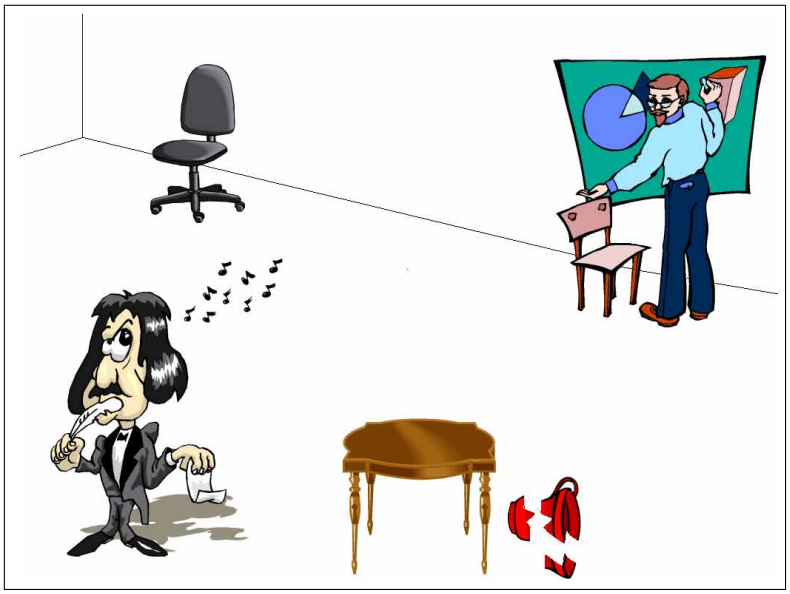

Figure B.13: Item 13

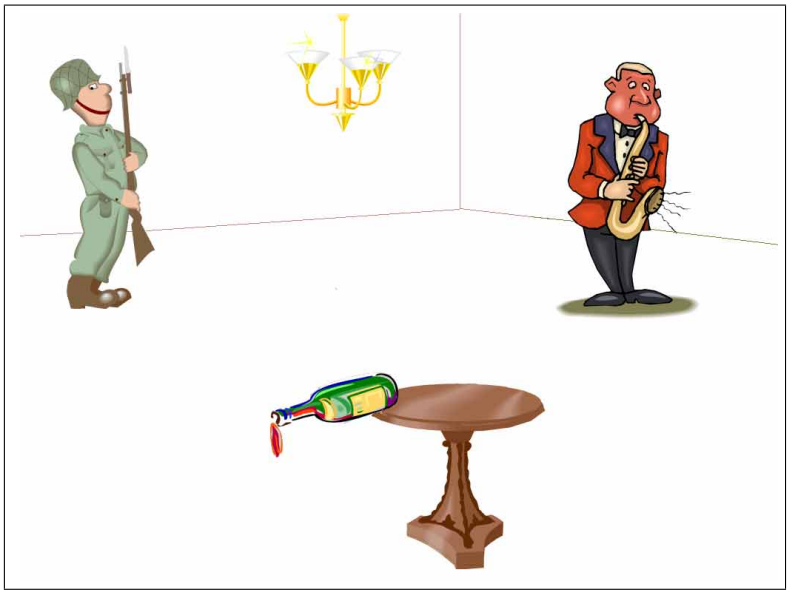

Figure B.14: Item 14

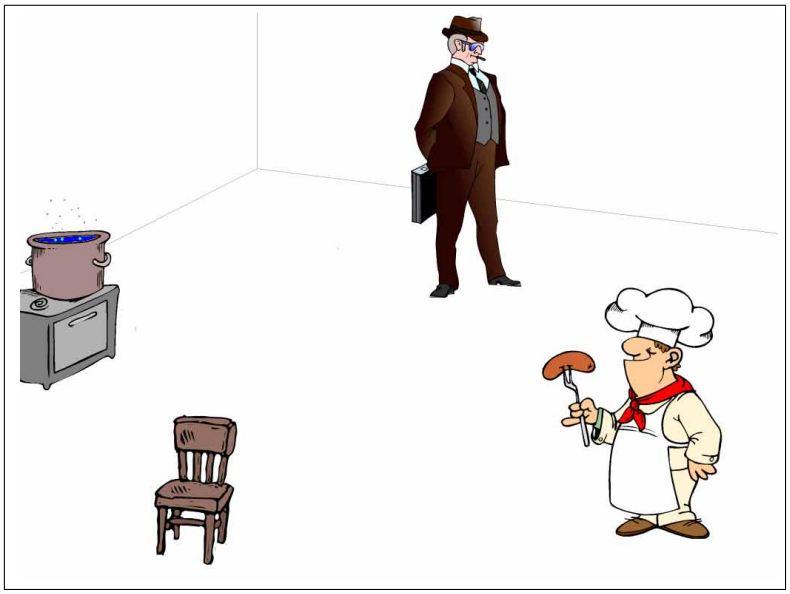

Figure B.15: Item 15

Figure B.16: Item 16

Figure B.17: Item 17

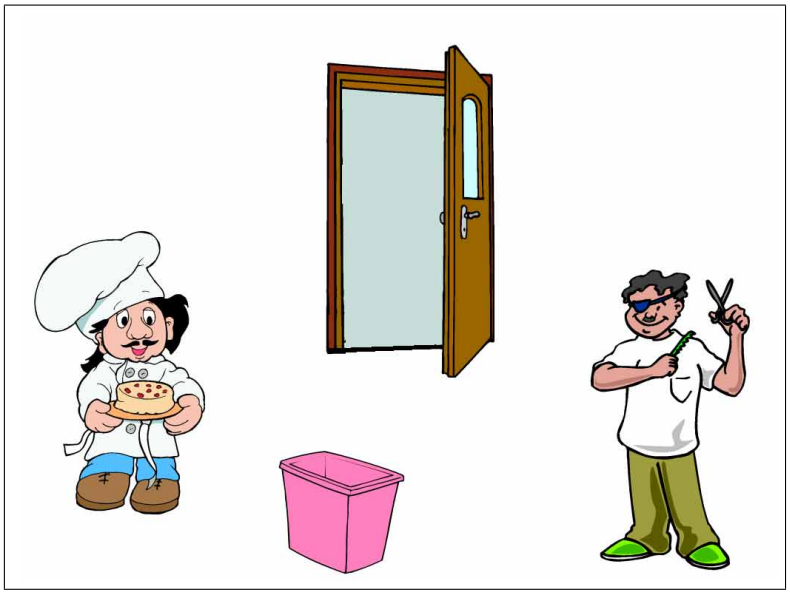

Figure B.18: Item 18

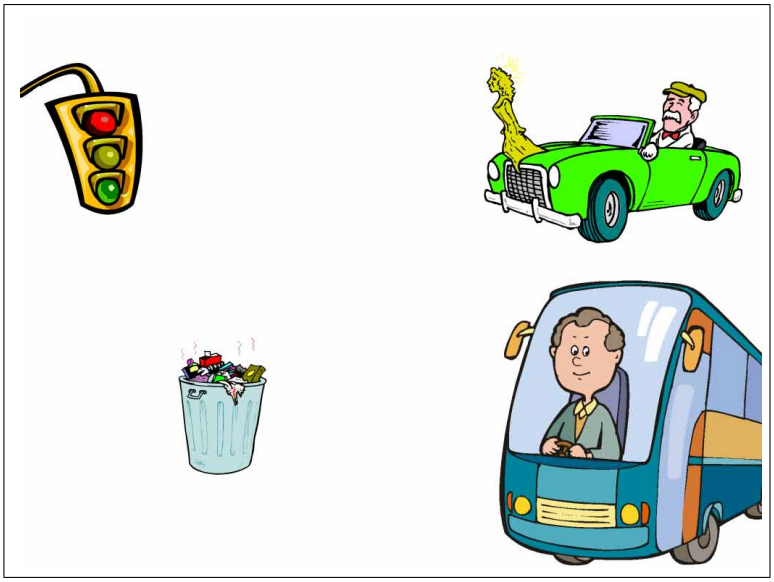

Figure B.19: Item 19

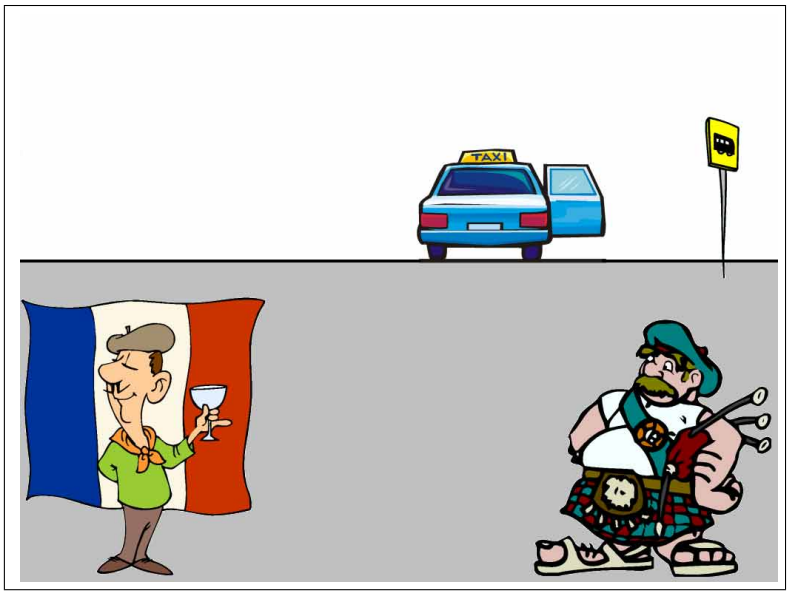

Figure B.20: Item 20

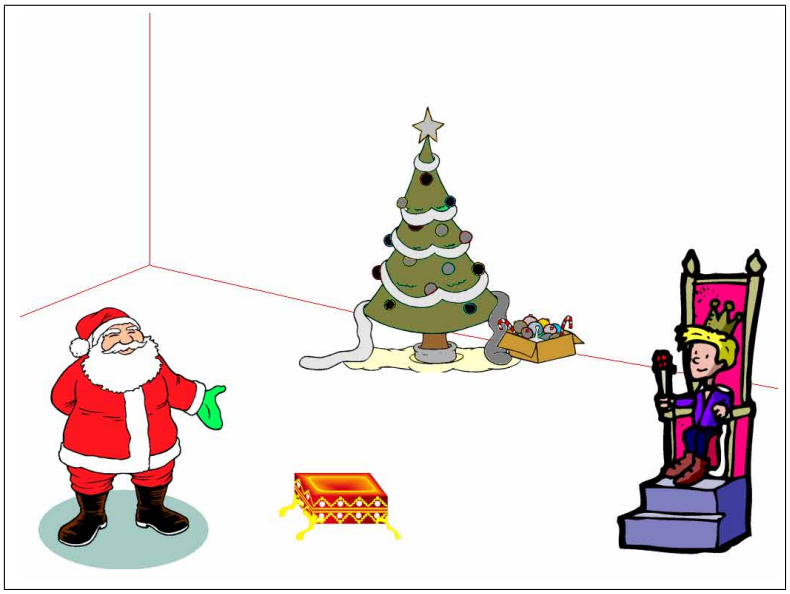

Figure B.21: Item 21

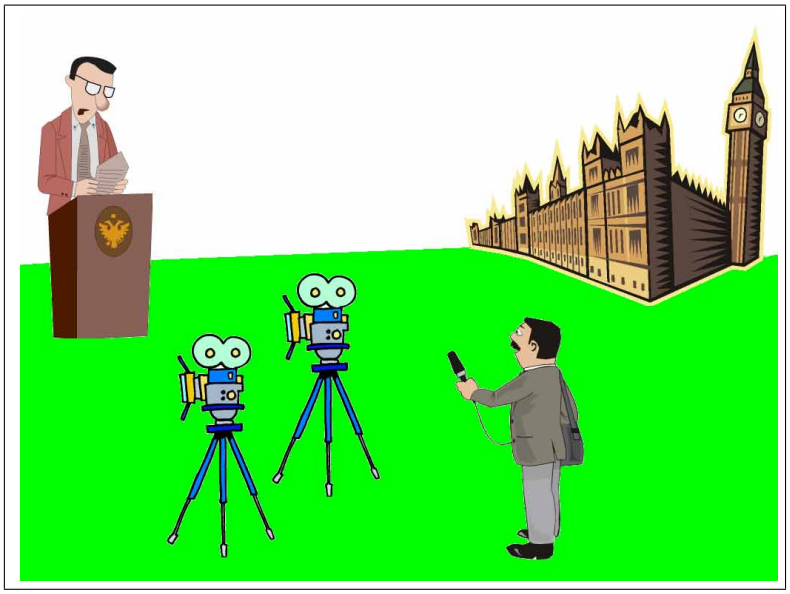

Figure B.22: Item 22

Figure B.23: Item 23

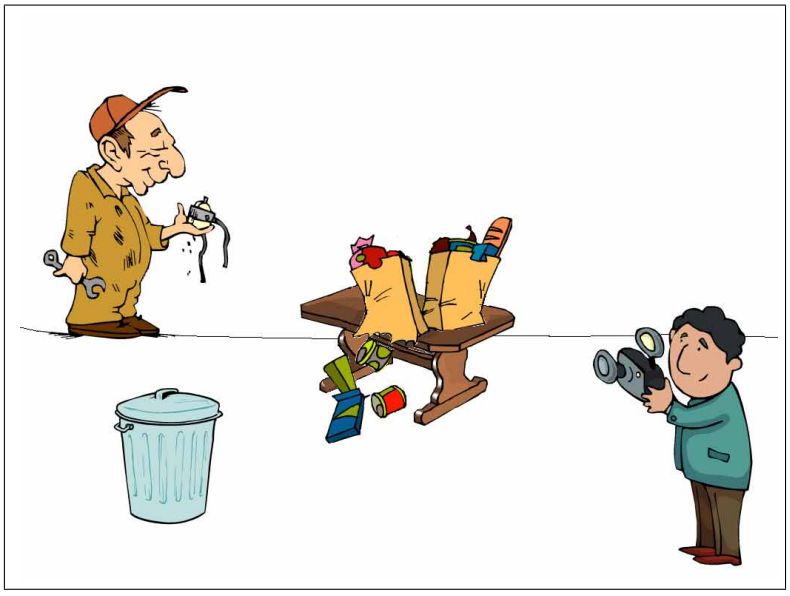

Figure B.24: Item 24

B.2.2 Experiments 5,7 and 9 Sentences

The first item listed shows all experimental conditions.

(B.1) a. *Der Polizist sieht den Dieb, als das Fenster zerbricht.*
the.nom policeman sees the.acc thief as the window breaks.
The policeman sees the thief as the window breaks.

b. *Den Polizist sieht der Dieb, als das Fenster zerbricht.*
the.acc policeman sees the thief as the window breaks.
The policeman is seen by the thief as the window breaks.

c. *Der ist offensichtlich sehr klug.*
he.dem is apparently very clever
He is apparently very clever.

d. *Er ist offensichtlich sehr klug*
he.pron is apparently very clever
He is apparently very clever.

(B.2) a. *Der Tennisspieler nervt den Fussballspieler als die Brille zerbrochen wird.*
the.nom tennisplayer annoys the.acc footballplayer as the glasses are broken
The tennis player annoys the football player as the glasses are broken.

b. *Der scheint offensichtlich sehr egozentrisch zu sein.*
he.dem seems apparently very egocentric to be
He seems to be very egocentric.

(B.3) a. *Der Schauspieler irritiert den Sänger obwohl das Geschenk sehr groβ ist.*
the.nom actor irritates the singer although the gift very large is

b. *Der ist wahrscheinlich sehr launisch.*
he.dem is probably very moody
He is probably very moody.

(B.4) a. *Der Arzt beschimpft den Patient nachdem die Uhr*
the.nom doctor scolds the patient after the clock
geklingelt hat.
rung has
The doctor scolds the patient after the clock has struck.

b. *Der ist sicherlich sehr aufgeregt.*
he.dem is surely very upset.
He is surely very upset.

(B.5) a. *Der Schwimmer sieht den Trainer als das Badetuch*
the.nom swimmer sees the coach as the towel
nass wird.
wet becomes
The swimmer sees the coach as the towel becomes wet.

b. *Der ist offensichtlich aktiv.*
He.dem is apparently active
He is apparently active.

(B.6) a. *Der Taxifahrer bemerkt den Japaner obwohl*
the.nom taxidriver notices the japanese.man although
das Schild sehr groβ ist.
the sign very big is
The taxidriver notices the Japanese man although the sign is very big.

b. *Der ist sicherlich lustig*
he.dem is surely funny
He is surely funny.

(B.7) a. *Der Lehrer observiert den Schüler als die Vase*
The.nom teacher observes the.acc pupil as the vase
zerbricht.
breaks
The teacher observes the pupil as the vase breaks.

b. *Der ist wahrscheinlich anständig*
he.dem is probably well.behaved
He is probably well behaved.

(B.8) a. *Der Professor informiert den Studenten als das*
the.nom professor informs the.acc student as the
Handy klingelt.
mobile.phone rings
The professor informs the student as the mobile phone rings.

b. *Der ist vielleicht müde.*
he.dem is probably tired
He is probably tired.

(B.9) a. *Der Basketballspieler observiert den Tennisspieler*
the.nom basketballplayer observes the.acc tennisplayer
als die Wasserflasche umkippt.
as the water.bottle tips.over
The basketball player observes the tennis player as the water bottle tips over.

b. *Der ist wahrscheinlich dumm*
he.dem is probably dumb.
He is probably dumb.

(B.10) a. *Der König ruft den Maler nachdem das Gold*
the.nom king calls the.acc painter after the gold
auf den Boden gefallen ist.
on the floor fallen is
The king calls the painter after the gold has fallen on the floor.

b. *Der ist offensichtlich charmant*
he.dem is apparently charming
He is apparently charming.

(B.11) a. *Der Zahnarzt ruft den Jungen sobald das*
the.nom dentist calls the.acc boy as.soon.as the
Telefon herunterfällt.
telephone falls.down
The dentist calls the boy as soon as the telephone falls down.

b. *Der ist vielleicht nervös.*
He.dem is probably nervous.

(B.12) a. *Der Kassierer informiert den alten Mann nachdem*
the.nom cashier informs the.acc old man after
ein €50 Schein auf den Boden gefallen ist.
a €50 note on the floor fallen is

The cashier informs the old man after a €50 note fell on the floor.

b. *Der ist wahrscheinlich ehrlich*
he.dem is probably honest
He is probably honest.

(B.13) a. *Der Mathematiker bemerkt den Komponist als die*
the.nom mathematician notices the.acc composer as the
Kaffeetasse zerbricht.
coffee.cup breaks
The mathematician notices the composer as the coffee cup breaks.

b. *Der ist offensichtlich sehr erfolgreich.*
he.dem is apparently very successful.
He is apparently very successful.

(B.14) a. *Der Schauspieler befragt den Musiker als die*
the.nom actor questions the.acc musician as the
Weinflasche umgekippt wird.
wine.bottle knocked.over becomes
The actor questions the musician as the wine bottle is knocked over.

b. *Der ist sicherlich sehr raffiniert.*
he.dem is surely very refined.
He is surely very refined.

(B.15) a. *Der Koch irritiert den Geschäftsmann während das*
the.nom cook irritates the.acc businessmann while the
Wasser kocht.
water cooks
The cook irritates the businessman while the water cooks.

b. *Der ist wahrscheinlich sehr arrogant.*
he.dem is probably very arrogant
He is probably very arrogant.

(B.16) a. *Der Pilot fragt den Touristen als das Fleugzeug*
the.nom pilot asks the.acc tourist as the aeroplane
ankommt.
arrives

The pilot asks the tourist as the aeroplane arrives.

b. *Der ist offensichtlich sehr nett.*
he.dem is apparently very nice
He is apparently very nice.

(B.17) a. *Der Briefträger ärgert den Sänger als die Briefe*
the.nom postman annoys the.acc singer as the letters
herunterfallen.
fall.down
The postman annoys the singer as the letters fall down.

b. *Der ist sicherlich sehr gesprächig.*
he.dem is surely very talkative
He is surely very talkative.

(B.18) a. *Der Bäcker begrüßt den Friseur als sich*
the.nom baker greets the.acc hairdresser as himself
die Tür öffnet.
the door opens
The baker greets the hairdresser as the door opens.

b. *Der ist wahrscheinlich sehr glücklich.*
he.dem is probably very happy
He is probably very happy.

(B.19) a. *Der Autofahrer beschimpft den Busfahrer während*
the.nom car.driver scolds the.acc busdriver while
die Ampel rot wird.
the traffic.lights red become
The car driver scolds the bus driver while the traffic lights become red.

b. *Der ist offensichtlich sehr spontan.*
he.dem is apparently very spontaneous
He is apparently very spontaneous.

(B.20) a. *Der Schotte erkennt den Franzosen*
the.nom scotsman recognises the.acc frenchman
sobald das Taxi ankommt.
as.soon.as the taxi arrives
The Scotsman recognises the Frenchman as soon as the taxi arrives.

b. *Der ist vielleicht sehr pünktlich.*
he.dem is perhaps very punctual
He is perhaps very punctual.

(B.21) a. *Der Weihnachtsmann begrüβt den Prinzen obwohl*
the.nom Santa greets the.acc prince although
die Weihnachtsdekorationen nicht schön sind.
the Christmas.decorations not beautiful are
Santa greets the prince although the Christmas decorations are not beautiful.

b. *Der ist sicherlich sehr einsam.*
he.dem is surely very lonely
He is surely very lonely.

(B.22) a. *Der Journalist ärgert den Politiker sobald*
the.nom journalist annoys the.acc politician as.soon.as
die Fernsehcameras drehen.
the television.cameras turn
The journalist annoys the politician as soon as the television cameras are filming.

b. *Der ist wahrschelinlich sehr intelligent.*
he.dem is probably very intelligent
He is probably very intelligent.

(B.23) a. *Der Detektiv erkennt den Kellner als das Bier*
the.nom detective recognises the.acc waiter as the beer
umgekippt wird.
tipped.over becomes
The detective recognises the waiter as the beer is tipped over.

b. *Der ist offensichtlich sehr fleiβig.*
he.dem is apparently very diligent
He is apparently very diligent.

(B.24) a. *Der Mechaniker nervt den Fotografen als die*
the.nom mechanic annoys the.acc photographer as the
Einkaufstasche zerreisst.
shopping.bag rips
The mechanic annoys the photographer as the shopping bag rips.

b. *Der* *ist* *wahrscheinlich* *sehr* *ahnungslos.*
he.dem is probably very clueless
He is probably very clueless.

B.3 Experiments 6 and 8

The same images and sentences were used in Experiments 6 and 8.

B.3.1 Experiments 6 and 8 Images

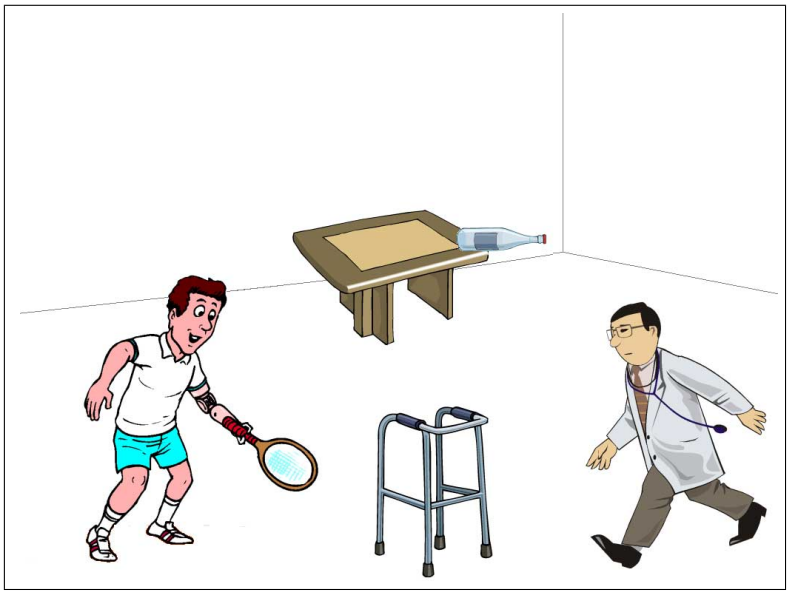

Figure B.25: Item 1

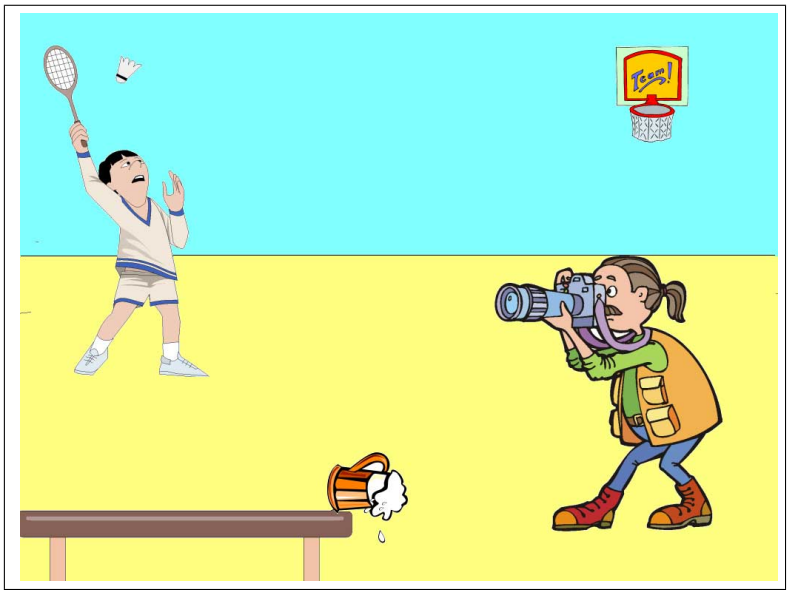

Figure B.26: Item 2

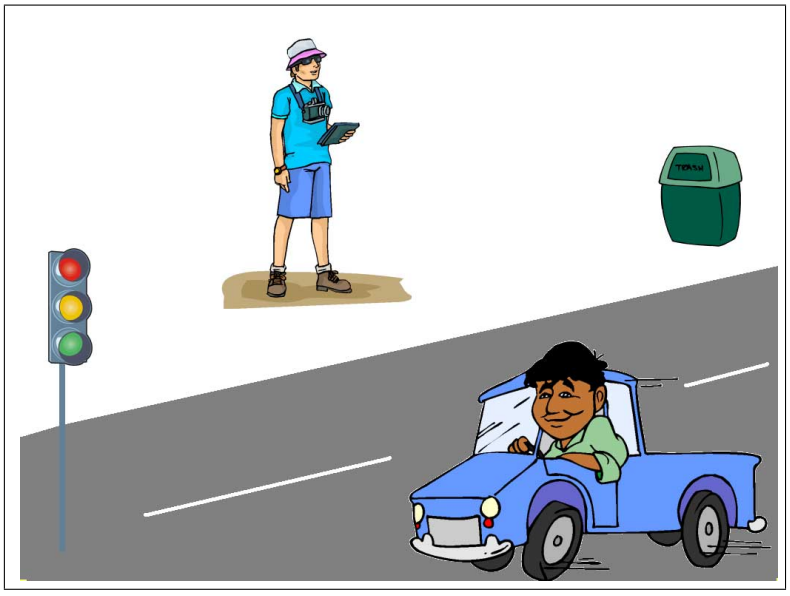

Figure B.27: Item 3

Figure B.28: Item 4

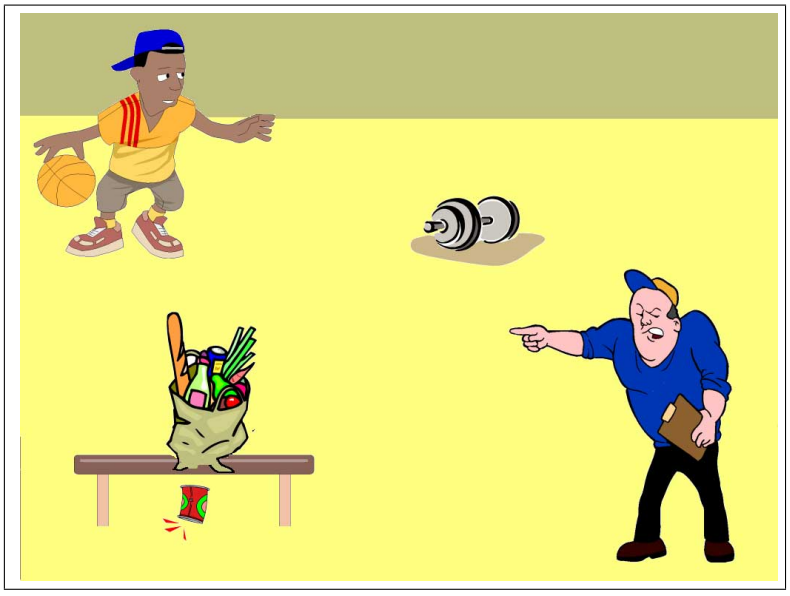

Figure B.29: Item 5

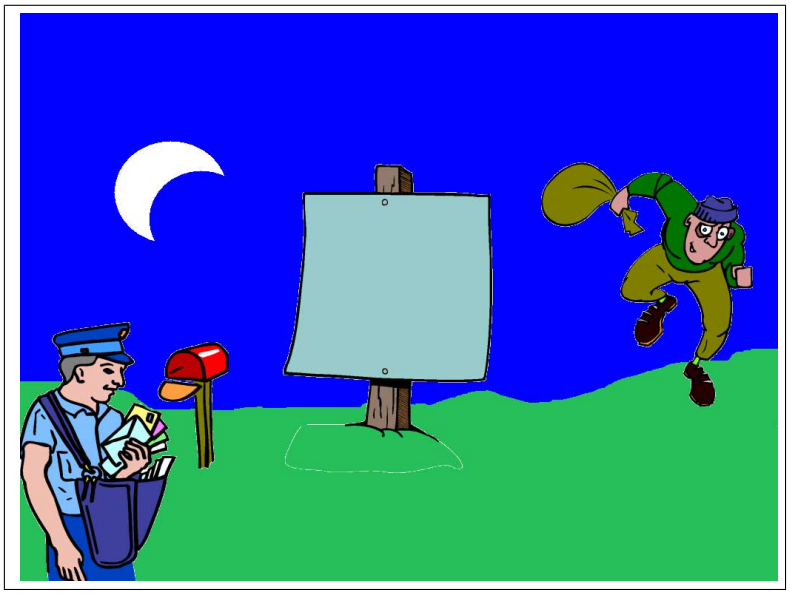

Figure B.30: Item 6

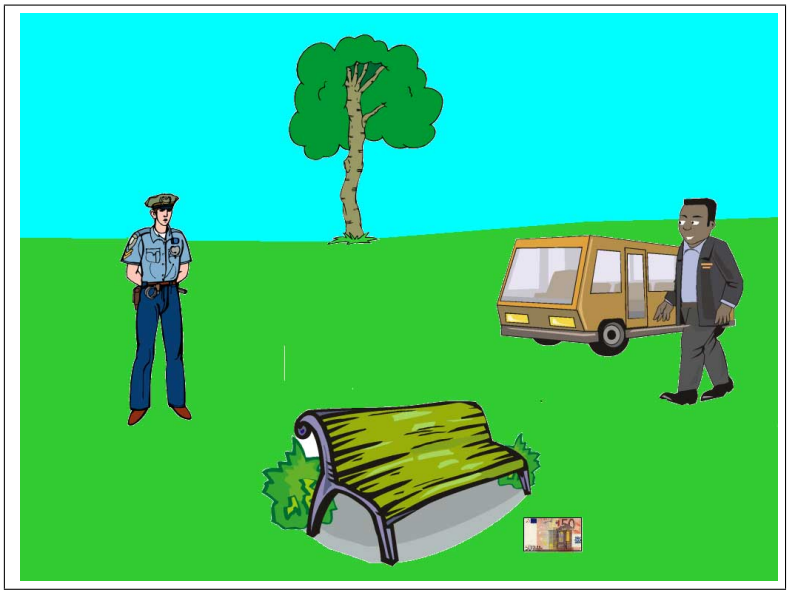

Figure B.31: Item 7

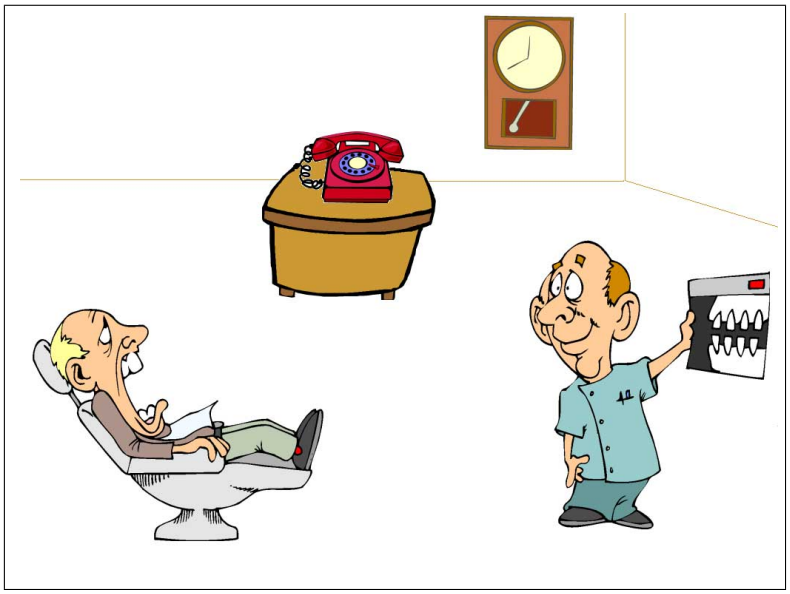

Figure B.32: Item 8

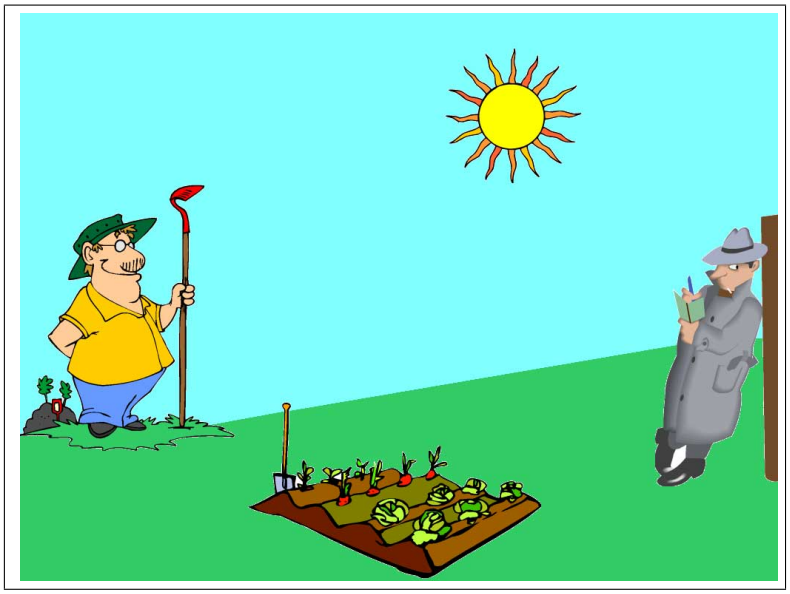

Figure B.33: Item 9

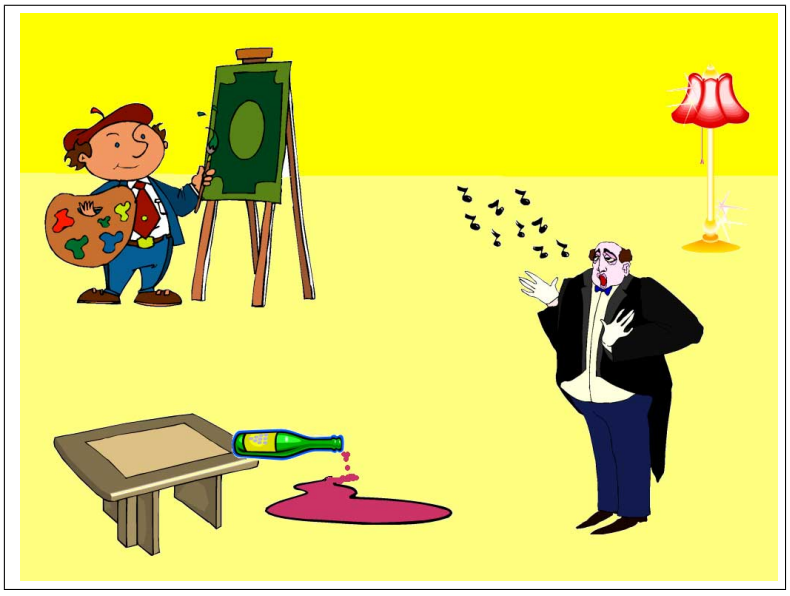

Figure B.34: Item 10

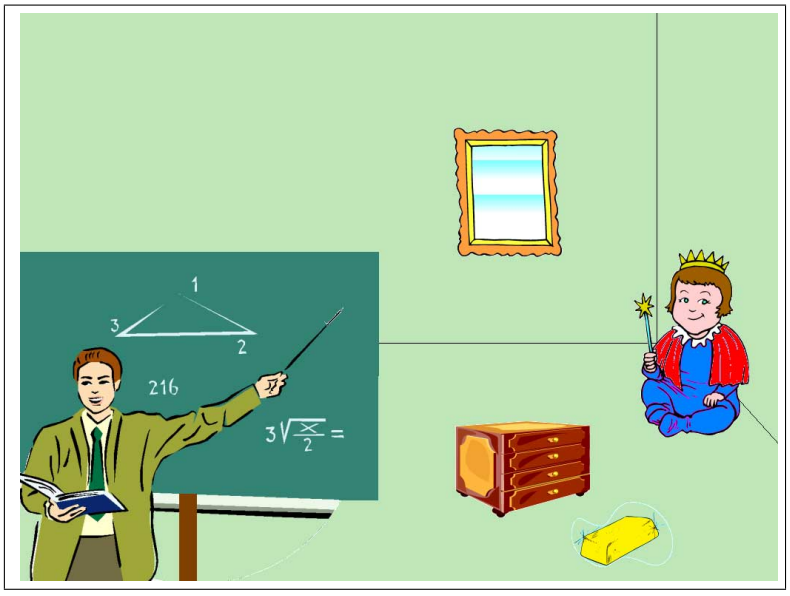

Figure B.35: Item 11

Figure B.36: Item 12

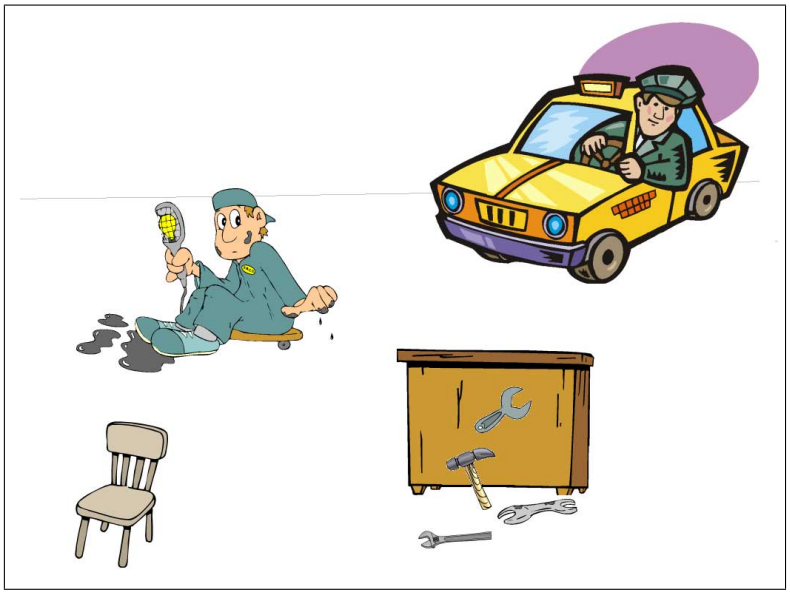

Figure B.37: Item 13

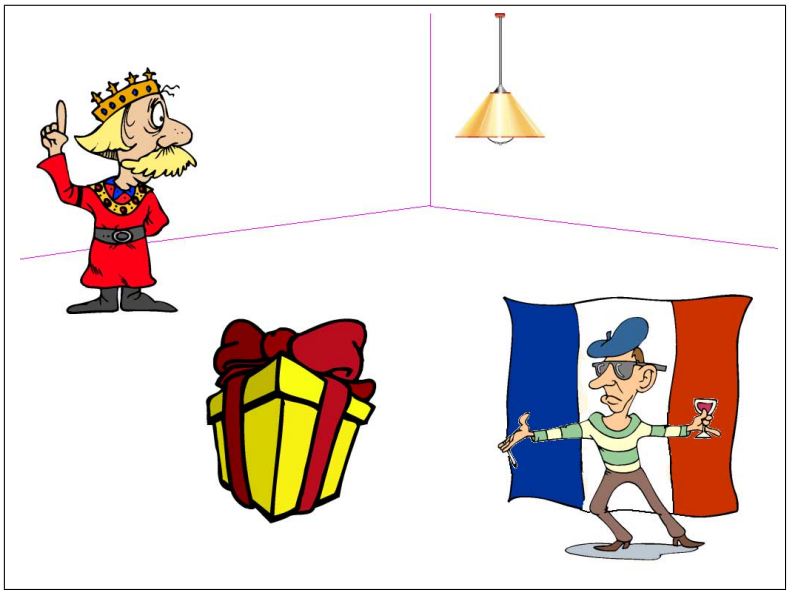

Figure B.38: Item 14

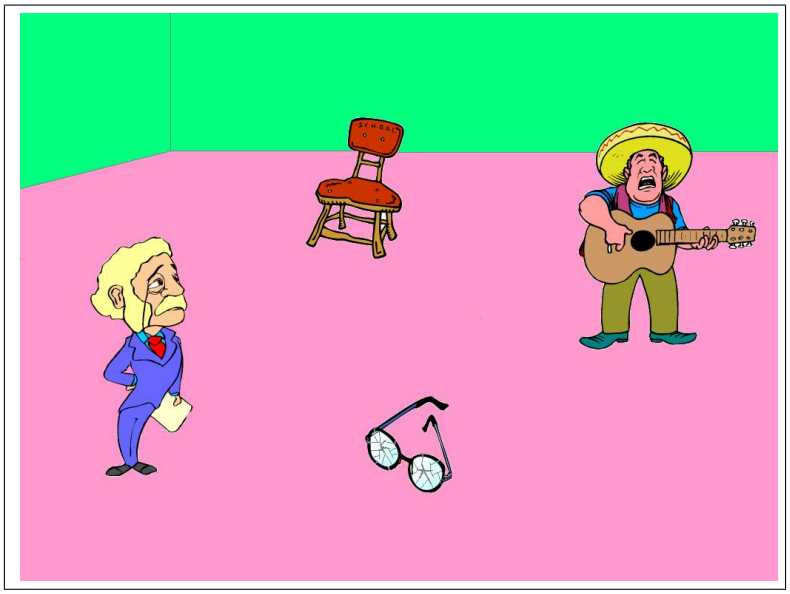

Figure B.39: Item 15

Figure B.40: Item 16

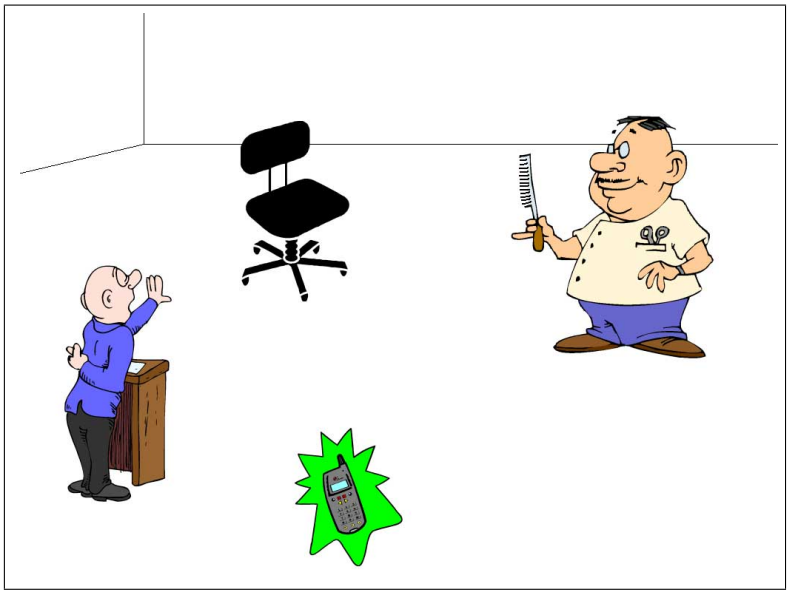

Figure B.41: Item 17

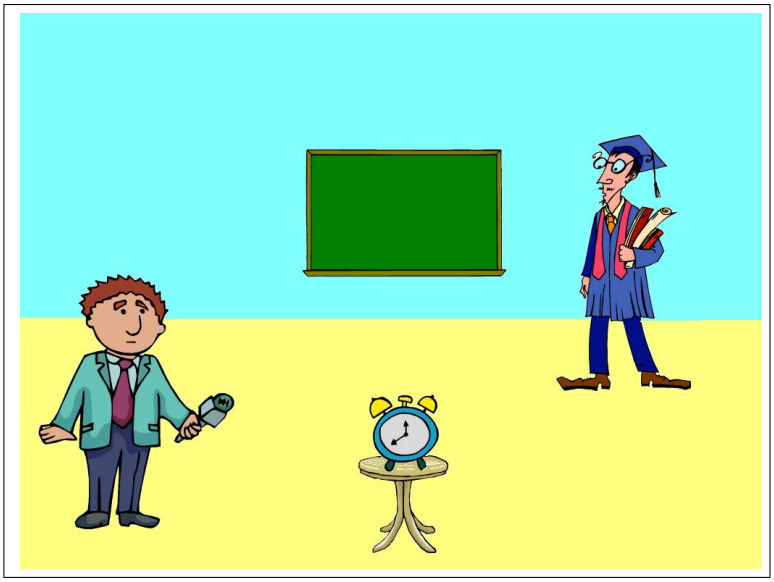

Figure B.42: Item 18

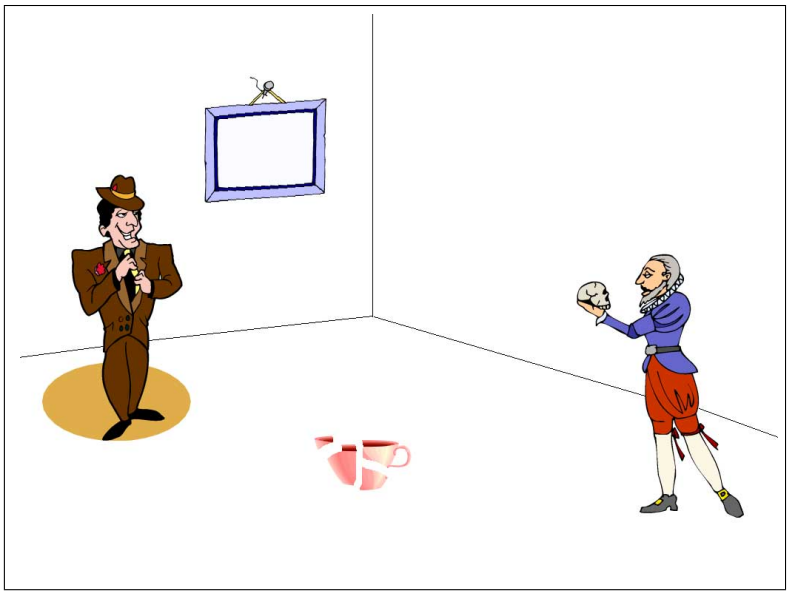

Figure B.43: Item 19

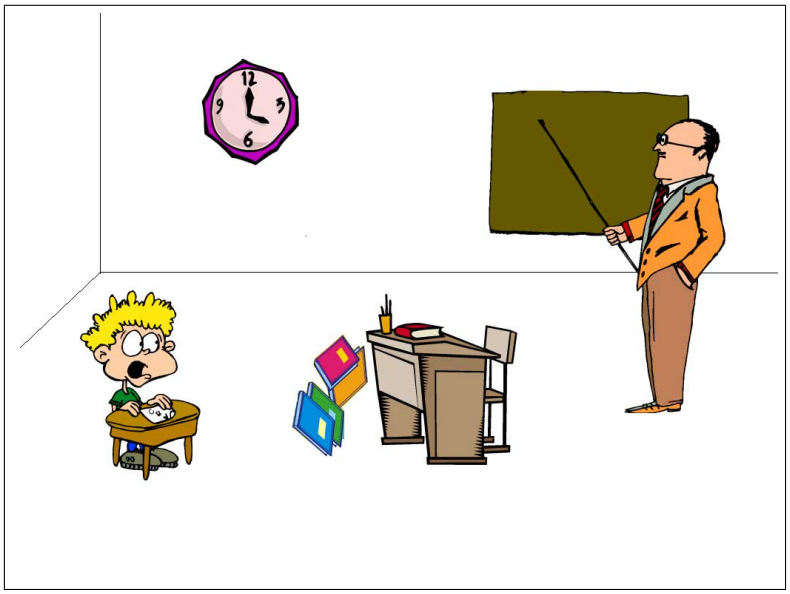

Figure B.44: Item 20

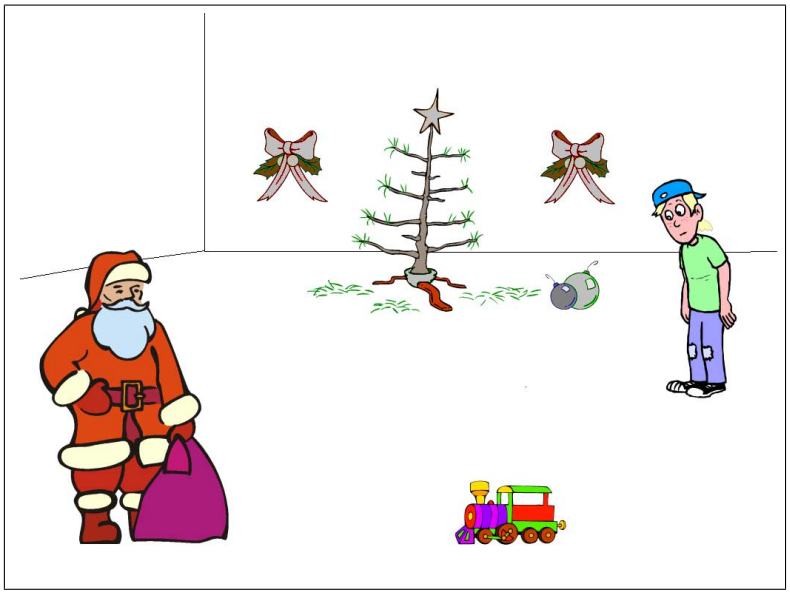

Figure B.45: Item 21

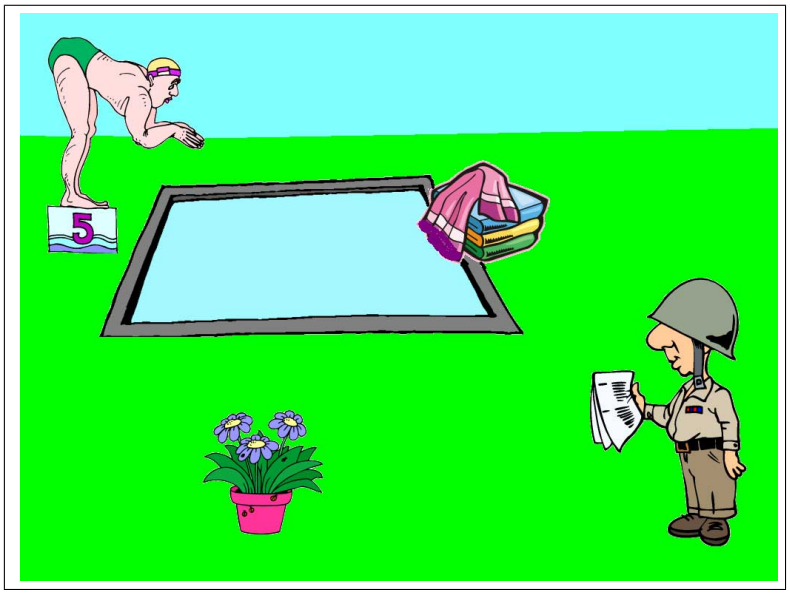

Figure B.46: Item 22

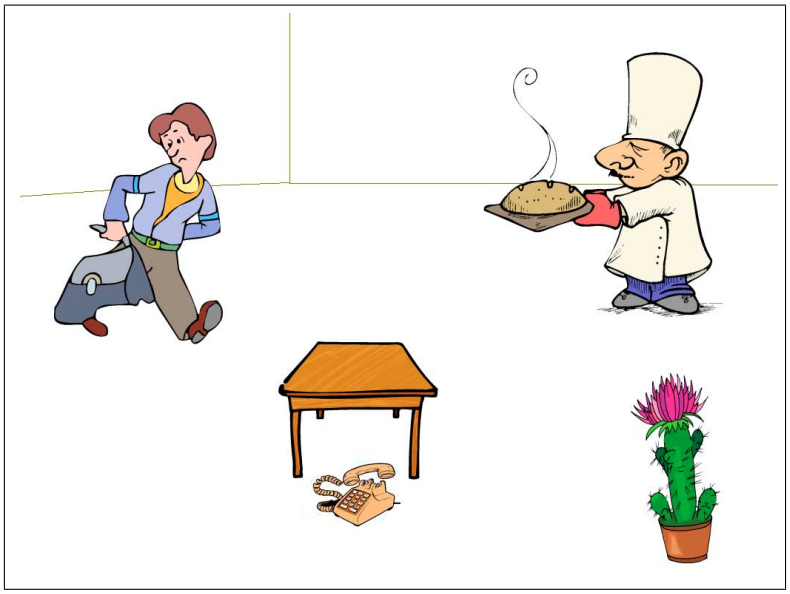

Figure B.47: Item 23

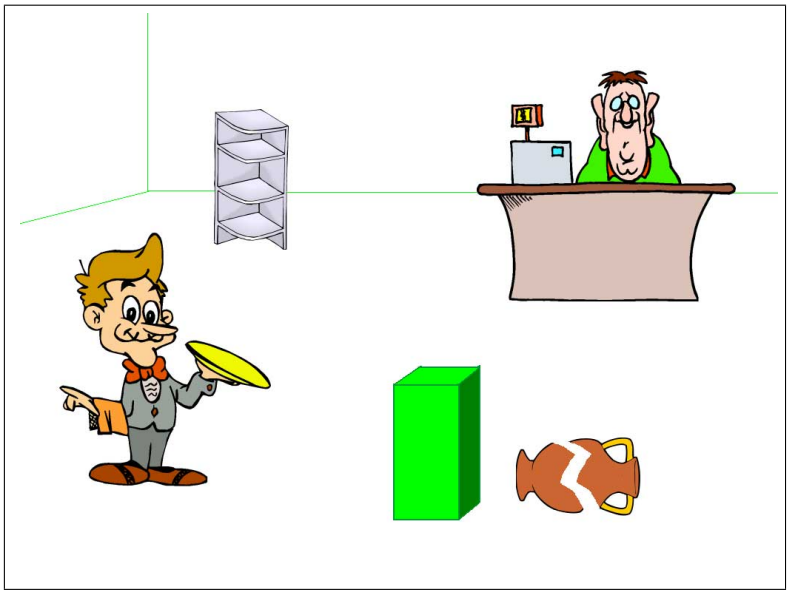

Figure B.48: Item 24

B.3.2 Experiments 6 and 8 Sentences

(B.25) a. *Der Arzt befragt den Tennisspieler, als die*
the.nom doctor asks the.acc tennisplayer as the
Wasserflasche umgekippt wird.
water.bottle knocked.over becomes
The doctor asks the tennis player as the water bottle is knocked over.

b. *Der Arzt wird vom Tennispieler befragt, als*
the.nom doctor becomes by.the tennisplayer asked as
die Wasserflasche umgekippt wird.
the water.bottle knocked.over becomes
The doctor is asked by the tennis player as the water bottle is knocked over.

c. *Er ist wahrscheinlich sehr ahnungslos.*
he.pron is probably very clueless
He is probably very clueless.

d. *Der ist wahrscheinlich sehr ahnungslos.*
he.dem is probably very clueless
He is probably very clueless.

(B.26) a. *Der Fotograf nervt den Badmintonspieler, als*
the.nom photographer annoys the badmintonplayer as
das Bier umgekippt wird.
the beer knocked.over becomes
The photographer annoys the badminton player as the beer is knocked over.

b. *Der ist offensichtlich sehr fleiβig.*
he.dem is apparently very diligent.
He is apparently very diligent.

(B.27) a. *Der Autofahrer sieht den Tourist, sobald die*
the.nom cardriver sees the.acc tourist as.soon.as the
Ampel rot wird.
traffic.light red becomes
The car driver sees the tourist as soon as the traffic light turns red.

b. *Der ist wahrschelinlich sehr intelligent.*
he.dem is probably very intelligent
He is probably very intelligent.

(B.28) a. *Der Bäcker ruft den Schotten, nachdem das Fenster*
the.nom baker calls the scotsman after the window
zerbrochen worden ist.
broken become is
The baker calls the Scotsman after the window has been broken.

b. *Der ist wahrscheinlich ehrlich.*
he.dem is probably honest.
He is probably honest.

(B.29) a. *Der Basketballspieler sieht den Trainer, als die*
the.nom basketballplayer sees the.acc coach as the
Einkaufstasche zerreisst.
shopping.bag rips
The basketball player sees the coach as the shopping bag rips.

b. *Der ist offensichtlich sportlich*
he.dem is apparently sporty
He is apparently sporty.

(B.30) a. *Der Briefträger bemerkt den Dieb, obwohl das*
the.nom postman notices the.acc thief, although the
Schild sehr groβ ist.
sign very big is
The postman notices the thief, although the sign is very big.

b. *Der ist vielleicht nervös.*
he.dem is perhaps nervous
He is perhaps nervous.

(B.31) a. *Der Busfahrer informiert den Polizisten, nachdem*
the.nom busdriver informs the.acc policeman after
ein €50 Schein auf den Boden gefallen ist.
a €50 note on the floor fallen is
The busdriver informs the policeman after a €50 note has fallen on the floor.

b. *Der ist offensichtlich sehr nett.*
he.dem is apparently very nice
He is apparently very nice.

(B.32) a. *Der Zahnarzt informiert den Patienten, sobald*
the.nom dentist informs the.acc patient as.soon.as
das Telefon geklingelt hat.
the telephone rung has
The dentist informs the patient as soon as the telephone has rung.

b. *Der ist vielleicht sehr pünktlich.*
he.dem is perhaps very punctual
He is perhaps very punctual.

(B.33) a. *Der Detektiv begrüßt den Gärtner, während die*
the.nom detective greets the.acc gardener while the
Sonne scheint.
sun shines
The detective greets the gardner while the sun shines.

b. *Der ist offensichtlich sehr spontan.*
he.dem is apparently very spontaneous.

(B.34) a. The painter recognises the signer as the wine bottle is knocked over. *Der Maler erkennt den Sänger, als die*
the.nom painter recognises the.acc singer as the
Weinflasche umgekippt wird.
wine.bottle knocked.over becomes

b. *Der ist sicherlich sehr raffiniert.*
he.dem is surely very refined
He is surely very refined.

(B.35) a. *Der Mathematiker ruft den Prinz, sobald*
the.nom mathematician calls the.acc prince as.soon.as
das Gold auf den Boden gefallen ist.
the gold on the floor fallen is
The mathematician calls the prince as soon as the gold has fallen on the floor.

b. *Der ist wahrscheinlich sehr arrogant.*
he.dem is probably very arrogant.
He is probably very arrogant.

(B.36) a. *Der alte Mann sieht den Fussballspieler, sobald*
the.nom old man sees the.acc football.player as.soon.as
das Taxi ankommt.
the taxi arrives
The old man sees the footballplayer as soon as the taxi arrives.

b. *Der ist sicherlich lustig.*
he.dem is surely funny
He is surely funny.

(B.37) a. *Der Mechaniker beschimpft den Taxifahrer, als die*
the.nom mechanic scolds the.acc taxidriver as the
Werkzeuge herunterfallen.
tools fall.down
The mechanic scolds the taxi driver as the tools fall down.

b. *Der ist sicherlich sehr aufgeregt.*
he.dem is surely very upset
He is surely very upset.

(B.38) a. *Der König irritiert den Franzosen, obwohl das*
the.nom king irritates the.acc Frenchman although the
Geschenk sehr groβ ist.
gift very big is
The king irritates the Frenchman, although the gift is very big.

b. *Der ist sicherlich sehr gesprächig.*
he.dem is surely very talkative
He is surely very talkative.

(B.39) a. *Der Musiker begrüβt den Komponist, als die*
the.nom musician greets the.acc composer as the
Brille zerbrochen wird.
glasses broken become
The musician greets the composer as the glasses are broken.

b. *Der ist wahrscheinlich sehr glücklich.*
he.dem is probably very happy
He is probably very happy.

(B.40) a. *Der Pilot bemerkt den Japaner, während das*
the.nom pilot notices the.acc Japanese.man while the
Fleugzeug ankommt.
aeroplane arrives

The pilot notices the Japanese man while the aeroplane arrives.

b. *Der ist offensichtlich sehr klug.*
he.dem is apparently very clever.
He is apparently very clever.

(B.41) a. *Der Politiker nervt den Friseur, als das*
the.nom politician annoys the.acc hairdresser as the
Handy klingelt.
mobile.phone rings
The politician annoys the hairdresser as the mobile phone rings.

b. *Der ist offensichtlich sehr egozentrisch.*
he.dem is apparently very egocentric
He is apparently very egocentric.

(B.42) a. *Der Professor ärgert den Journalist, nachdem die*
the.nom professor annoys the.acc journalist after the
Uhr geklingelt hat.
clock rung has
The professor annoys the journalist after the clock has rung.

b. *Der ist vielleicht müde.*
he.dem is perhaps tired
He is perhaps tired.

(B.43) a. *Der Schauspieler ärgert den Geschäftsmann, als*
the.nom actor annoys the.acc business.man as
die Kaffeetasse zerbricht.
the coffeecup breaks
The actor annoys the business man as the coffee cup breaks.

b. *Der ist offensichtlich sehr erfolgreich.*
he.dem is apparently very successful
He is apparently very successful.

(B.44) a. *Der Schüler irritiert den Lehrer, als die Bücher*
the.nom pupil irritates the.acc teacher as the books
herunterfallen.
fall.down
The pupil irritates the teacher as the books fall down.

b. *Der ist wahrscheinlich sehr launisch.*
he.dem is probably very moody

He is probably very moody.

(B.45) a. *Der Junge bemerkt den Weihnachtsmann, obwohl*
the.nom boy notices the.acc Santa although
die Weihnachtsdekoration nicht schön ist.
the Christmas.decoration not beautiful is
The boy notices Santa, although the Christmas decorations are not beautiful.

b. *Der ist sicherlich sehr einsam.*
he.dem is surely very lonely
He is surely very lonely.

(B.46) a. *Der Schwimmer erkennt den Soldat, als das*
the.nom swimmer recognises the soldier as the
Badetuch nass wird.
towel wet becomes
The swimmer recognises the soldier as the towel becomes wet.

b. *Der ist wahrscheinlich anständig.*
he.dem is probably well.behaved
He is probably well behaved.

(B.47) a. *Der Student beschimpft den Koch, sobald das*
the.nom student scolds the.acc cook as.soon.as the
Telefon herunterfällt.
telephone falls.down
The student scolds the cook as soon as the telephone falls down.

b. *Der ist wahrscheinlich dumm.*
he.dem is probably dumb
He is probably dumb.

(B.48) a. *Der Kellner begrüßt den Kassierer als die Vase*
the.nom waiter greets the.acc cashier as the vase
zerbricht.
breaks
The waiter greets the cashier as the vase breaks.

b. *Der ist offensichtlich charmant.*
he.dem is apparently charming
He is apparently charming.

APPENDIX C

Final Statistical Models for Experiments

C.1 Introduction

In this chapter I list the final models of the analyses of the data presented in the thesis, including all fixed and random effects. The models are described as they were in the output produced by R, i.e. in the form of *dependent variable* $\sim$ *Fixed factors* + *Random factors*. Models where an * separates the fixed factors indicate fully specified models, those models where higher level interactions have been removed separate fixed factors with a +. Random factors are described in the form (1 | Random factor) for an intercept term; where a factor is crossed with the random factor, it is described as (1 + Factor | Random Factor).

Chapter 3 gives a full description of the method used to obtain these models.

C.2 Experiment 1

Formula: I(IsLooking == "yes") $\sim$ Wordorder + NP Pron + object + Time + Wordorder:NP Pron + Wordorder:object + NP Pron:object + Wordorder:Time + NP Pron:Time + object:Time + NP Pron:object:Time + (1 + object | SubjectID) + (1 + object | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
3254	3366	-1609	3218

Table C.1: Experiment 1

C.3 Experiment 2

Formula: I(IsLooking == ″yes″) ∼Wordord + NP Pron + object + time + Wordorder:time + (1 + object | SubjectID) + (1 + object | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
2752	2827	-1364	2728

Table C.2: Experiment 2

Formula: I(IsLooking == ″yes″) ∼ Wordorder * NP Pron * object * time * Proficiency + (1 + object | SubjectID) + (1 + object | Item) + (1 + NP Pron | SubjectID)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
2745	3000	-1332	2663

Table C.3: Experiment 2 with additional factors

C.4 Experiment 3

Formula: I(IsLooking == ″yes″) ∼ voice + object + time + voice:object + voice:time + (1 + object | SubjectID) + (1 + object | Item) + (1 + voice | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
2833	2941	-1401	2803

Table C.4: Experiment 3

C.5 Experiment 4

Formula: Rating $\sim$ SVO1OVS2 * pro1dem2 * WhichNP + (1 + WhichNP | Participant)

AIC	BIC	logLik	MLdeviance	REMLdeviance
1824	1871	-901	1791	1802

Table C.5: Experiment 4

C.6 Experiment 5

C.6.1 SVO pronoun

Formula: I(IsLooking == ″yes″) $\sim$ object * Time + +(object | subj)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
3241	3284	-1614	3227

Table C.6: Experiment 5 SVO pron

C.6.2 SVO demonstrative

Formula: I(IsLooking == ″yes″) $\sim$ object + Time + (1 + object | Item) + (1 + object | subj) + (1 + Time | subj)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
3004	3076	-1490	2980

Table C.7: Experiment 5 SVO dem

C.6.3 OVS pronoun

Formula: I(IsLooking == ″yes″) ∼ object + Time + (1 + object | subj)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
3195	3231	-1592	3183

Table C.8: Experiment5 OVS pron

C.6.4 OVS demonstrative

Formula: I(IsLooking == ″yes″) ∼ object + Time + +(1 + object | subj)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
3200	3237	-1594	3188

Table C.9: Experiment 5 OVS dem

C.7 Experiment 6

C.7.1 Active pronoun

Formula: I(IsLooking == ″yes″) ∼ object + Time + +(1 + object | Item) + (1 + object | subj)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4219	4284	-2100	4201

Table C.10: Experiment 6 Active pron

C.7.2 *Active demonstrative*

Formula: I(IsLooking == ″yes″) ∼ object + Time + +(1 + object | subj)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4805	4849	-2397	4793

Table C.11: Experiment 6 Active dem

C.7.3 *Passive pronoun*

Formula: I(IsLooking == ″″yes″″) ∼ object + Time + (1 + object | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4606	4650	-2297	4594

Table C.12: Experiment 6 Passive pron

C.7.4 *Passive demonstrative*

Formula: I(IsLooking == ″yes″) ∼ object + Time + +(1 | Item) + (1 + object | subj)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4611	4662	-2299	4597

Table C.13: Experiment 6 Passive dem

C.8 Experiment 7

C.8.1 SVO pronoun

Formula: I(gIsLooking == ″yes″) ∼ object + Time + (1 | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4478	4507	-2235	4470

Table C.14: Experiment 7 SVO pron

C.8.2 SVO pronoun with additional factors

Formula: I(gIsLooking == ″yes″) ∼ object + Time + Lived + (1 | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4466	4502	-2228	4456

Table C.15: Experiment 7 SVO pron with additional factors

C.8.3 SVO demonstrative

Formula: I(gIsLooking == ″yes″) ∼ object + Time + Lived + (1 | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4242	4278	-2116	4232

Table C.16: Experiment 7 SVO dem

C.8.4 OVS pronoun

Formula: I(gIsLooking == ″yes″) ∼ object + Time + object:Time + (1 | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4407	4444	-2199	4397

Table C.17: Experiment 7 OVS pron

C.8.5 OVS demonstrative

Formula: I(gIsLooking == ″yes″) ∼ object + Time + (1 + object | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4478	4507	-2235	4470

Table C.18: Experiment 7 OVS dem

C.8.6 OVS demonstrative with additional factors

Formula: I(gIsLooking == ″yes″) ∼ object + Time + Testscore + object:Testscore + (1 + object | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4470	4529	-2227	4454

Table C.19: Experiment 7 OVS dem with additional factors

C.9 Experiment 8

C.9.1 Active pronoun

Formula: I(gIsLooking == ″yes″) ∼ object + Time + (1 + object | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
5013	5071	-2498	4997

Table C.20: Experiment 8 Active pron

C.9.2 Active pronoun with additional factors

Formula: I(gIsLooking == ″yes″) ∼ object + Time + TestScore + object * Time + (1 + object | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4771	4829	-2377	4755

Table C.21: Experiment 8 Active pron with additional factors

C.9.3 Active demonstrative

Formula: I(gIsLooking == ″yes″) ∼ object + Time + (1 + object | Item) + (1 + object | SubjectID)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4059	4124	-2020	4041

Table C.22: Experiment 8 Active dem

C.9.4 Passive pronoun

Formula: I(gIsLooking == ″yes″) ∼ object + Time + (1 + object | Item) + (1 | SubjectID)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4198	4249	-2092	4184

Table C.23: Experiment 8 Passive pron

C.9.5 Passive pronoun with additional factors

Formula: I(gIsLooking == ″yes″) ∼ object + Time + TestScore + object * TestScore + (1 + object | Item) + (1 | SubjectID)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4010	4076	-1996	3992

Table C.24: Experiment 8 Passive pron with additional factors

C.9.6 Passive demonstrative

Formula: I(gIsLooking == ″yes″) ∼ object + Time + (1 + object | Item) + (1 + object | SubjectID)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
4489	4554	-2236	4471

Table C.25: Experiment 8 Passive dem

C.10 Experiment 9

C.10.1 Pronoun

Formula: I(IsLooking == ″yes″) ∼ object * Time * Load * TimelivedinGB * useofGerman + +(1 | Item) + (1 | Subj)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
6892	55	-3412	6824

Table C.26: Experiment 9 pron

C.10.2 Demonstrative

Formula: I(IsLooking == ″yes″) ∼ object + Time + Load + TimelivedinGB + useofGerman + object:Time + object:Load + Time:Load + object:TimelivedinGB + Time:TimelivedinGB + Load:TimelivedinGB + object:useofGerman + Time:useofGerman + Load:useofGerman + TimelivedinGB:useofGerman + object:Time:Load + object:Time:TimelivedinGB + object:Load:TimelivedinGB + Time:Load:TimelivedinGB + object:Time:useofGerman + object:Load:useofGerman + Time:Load:useofGerman + object:TimelivedinGB:useofGerman + Time:TimelivedinGB:useofGerman + Load:TimelivedinGB:useofGerman + object:Time: TimelivedinGB:useofGerman + Time:Load: TimelivedinGB:useofGerman + (1 | Subj) + (1 | Item)

Family: binomial(logit link)

AIC	BIC	logLik	deviance
6490	6720	-3215	6430

Table C.27: Experiment 9 dem

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