Choice of syntactic structure during language production: The production of unbounded dependencies

Clare Joanne Huxley

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Declaration

I hereby declare that this thesis is my own composition, that the work is my own unless otherwise acknowledged, and that the work has not been submitted for any other degree or qualification.

Clare Joanne Huxley

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Abstract

During language production, conceptual messages are encoded into a target language and articulated. Existing models of language production assume several stages of processing including a conceptual level, a level where lexical selection and syntactic processing occurs and a level where morphological and phonological features are added ready for production (e.g. Levelt et al., 1999). Previous research has considered how lexical and syntactic information could be stored via lemma (Kempen & Huijbers, 1983), syntactic nodes (Levelt at el., 1999) and combinatorial nodes (Pickering & Braingan, 1998), but little is understood about how syntactic structures are selected. This thesis examines how constituent structures are selected by investigating choice of structure in unbounded dependencies such as *Which jug with the red spots is the nun giving the monk?* and how this is affected by factors such as verb-subcategorisation preferences and global sentence structure complexity.

A series of language production experiments investigate how global structure complexity and verb-subcategoricatisaion preferences affect choice of syntactic structure at the clause level in unbounded dependencies. A picture description task reveals an unusual preference for the dispreferred passive voice structure as a result of global structural complexity. Sentence recall experiments demonstrate that both global structural complexity and verb-subcategorisation preferences can affect choice of structure and that competition between these factors decides the final structure. Finally, syntactic priming experiments show that processing mechanisms are shared between simple matrix clause structures and unbounded dependency clause structures, but that the influence of these shared mechanisms vary between the different structure types. This could be attributed to a modal of processing where choice of structure is decided by competition between structure representations which are influenced by different factors in different global syntactic conditions.

The results suggest that choice of syntactic structure is decided through competition between possible structures. These possible structures may receive

further activation or inhibition from other factors such as global structural complexity or verb-subcategorisation preferences and thematic fit. Global structural complexity may influence structure preferences through increased processing load or through attempts to integrate the clause structure with another global structure. Thematic role arguments may influence structure through a preference that syntactic roles fit with specified thematic roles. (e.g. experiencer as subject). This model assumes parallel processing of possible structures and individual structures within a complex larger structure. It also assumes an incremental model of processing which attempts to integrate structures as soon as possible.

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Chapter 1

Introduction and Literature Review

1.0. Introduction

This chapter lays out the aims of the thesis, followed by its structure and discusses relevant literature.

1.1. Aims and Goals of the Thesis

This thesis examines how speakers produce sentences, and, in particular, how they select syntactic structures. Language production involves several processes including generating a conceptual message, selecting lexical items, choosing a syntactic structure (including a word order) and then articulating the final message. Language production models have provided possible representations for lexical structure, syntactic structure and phonological structure (e.g. Caramazza (1997), Levelt (1989), Dell (1986)). While there has been some attempt to address how syntactic structures are represented (e.g. Pickering & Branigan, 1998), there remains the question of how syntactic structures are selected. This thesis investigates factors which affect choice of syntactic structure, focusing on choice of structure within a clause, and discusses possible implications for language processing and linguistic theories of grammar.

One important question regarding structure choice is that of which factors influence choice of structure. What kind of information is available to the processor during production, and how does this information become available? Evidence from comprehension studies shows that factors such as subcategorisation preferences at

the verb can affect ease of processing (e.g. Ferreira, 1994).It is possible then that such factors also influence production of structures. As part of this thesis, I will investigate verb subcategorisation preference effects on choice of structure during production.

Another possibly relevant type of syntactic information available to the processor is that of the overall sentence structure in which a particular clause structure appears. For example, a clause structure may occur as an independent matrix clause such as *The girl kissed the boy* or as a relative clause embedded in a main clause structure such as *The boy that the girl kissed was embarrassed*. Evidence from comprehension studies shows processing difficulties for syntactically complex sentence structures such as object relative clauses like *The boy that the girl kissed was embarrassed* (Wanner & Maratsos, 1978). Does this then mean that choice of structure for a clause during production is influenced by whether the clause is part of a larger, complex sentence structure?

In this thesis, we look at the processing of unbounded dependencies to investigate factors which influence choice of syntactic structure. Unbounded dependencies are the phenomenon whereby there is a dependency between two constituents that may in principle cross an arbitrary number of clause boundaries. For example, in *The boy that the girl kissed was embarrassed, the boy* is associated with the verb *kissed* that occurs within a relative clause which is embedded within the main clause of which *boy* is the subject is separated from the rest of the main clause (*was embarrassed*) by a relative clause (*that the girl kissed*). By studying unbounded dependencies, we can examine processing during the production of a complex sentence structure containing more than one clause.

The experiments focus on how speakers select clause structures. Previous research suggests that clauses are a basic unit in planning (e.g. Ford & Holmes, 1978). In this thesis, we will be distinguishing between a clause currently being processed, which I will call a 'local clause structure' or 'local structure' , and the context of the overall syntactic structure of the sentence it occurs in, which I will call the 'global sentence structure' or 'global structure'. For example, in the sentence *The*

boy that the girl kissed was embarrassed, the clause *that the girl kissed* is the local structure which occurs as part of the global sentence structure *The boy that the girl kissed was embarrassed*, and acts as an object relative clause that is embedded in the main clause structure.

1.2. Overview of the thesis

In Chapter 1, I will give an overview of the literature relevant to this thesis. First, I discuss some linguistic theories of grammar and their predictions for language processing and the selection of syntactic structures during production. I shall discuss current models of language production and possible accounts for syntactic processing, as well as reviewing evidence for planning and planning units during production which suggest that the clause is a basic planning unit during production. The second section discusses the findings from psycholinguistic studies investigating syntactic processing in both the comprehension and the production literature. A further section looks at observations from the psycholinguistic literature about the processing of unbounded dependencies.

In Chapter 2, I investigate whether syntactic complexity affects choice of syntactic structure in a sentence description task where speakers produced interrogative sentences with heavy noun phrases such as *Which jug with the red spots did the nun give to the monk?*. I discuss empirical evidence and processing theories regarding heavy noun phrase shift and examine psycholinguistic evidence regarding filler-gap phenomena and the existence of empty categories. While the experimental results do not provide clear evidence about the nature of heavy noun phrase shift, analysis of the responses raises interesting questions about the possible effects of syntactic complexity.

In Chapter 3, I investigate factors which may influence choice of local clause structure, specifically overall sentence structure and verb subcategorisation preferences. I discuss previous comprehension research on the processing of relative

clauses regarding ease of processing and factors which affect ease of processing as well as looking at data on the production of relative clauses from first language acquisition research. Then, I examine evidence from corpora and psycholinguistic studies about the occurrence and processing of passive grammatical voice structures. Two sentence recall experiments investigate preferences for producing active or passive structures in the context of overall sentence complexity and verb subcategorisation preferences.

In Chapter 4, three syntactic priming experiments are used to investigate whether syntactic structures or mechanisms are shared between unbounded dependencies and matrix clauses. Evidence concerning the priming of clause structures which occur in larger complex structures or priming of the relationship of a local clause to its global structure is unclear. Scheepers (2003) and Desmet and Declerq (2006) found evidence that the attachment of a relative clause could be primed, but Branigan and colleagues (2006) found that priming was not affected by the position of the clause within a larger, complex global sentence structure. In order to shed more light on this debate and how global sentence complexity affects processing, three experiments examine priming between matrix clauses and clauses with an unbounded dependency.

Finally, Chapter 5 summarises the main findings of the thesis. I discuss the implications of these findings for syntactic processing and models of production, as well as considering compatibility with theoretical linguistic theories of grammar. Furthermore, I note that the study of unbounded dependencies can provide valuable insight into syntactic processing and suggest possible future studies.

1.3. Grammars

The last aim of this thesis is to reconcile the psycholinguistic data and the models of syntactic processing with a theory of grammar, such as theories proposed in the Theoretical Linguistic literature. While the underlying fundamental ideas and

assumptions must be shared by both the processing account and the grammar, there are many variations among suggested grammars. There are many possible grammars that have been suggested by those working on language in varied disciplines such as Linguistics, Psychology, Philosophy and Computer Science. As the task of a grammar is very complicated, describing a list of rules or behaviours that would allow for the production of utterances such as those in an existing language, grammars are usually created with focus on particular aspects or features of language. Thus existing grammars very often reflect the perspective of the task or the discipline that they have been created to address. Different disciplines may focus on the same challenge, but take varied approaches from different perspectives, so that ideas from different fields of language research can feed into and enrich other fields.

This thesis will focus on those theories of grammar which address issues of syntactic units in language production and building syntactic structures. In particular, we will consider the issue of how phrase and clause structures are integrated into larger complex structures and which factors influence their selection. The emphasis will be on those grammars which can provide an account for psycholinguistic data and language behaviours investigated in this thesis, such as structure preferences and syntactic persistence. This chapter will discuss Tree-Adjoining Grammar, Incremental Procedural Grammar and Construction Grammar. It will discuss and compare the overall architectures proposed in these theories and examine the implications for processing mechanisms.

1.3.1 Tree-Adjoining Grammar

Ferreira (2002) presented an account of language production using Tree-Adjoining Grammar (TAG) (Joshi, 1985; Joshi, Levy & Takahashi, 1975; Kroch & Joshi, 1985) combining elements of Principals and Parameters or Minimalist Grammars and observations in psycholinguistic data, and its application during language production. Ferreira states that the basic TAG approach can be integrated with

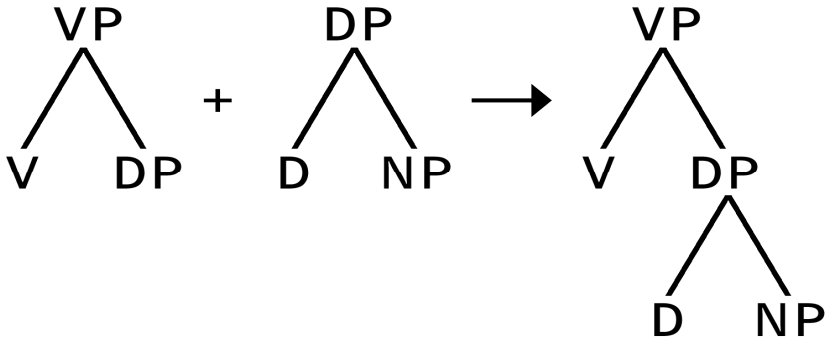
different linguistic theories of grammar; the grammar dictates permitted structures and TAG performs syntactic operations according to a basic set of operations. TAG itself consists of a set of objects and a set of operations which can be performed on those objects. The objects referred to in TAG are syntactic trees. These tree structures can be of differing size and there are different types of tree. Elementary trees consist of a lexical head and arguments that it licenses. Frank (1992) summarises this as the Condition for Elementary Tree Minimality (CETM) where every elementary tree consists of the extended structure licensed by a single lexical head. For example, an elementary tree may consist of a verb as lexical head and the arguments it permits, such as 'kick' which may license an Determiner Phrase (DP) position, which could be filled later by an activated DP such as 'the ball'. There are two kinds of elementary tree: 'auxiliary trees' and 'initial trees'.

The distinguishing feature of auxiliary trees is that the root node is the same as one of the nonterminal nodes in its structure. This allows the auxiliary trees to be recursive. For example, a matrix clause may take a clause as the complement to the verb - Complementiser Phrase (CP) root node and CP nonterminal node, or a noun phrase embedded in another noun phrase - root node NP and nonterminal NP node. Initial trees are all other trees which are not auxiliary trees. These trees do not permit recursion. For example, a DP structure consisting of a determiner and noun phrase only is an initial tree where the determiner is the lexical head. These are the basic types of tree structures which can be combined to make longer utterances. Indeed, while the head of a frame projects its arguments, the positions remain empty as the projection contains no other semantic content and must be filled through tree combining operations.

Trees can be combined through two types of operations: 'substitution' and 'adjoining'. In the substitution operation, one elementary tree is attached to the bottom node of another elementary tree. In the adjoining operation, one tree is inserted into another tree. In order for either operation to take place, certain conditions must be fulfilled. During substitution, the root node of the tree which is to be inserted must be of the same type as the node which it will connect to at the

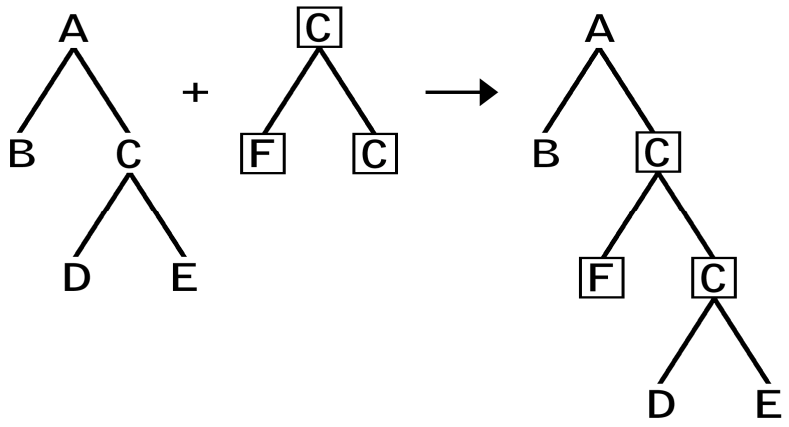
insertion site.

Figure 1. Substitution operation in Tree-Adjoining Grammar



For example, a DP tree may be attached to an available DP node. In this way, a set of argument positions licensed by a head can be filled to produce the complete intended utterance (See fig. 1). As the adjoining operation involves inserting or embedding one tree structure within another, its requirements are slightly more specific. As mentioned previously for the substitution operation, the root node of the tree being inserted needs to be of the same type as the node at the place of insertion. However, in the case of adjoining operations, the structure which is inserted must license the continuation of the rest of the structure.

Figure 2. Adjoining operation in Tree-Adjoining Grammar



For example, a structure that is inserted at the C' complementiser position needs to itself license a C' position to fit into the original structure (see figure 2 for an illustration of the principles of adjoining). Ferreira (2002) suggests that this operation means that only the minimum required number of empty categories need be created, and that this procedure can provide an account of features such as wh-movement and inclusion of adjunct phrases. This allows for different types of structures and more complex structures.

Ferreira (2002) outlines some features of TAG theory which have certain implications for language production. Elementary trees are retrieved in one chunk and all dependency relations are specified within this syntactic chunk. The relationship between a wh- phrase and its thematic position is already clear with one structure. There is no need for interim positions for features such as wh-structures, as structures can be inserted directly. Finally, Ferreira also suggests that the operations may differ in processing difficulty when they are being performed, which may account for effects in the psycholinguistics literature.

A possible application of Ferreira's TAG-based model is one where the processor works on possible alternate structures in parallel. This may also extend to an overall processing strategy where processing occurs at different levels of language processing simultaneously instead of waiting for a completed final structure to be built at one level before initiating processing at the next level. For example, a phonological representation may start being built for one part of an utterance while other parts of the syntactic structure are still being filled. As trees are retrieved as chunks specifying roles and grammatical requirements, there is less processing work required than if a structure were built anew piece by piece every time during production. Because some grammatical information is already specified with the lexical head, this reduces the number of decisions required when building a syntactic structure.

As verbs are commonly the lexical head of a tree, this means that they play a particularly important role in syntactic processing licensing structures and providing grammatical information. With regards to the TAG-based production

model proposed by Ferreira (2000) the author states that '*the model does not allow an initial DP or NP to be encoded grammatically as a subject until the verb for the sentence is known'*. This suggests that the model has aspects of Lexicalized Tree Adjoining Grammar (LTAG) (Schabes, Abeille & Joshi, 1988) where each elementary tree is associated with at least one lexical element. The requirement that the verb be selected before further encoding occurs causes compatibility problems with incremental views of language production. In particular, it is unclear how speakers would produce non-sentential utterances as these may not include verbs. It is also possible that in verb-final languages speakers may sometimes leave the choice of verb until relatively later stages of processing a sentence. Ferreira (2000) presumes that an initial phrase is not produced unless it is combined into an auxiliary tree, although it is unclear why this must be the case unless procedures that combine trees must be completed before articulation.

A model where structures are accessed as part of the verb has certain implications for processing behaviour during language production. If syntactic structure is specified by the verb, one would expect limited influences on the production of syntactic structures but a strong if not exclusive influence from the verb. Syntactic structures should play a significant role in language processing behaviours, e.g. syntactic persistence, whereas syntactic structures play a far smaller role in a piecemeal model of language processing. However, the TAG model places strict limitations on the role of abstract syntactic structures in language processing by harnessing them to verbs. In view of overall planning in production, the elementary tree is necessarily the basic unit in planning production. Structures are built in parallel and some may be in competition as all structures licensed by a head or lemma are activated at the same time. Structures are combined to create full utterances.

Ferreira (2002) describes language production thus: a message is translated to a propositional representation. This is a formal representation of the utterance's meaning. This proposition specifies whether the utterance describes a state or an event. This is then realised as a function-argument structure, where typically the

main verb is the function and the rest of the structure consists of its arguments including tense and aspect. The information for which argument is topic is also provided and nominals are specified for definiteness, number and thematic role. Once the concept is activated, then its lemma is also activated. The lemma corresponds to a syntactic head and the accompanying tree structure is accessed. It is the thematic role of an activated nominal concept that determines which possible tree structure is selected, e.g. trees representing active, passive, prepositional dative, double object dative structures, etc. Accessing the verb results in activating the syntactic structure for the whole clause. Any already constructed argument will be inserted at the earliest possible point. Overall sentence structure is driven by the arguments and structures licensed by the verb or main predicate and the choice of structure is determined by thematic information and featural information which is available beforehand when the conceptual message is translated into a prepositional representation.

1.3.2. Incremental Procedural Grammar and the Incremental Parallel Formulator

A fundamental assumption of Incremental Procedural Grammar (IPG), developed by Kempen and Hoenkemp (1987), is that language production involves different stages of language processing occurring in parallel. If production were serial there would be inefficient use of resources as the processor would experience periods of idling and then periods of intense activity, because each level of processing would be required to wait for information from a previous process in the system. Focusing on syntactic processing, Kempen and Hoenkamp (1987) propose that syntactic structures are built incrementally in sections and these sections then connect together to form a final utterance. Additionally, they assume that syntactic knowledge is not stored but that this knowledge is contained within a set of syntactic procedures so that Noun Phrases are built by calling on a NP procedure, whose function is to build Noun Phrases. Another procedure assigns Subjects. A

procedure may in turn call upon other procedures as subprocedures. These syntactic procedures draw upon conceptual and semantic information in a Lexico-Syntactic phase and then a Morpho-Phonological stage. It is assumed that the order of conceptual fragments does not necessarily correspond with the order of syntactic fragments which are built separately and then placed into a final order. This would indicate that building syntactic trees and assigning word order are to some extent separate processes.

Kempen and Hoenkamp (1987) distinguish between two types of procedures: categorical procedures and functional procedures. Categorical procedures build structures for clauses and phrases, such as noun phrases or prepositional phrases. Functional procedures build the grammatical and functional relationships between those structures, such as subjects, objects, etc. Furthermore, categorical procedures consist of two types: phrasal categorical procedures and lexical categorical procedures. Phrasal categorical procedures correspond to structures such as noun phrases, prepositional phrases and similar. Lexical categorical procedures correspond with notions of parts of speech such as noun, adjectives and verbs. A lexicalisation system reads conceptual structures and accesses the lexicon often using path functions to locate words and expressions to express the intended message. For example, accessing the lemma for the word 'hit' would initiate calls to procedures subject, verb and object although not necessarily in that order but most likely in parallel.

The hierarchy of procedure calls is determined by a set of appointment rules. The appointment rules specify the overall structural outcome of the utterance by informing the procedure calls at the lemma which roles have been assigned by the lexicalisation process. The functorisation process allocates inflection and function words by amending the procedural calls at the lemma by inserting a new function (function words) or adding a subprocedure call (inflection). Finally, trees are combined to create the complete utterance. A syntactic procedure also processes the values that its sub-trees return which represent whether they are subject, finite verb, etc. It is presumed a further procedure creates a holder data structure with a

sequence of positions which accept the corresponding subtree, e.g., subject. When a procedure receives the value of a subtree it places it in an appropriate holder slot. That is to say, a structure is created with assigned roles which can hold items until they are ready to be produced. Items can be placed into the appropriate position as they become available. This may be particularly useful when processing embedded clauses, as items may be held in a structure or processing may be ongoing, while the processor focuses on completing the embedded clause first.

The Incremental Parallel Formulator (IPF) developed by De Smedt (1990) builds upon the basic ideas of the IPG, but makes significantly different assumptions in its model of language processing. These include building structures upwards from the syntactic processing level as well as downwards from the conceptual level, and an assumption that linear order can be specified before function assignment. De Smedt built a model where semantic information feeds syntactic processing, but where structural requirements at the syntactic level inform further processing occurring at the conceptual and syntactic levels.

The model assumes two main components of language generation: a conceptualiser which creates the semantic context of the message, and a formulator which builds the syntactic structures. De Smedt focuses on the formulation stage and the constraints under which the syntactic formulator operates, and proposes certain fundamental properties of the formulator (Kempen, 1987). Syntactic structures can be built both downwards from the conceptual information and upwards from syntactic or morpho-phonological information as conceptual information may not necessarily be provided in an order corresponding to articulation output. Individual branches can be attached to already existing syntactic structures as conceptual fragments may not correspond exactly to syntactic fragments. Furthermore, as production of conceptual fragments is not linear, the formulator should be flexible as to how it forms a structure within the permitted structures of the language.

The structures created by the formulator are segments representing one immediate dominance relation. The segments consist of a root, a foot and an arc.

The root contains syntactic/semantic information, the foot contains morphological information and the arc represents the grammatical function. The root unifies with the foot through a process called 'concatenation' and two roots may unify together to build a larger structure in a process called 'furcation'. There are three types of semantic information distributed from the conceptual level to the syntactic formulator: semantic concepts, semantic roles and features. The semantic concepts refer to entities, events and similar content. The semantic roles are the relations between the concepts and provide the case and thematic role information. The features inform the syntactic features with details such as definiteness, number and such like. The formulator builds f-structures which contain the syntactic relations between the segments or constituents. In this way, the semantic information is encoded as syntactic relations, features and subcategorised lexical elements.

For the IPF generation is driven by conceptual and lexical information so an important aspect of formulation is the subcategorisation preferences specified at the lexical item itself. For example, verbs specify preferences for the structures they permit. Depending on the order of conceptual information entering the formulator, it is also possible for subcategorisation preferences to project upwards towards incoming content if the subcategorisation information has been processed earlier.

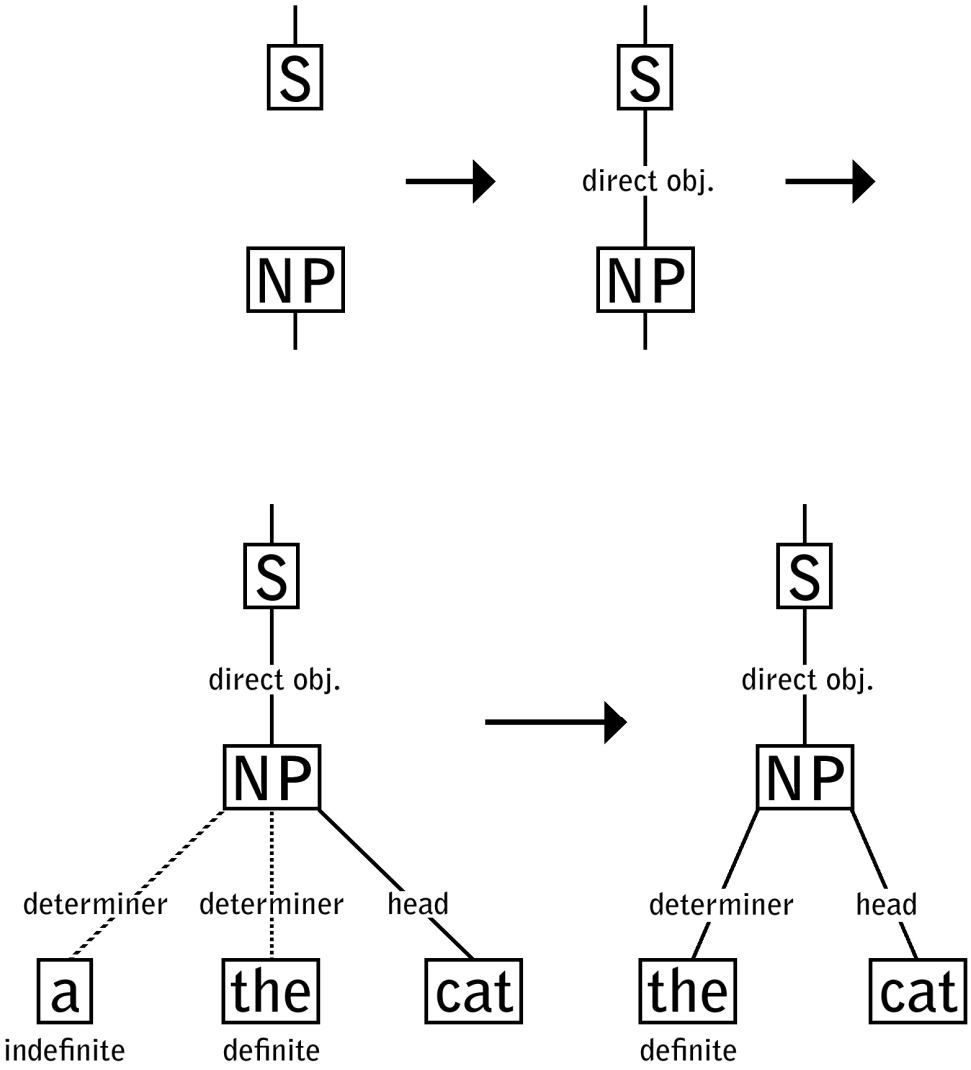
Lexical entries are themselves complex structures. In a lexical structure, the foot is a word and the arc which specifies the grammatical relation is the head. Thus, a noun structure consists of a foot which is the word itself and then an arc specifying the syntactic category noun which acts as the head, likewise, a verb structure consists of a foot which is the word itself and an arc specifying for the syntactic category verb which acts as the head. The root of the lexical segment or lemma contains semantic content and subcategorisation frames specifying syntactic information and preferences. Morpho-phonological information is accessed at the foot.

As syntactic information and preferences are provided by the conceptual and lexical aspects the grammar is therefore a part of the lexicon and not distinct from it. De Smedt also proposes a phrasal lexicon where multi-word structures can be

stored as part of the lexicon allowing idioms or other frequently used syntactic fragments to be stored for retrieval. It is assumed that the lexical entries are accessed in parallel and thus the IPF selects from competing parallel processes. Thus, incoming structures may be rejected if they are incompatible with already selected structures. For example, passivisation structures are treated as structures stored within the lexicon.

Syntactic roles are assigned using a case frame which attaches to the roots of the lexical segments. In order to create semantic and case relations between the lexical segments, the formulator looks for the semantic information at the case frame and then locates the syntactic relations associated with the semantic role. For example, the formulator may create a segment consisting of the corresponding roles subject and NP (see figure 3). First the segment is assigned the role of direct object. Having selected the noun *cat,* possible candidates '*a'* and '*the' are* consided for the determiner role. The broken line indicates that these candidates have been activated but that the final selection and association have not yet been made. Finally, we see the completed NP segment.

Figure 3: Forming an NP segment in IPF



Cases where one phrase is related to another, such as semantic role and grammatical role are classified as intercalating segments. Features are assigned to nodes but before lexicalisation occurs as they pose constraints selection. Features guide the functorisation process where function words and inflection are added to an utterance. Features which initiate inflectional change may be shared. Features which initiate function words may require the addition of segments which are called functor segments.

While F-structures create the relations and dominance structure of the utterance, the actual word order for articulation is built in the C-structure. The C-

structure represents the final structure which can be articulated in a serial order. This process occurs after all segments have been incorporated and their values validated, and after functorisation has occurred completing the relational information. The procedure works from the bottom upwards assigning the feet to a destination slot in the C-structure. This position is still determined by the root in the f-structure which contains the dominance and relational information.

As information and constituents become available at differing times, once a node has been lexicalised it can be assigned to a holder. The holder consists of a series of numbered positions or slots and the segments are assigned to. The foot node has the feature positions which details all the possible positions the foot can occupy as its destination. This allows for language specific constraints on word order. The final slots in the holder may be used as a place to store constituents which cannot yet be assigned, such as during production of relative clauses. As relative clauses can be embedded within a main clause, a situation may arise where the processor has built the main clause elements but needs to finish building the relative clause structure before allocating the continuing main clause elements.

Finally, topic and focus are not coded with features but are reflected in the order in which the conceptualisor produces segments. The topic is that which is being talked about. This may be information that has been mentioned in a previous sentence. The focus is information which is new or important. It is assumed that the topic/focus should be highly accessible and more conceptually available and therefore more likely to be passed onto the formulator earlier. Being passed onto the formulator earlier may increase the probability of being assigned features earlier and establishing subcategorisation preferences. Increased activation may also mean that a word is available earlier and more likely to be selected for a prominent position which then affects processing of the rest of the sentence such as the patient being assigned a subject position resulting in a passive structure. This would link well with the phenomenon of fronting prominent items found in some languages. Furthermore, if processing is occurring in parallel, it may be possible to allocate resources to differing degrees among the processes. A highly salient or important

item may have more resources allocated to its processing. This allows for discourse relevant information and context to be reflected in syntactic processing without the procedures themselves directly processing non-syntactic information.

De Smedt (1990) further suggests that the most effective strategy for accommodating a high level conceptual change during processing or even articulation is for the processor to discard the whole utterance or utterance segment and rebuild the structure anew, although accessing recently discarded structures will be facilitated. Although the structures are built from smaller component structures which are joined to form larger more complex structures, substituting one segment for another would be a complex and possibly lengthy process which requires that relations between structures be recalculated. The substituted structure may be incompatible with constraints of the existing structure, which would then require the structure to be dismantled and possible combinations to be calculated. In the worst case scenario, there could be conflicting constraints and preferences being dictated from both the semantic and conceptual level at the roots, the features at the feet and the syntactic relations at the arcs. Discarding a structure and rebuilding with facilitation from previous activation would avoid these possible complications.

1.3.3. Construction Grammar

While TAG and IPG place considerable focus on the processes involved when building a syntactic structure, Construction grammar as proposed by Goldberg (1995, 2006) focuses on the role of syntactic structures themselves in language processing as a whole. In this way, Construction Grammar represents an attempt to reconcile current thinking in theoretical linguistics with contemporary psycholinguistic research. Goldberg draws upon psycholinguistic data on syntactic processing as well as first language acquisition data in the developmental field such as that presented by Tomasello (2003). Construction grammar is based upon the principle of pairing form with meaning; these pairings are referred to as constructions. Constructions occur on a scale from the level of individual words,

referred to as morphemes, to set idioms, e.g. "to kick the bucket'. This idiomaticity continuum (Goldberg 2002) includes many different types of phrases varying in degrees of size, complexity and predetermined specified elements. A determiner phrase is a small, partially specified construction where elements can be substituted in as appropriate, e.g. 'the car', 'the nightmare', etc. Constructions are considered separate entities with unique intrinsic semantic meanings because their meaning cannot always be derived from the separate entities within the utterance. This is especially relevant for English where there is very little inflection and overt case marking, and changes in word order can result in very different meanings.

Constructions vary to the extent which elements are specified or can be substituted. For example, sentences such as '*The bigger, the better*' and similar are examples of the covariational conditional construction ‘The X-er, The Y-er’ (Goldberg, 2006; Fillmore, Kay & O’Connor, 1988). This expresses a relationship between two clauses, neither of which contain a verb, where the proportion of one property is dependent on the proportion of another. The previous example expresses the sentiment that if there is more of something then this will result in a better situation and how much better correlates with how much more. It is still productive but highly specified and a very unusual structure. There are few occasions where an utterance occurs with no verb, unless it is a partial utterance where the rest of the sentence containing the verb is omitted. Even in an example containing verbs, e.g. 'The more you eat, the better it tastes.', the verb final word order is unusual for English. It would also be ungrammatical to attach the equivalent matrix clauses with only a comma, e.g. 'You eat more, it tastes better.'. A spontaneous production like this would require the two phrased to be joined with 'and'.

Bencini and Goldberg (2000) classify ditransitive double object utterances such as “The nun is giving the monk the jug” as associated with transfer. In this case, the syntactic form 'Subject Verb Object1 Object2' is linked to the structural meaning 'X causes Y to receive Z'. The verb and the nouns in this utterance may all be manipulated but as long as the actual words or morphemes used allow a literal or

figuratively relevant interpretation, this structure carries a cause-receive meaning of transfer.

If different structures have to some extent different meanings, it follows that any word orders and structures reflecting features such as tense or voice are considered separate constructions. Instead of proposing an underlying hierarchy of syntactic dominance which is then manipulated to achieve non canonical word orders, construction grammar proposes that non-canonical structures exist as distinct constructions. These constructions specify particular syntactic properties and meanings. For example, the passive voice can be represented by the construction Subj aux VPpp (PP*by*), as in *The boy was kissed by the girl*, and the active voice by the construction Subj V Obj, e.g. *The girl kissed the boy* (Goldberg 2006); whereas at the other end of the spectrum, entire lexical phrases can be stored in the lexicon with specific meanings.

In terms of production, this means that as well as accessing a specific verb for an utterance it is assumed that the speaker also accesses a construction that is semantically congruent for the message being expressed. Syntactic structures are a part of the lexicon so therefore grammatical knowledge is considered to be integrated into the lexicon, and the distinction between abstract grammar and lexical knowledge is unnecessary. In this way, during processing, meaning and preferences stored at the verb, e.g. verb-subcategorisation, are important, but are not the only means of selecting the final structures in which a verb appears. There is an interplay between verb preferences and possibly suitable constructions. This can be seen in the novel use of verbs in structures which are not typically licensed by the verb in common usage.

For example, the verb 'sneeze' is considered an intransitive verb but in the following sentence the verb is used with multiple arguments: a theme and a goal, e.g. "He sneezed his tooth right across the town" (Robert Munsch, *Andrew's Loose Tooth*, Scholastic Canada Ltd., 2002). This usage fits, however, into a 'caused motion' construction such as 'The footballer kicked the ball into the net'. An action (sneezing) causes an object (a tooth) to be transferred to a new location (across the

town). The interlocutor is able to understand this utterance by recognising and accessing the appropriate construction and understanding the novel verb use within this context.

Information about preferred structures and typical language use is stored with the verb in the lexicon but by storing constructions that have their own semantic meanings, the language user is able to create and comprehend novel utterances as the need arises. This allows for a certain degree of innovation and productivity in the language, but novel utterances can still be understood by analogy to already existing structures and context. By storing grammatical information in the lexicon and allowing retrieval of both verb-subcategorisation preferences and larger constructions as distinct entities, construction grammar has certain implications for language processing.

A possible construction grammar account of language production may involve the following processes. A message is formulated at the conceptual level, e.g. the speaker wants to describe the act of a nun giving a jug to a monk. These concepts will activate lemma and possible constructions at the lexical level. So morpheme constructions such as 'nun', 'jug', 'monk' and 'give' will be activated. Constructions representing the meaning at a thematic level will be activated. For example, the meaning constructions 'cause X to receive Y' or 'provide with' may both be activated. Subcategorisation preferences at the verb may only license one of these structures or strongly select for one structure more than the other. Other factors may influence this decision such as the availability of completed component structures possibly reflecting activation levels.

The processor builds all these constructions in parallel: phrase based meaning constructions are accessed at the same time that the processor is building smaller constructions such as determiner phrases, e.g. 'the nun', or the verb 'give'. The smaller constructions are integrated into the larger construction, although this depends on the degree to which the desired phrase construction is lexicalised, i.e. idiomatic. The greater the degree to which a construction is lexicalised the less it will allow substitution of determiner phrases, verbs, prepositional phrases, etc. In

the case of an idiomatic expression, the entire phrase, such as 'pushing up daisies', may be stored as a single lexical item. Flexible constructions can be modified by substituting noun phrases, adjectives, verbs, prepositions, etc as required. For example, *The nun is giving the jug to the monk* or *The cowboy is handing the hat to the teacher* contain different nouns and different verbs but both arise from the construction 'cause X to receive Y'. Also, a verb may be substituted into a construction that it does not categorise for and in this way a novel utterance is produced. This process of integrating smaller structures into larger phrases with meaning allows novel constructions to be built and understood in a systematic fashion.

1.3.4. Grammar Summary

Although Tree-Adjoining Grammar (TAG), the Incremental Parallel Grammar and Formulator (IPG/IPF) and Construction Grammar arise from different disciplines and are created to address slightly different aspects of processing, they share many features and fundamental principles. The above models all assume the principle of parallel processing and that the production system is able to and actively engages in processing of multiple structures and different levels of processing, i.e. conceptual, lexical/syntactic and morpho-phonological processing. Furthermore, these structures which are being built in parallel are assumed to be in competition. The processor builds multiple structures in parallel and the first available structure which does not violate the constraints of the target language is the structure which will be produced and articulated in full. In all the models, the processor builds structures which vary in size. The processor may build smaller structures such as a Determiner Phrase which consists of a noun and an article only, e.g. 'the jug', or the processor may build an entire phrase structure such as a ditransitive structure, e.g. 'The nun is giving the jug to a monk'. These smaller structures are then integrated into larger structures to form longer utterances and complete sentences. This strategy is extremely efficient in a processor which works on structures in parallel.

Having smaller constructions and larger constructions activated in parallel aids the processor flexibility in the production of utterances while operating within the constraints of a specified language. Another necessary assumption underlying this style of processing is that excluding actual articulation, the processor works in an incremental fashion, working on structures as soon as the information becomes available, whether this is conceptual information or phrase structure level information. The processor will attempt to build whichever structures it can and will try to integrate these into a larger structure as soon as it can.

All three approaches posit that syntactic/grammatical information does not exist in a separate isolated location but is part of the information stored in the lexicon and is reflected in the processing that builds syntactic structures. Incremental Procedural Grammar suggests that grammatical rules exist as procedures which are called, but the Incremental Parallel Formulator presents a more detailed approach where information is provided from the conceptual specifications at the root and from information provided at the lemma. Indeed, all the models presented suggest that information for grammatical features including definiteness, number and tense is determined by information from the conceptual message level which is then translated into lexical or grammatical components. More abstract syntactic information such as phrase structures is attributed to information accessed at the lemma. In particular, individual verbs will specify the structures which the licence and degrees of preference for different structures. Verb subcategorisation is a core element for the production of phrases according to all the models mentioned. The ability to store larger structures in the lexicon is a shared property in all three types of grammar mentioned although there is some variance in the degree to which this is considered possible and which structures are included in this. For Incremental Parallel Formulator, TAG and Construction Grammar, it is suggested that the passive voice is a specifically selected structure stored at the lexicon and chosen using meaning information from the conceptual level. This stands in direct opposition to the idea that the passive voice structure is somehow derived from the canonical and more frequent active voice structure which is

assumed to be the default syntactic structure of choice independent of individual verb specifications.

The grammars all advocate the existence of larger structures bridging the conceptual and lexical-syntactic processes which represent the thematic roles and meaning structures specified by the conceptual message. Tree-Adjoining Grammar calls upon a propositional representation, the Incremental Parallel Formulator includes a case frame specifying roles and the idea of meaning structures is integral to the Construction Grammar account of language production. These meaning constructions specify thematic relations but do not specify any syntactic structural information. Finally, by specifying this parallel approach to processing and building structures, language production cannot be viewed as a process where information and structures are simply dictated from a higher level of processing. Integrating multiple structures requires that the processor be able to check whether an integration is permitted or whether it violates thematic or syntactic specifications of either structure. Thematic roles and syntactic roles should agree or be compatible for a successful utterance. The processor should avoid integration which produces a syntactic or thematic violation of the intended message.

As highlighted above, Tree-Adjoining Grammar, the Incremental Procedural Formulator and Construction Grammar are closely related in their approach to language production and share many fundamental assumptions and principles of processing. However, they still vary in how they choose to incorporate and implement these ideas as processing strategies. Tree-Adjoining Grammar presents the basic levels of structures as trees which reflect dependencies and hierarchies. Ferreira (2002) also specifies that verb subcategorisation is crucial to the building of a structure to the extent that component structures such as an initial determiner cannot be assigned and therefore articulated unless it is licensed by the verb of that structure.

IPF presents a very technical computational account of how syntactic structures are built and to a certain extent integrated with morpho-phonologcal information. A very detailed account is given for forming small structures and

integrating them into larger structure, but there is less detail on how processing of larger structures occurs. Structural information is found at the lemma level and particularly at verbs, but there is no account given for how the processor deals with lexicalised idiomatic phrases. A structure designating case is proposed but it is unclear how this fits into the overall picture of syntactic processing. It is unclear how a system largely based on the concept of rules and procedures deals with larger structures, how they are stored and how they are selected.

The main emphasis of Construction Grammar lies with the pairing of forming and meaning. It is with this perspective that it places a great emphasis on the idea of meaning constructions which are stored in the lexicon. Whereas TAG and IPF may propose structures which specify thematic roles relations, Construction Grammar creates a whole vocabulary of meaning structures which are then realised as actual syntactic structures. The model of how syntactic structures are processed is less specific but great explanatory power is given to the interface between meaning and syntactic structures.

1.4. Models

In order to produce an utterance, an abstract conceptual message needs to be mapped to correlating vocabulary items, marked with relevant grammatical information, placed in a suitable order and linked to articulatory features as appropriate for the intended language. This section will provide a general overview of language production models and discuss the underlying assumptions and evidence.

Models of language production have been greatly informed by research on speech errors. Speech errors demonstrate clear effects of interference or malfunction during the production process. Observing which types of error and interference take place and where can provide information as to which processing activities are taking place and when. Evidence from speech errors suggests that errors can occur

at separate levels of processing. Errors such as substitutions, blends, stranding and tip-of-the-tongue state show isolated cases of selection error which can clearly be attributed to a semantic, syntactic, phonological or attentional cause (Garrett, 1988).

Errors during semantic processing can be seen in substitutions like *No-I'm amphibian* (intended: *ambidextrous*) where the wrong word has been selected, and also in blends like *That's torrible!* (intended: *terrible/horrible)* where two related words are blended together as one (Garrett, 1980). Syntactic processing errors can be seen clearly in exchanges like *Oh, that's just a back trucking out* (intended: *truck backing out*) where words and morphemes exchange places but acquire the appropriate grammatical morphemes for those positions (Garrett, 1975). Finally, phonological processing errors can be seen in sound exchanges like *a monkle's unkey* (intended: *a monkeys uncle*), where there has been an exchange of the final sounds of the two words. Information about when and how different aspects of language processing occur can help guide models of how language is produced.

Among those models proposed, there have been models which involve three stages of processing where information feeds forward (e.g. Levelt 1989), two stages of processing which feed forward (Caramazza, 1997) and a spreading activation network where feedback can occur in both directions (Dell, 1986). This thesis focuses on language production models based on Levelt's feedforward models from 1989 onwards, but alternative two stage and spreading activation models are considered first.

1.4.1. Dell's Model (1986)

The spreading activation model (Dell, 1986) consists of four levels of production: semantic, syntactic, morphological and phonological. During production a structure of the utterance is built at each of these levels and these map on to adjacent levels and structures. Some grammatical information is stored at the lexical network as nodes which link to the word entries, such a noun, verb, etc. Other grammatical information is accessed at each level which has a set of rules licensing combinations

permitted and produces frames. For example, the syntactic level may produce the frame "Determiner Noun present-tense Verb Noun" for *this cow eats grass*, and the phonological frame for *this cow* might be represented as "IC V FC IC V" for initial consonants (IC), vowel (V) and final consonant (FC).

Finally, as activation spreads through the levels, the lexical nodes are marked for category so that they may be correctly inserted into the frames. All frames are built in parallel to the extent that is possible depending on necessary information from higher levels. At each level, items are selected for frames according to how highly activated they are and then assigned to a position. Activation can be boosted by activation coming from other nodes or from other levels. Activation of a particular node may be boosted by activation spreading down from a higher level such as the lexicon but also by activation spreading upwards from a lower level such as the phonological level, such as when a phonologically similar word is encountered.

By assuming a processor which selects according to activation levels and spreading activation carrying information in both directions, Dell's model is particularly suited to account for production errors; some anomaly during processing causes an item to be particularly highly activated and thus more likely to be selected and incorrectly assigned. However, this model focuses on the production of speech errors at the morphological and phonological levels, and does not elaborate on syntactic processing beyond the proposal of frames and syntactic information stored at the lexicon. Dell does not discuss whether in the case of possible syntactic alternatives the processor would build all possible structures in tandem or whether any preference for structure could be specified at the lexicon itself. While the model provides a possible account for variation and possible error within a set structure, it fails to address the issue of variance between plausible structures. Spreading activation allows certain information and factors to influence activation levels for individual items but there is no discussion of whether such factors may affect the selection of frames themselves.

As this thesis concerns itself with possible influences of thematic role,

syntactic complexity and verb subcategorisation, the Dell (1986) model would be somewhat limited in its application as most of its explanatory power lies in the integration of morphological and phonological features with syntactic structures. Also, as the influences under investigation are all of a conceptual, semantic or lexical nature, there is little to be gained from a model where activation flows up from the morphological and phonological levels because conceptual, semantic and lexical information would all flow downwards to the level of syntactic assembly. The experimental studies in this thesis do not require bidirectional information flow and the data would not be able to provide any evidence for this as they focus on conceptual and syntactic information, not morphological or phonological features.

1.4.2. Caramazza's Independent Network Model (1997)

The Independent Network (IN) model proposed by Caramazza (1997) consists of a two stage model which does not contain an intermediate level of representation such as lemma which are the abstract representation of a word (Kempen & Huijbers, 1983). Caramazza draws upon language disorders to motivate direct links between lexical-semantic information and the forms produced. According to the IN model, lexical knowledge is arranged in sets of independent networks which connect to each other via a modality-specific node. The lexical-semantic network stores word meanings as sets of semantic properties, features or predicates. The lexical-syntactic network stores a word's syntactic features such as grammatical category, gender, auxiliary type, tense, etc. Within this network are subnetworks corresponding to syntactic functions. Possible subnetworks include category nodes (e.g. noun, verb, etc.), gender nodes (e.g. male, female, etc.), and auxiliaries (e.g. be, have) and other such. Nodes within a network would inhibit other nodes as they are in competition. Phonological-lexeme and orthographical-lexeme networks consist of modality-specific representations of lexical items, most likely the stems. Nodes with these two networks are also inhibitory and in competition.

Activation originates at the lexical-semantic network and spreads out to the

lexical-syntactic, phonological and orthographical networks. It is assumed that while certain syntactic features would not receive activation from the semantic network, features such as grammatical category and verb tense may receive activation, although this would not be sufficient to reach threshold. In order to select the full set of grammatical features for a word, there must be prior activation and selection of the modality-specific node. Activating and selecting a modality-specific lexical form at the phonological- or orthographic-lexeme networks activates its associated phonological and orthographical properties. Selection of grammatical features occurs before selection of phonological and orthographical features but it is possible for these features to be activated before grammatical features are selected thus allowing speech errors to occur. Overall the model operates over two stages; initial activation at the lexical-semantic network and then activation at the lexical-syntactic, phonological and orthographical lexeme networks.

This model rejects a lemma level in favour of direct mediation between semantic and phonological or orthographic stages, primarily because of instances of language impairment where an individual is unable to produce a word in one modality but is still capable of producing it in another modality (Caramazza & Hillis, 1991), and furthermore attempts to produce the word in the impaired modality result in a semantic substitution (Caramazza & Hillis, 1990). Caramazza argued that if syntactic processing had already occurred prior to phonological or orthographic formulation distinct from the semantic stage then semantic substitutions should not occur for this kind of error. A model where semantics links directly with phonological and morphological stages and grammatical information is stored within every network can provide rich grammatical information, but the model not only excludes the lemma stage but also excludes any syntactic processing other than assigning grammatical features. It is suggested that information concerning syntactic structures may come from outside this model of networks, but it is unclear how this would integrate into the system. Activation levels offer an explanation as to how individual items are selected but there are no clear implications as to how syntactic structures should be stored or selected or how

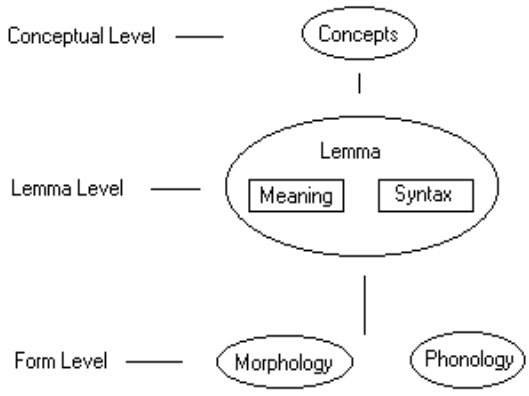
word order is selected within this model.

As morphological and phonological factors are not manipulated in the studies in this thesis, there will be inadequate data to draw any conclusions on the integration of morphological and phonological processes in production. By focussing on what would be the lexical-semantic and lexical-syntactic networks and processes of this model and disregarding the modalities, the narrow scope of the investigation would effectively reduce the lexical-syntactic network to a similar state as a lemma model. Adopting this model would bring little extra benefit as it fails to address the processing of syntactic structures and concentrates on the integration of modality based processing which is irrelevant to the current study.

1.4.3. Levelt's models

Levelt (1989) proposed that a lexical entry contains four types of information: meaning, syntactic category, morphology and phonology. This language production system draws upon this information over three levels of processing: a conceptual level, a lemma level (Kempen & Huijbers, 1983) and a form level. Figure 1 presents a model of these three levels of processing.

Figure 4: A basic model of language production (Levelt, 1989)



An abstract message originates at the conceptual level and links to the lemmas which are closest in meaning. The lemma contains syntactic information such as syntactic category, arguments required and features such as person, number, tense and aspect. At the form level, morphological information becomes available for assigning inflectional information and then phonological information is accessed to begin articulation. It is assumed that morphology and phonology occur last as both lexical and syntactic information is required to produce a word or utterance's final form. As this thesis concerns syntactic processing and the formulation of constituents, the discussion will focus on the processes at the lemma level and will leave discussion of the conceptual and form levels.

Levelt suggested that lexical entries are linked either directly or in a mediated fashion. A direct link may exist between semantically related words such as 'green' to 'red' or 'blue' to words that describe colour. A mediated link may occur between words that share certain features, which need not be semantic features. Words that share morphological, phonological or syntactic features could have mediated connections between them, which could account for speech errors such as, substituting words with the same onset as the intended word.

Levelt argued that a parallel processing system would be necessary. From concept to articulation, language production involves many selection processes including selecting the semantically appropriate lemma, the grammatical features relevant for this construction, the morphological features and the phonological features for articulation. If all these selection decisions were made in a serial fashion then the process would take a long time. Parallel processing allows for quicker selection regarding individual lemmas as well as the possibility of accessing several lemmas at the same time. This allows for a system where several words can be processed simultaneously and then inserted into syntactic structures as they become available, and provides a possible explanation for speech errors with switched words.

Bock and Levelt (1994) adopted the Levelt (1989) model but separated

syntactic processing into two stages: the functional level and the positional level. The functional level accesses the appropriate lexical concepts (lexical selection) and assigns grammatical roles or syntactic functions (function assignment). The positional level creates an ordered structure for words (constituent assembly) and morphology (inflection). For example, at the lexical level a lemma becomes activated. The lemma contains syntactic information for word class, e.g. noun, but then links to a grammatical function node such as 'dative'. The positional level then assigns this to a position in a structure and accesses relevant morphological feature nodes, e.g. singular.

By creating these two stages of syntactic processing, functional and positional, the model allows for word order variation. In English, word order is very strongly linked with syntactic role, but other languages allow much freer word order (e.g. Dutch). Once possible argument structures have been activated, word order can be assigned in an incremental fashion as items become available. In this way, a previously activated or particularly salient item may be highly activated and assigned a position early on in the processing of a structure. However, the speaker may still choose a structure in order to place focus and convey a message with certain emphasis on a particular element.

This two stage approach to production may be somewhat at odds with the grammars discussed earlier. Possible conflict arises over the issue of whether the model allows for syntactic structures to be stored in the lexicon and then accessed as a whole, or whether the positional stage can only assign a syntactic position once the lexeme and thematic role are selected. In Construction grammar (1995, 2006) syntactic structures are stored in the lexicon and a structure is selected which best matches the thematic role requirements. The Incremental Parallel Formulator (De Smedt, 1990) and Ferreira's interpretation of Tree Adjoining Grammar (2002) both allow for structures to be stored in the lexicon (e.g. passive voice) but also build on the idea of working on segments and structures in parallel and dropping or integrating structures as processing proceeds. Also, in Ferreira's TAG interpretation the verb very strongly dictates the structure of the clause it occurs in and this could

conflict with a processor which assigns structure as items become available.

The Levelt, Roelofs and Meyer (1999) model formalised the ideas of processing at different levels into a series of strata and nodes. They presented a three stage model consisting of a conceptual stratum, a lemma stratum and a form stratum. Nodes at the conceptual stratum represent lexical concepts. Nodes at the lemma stratum represent lemmas and their syntactic nodes. Nodes at the form stratum represent morphemes and phonemic segments. At the lemma level, lemmas connect to nodes representing syntactic properties such as category (e.g. verb) and features such as person, number, tense and aspect. Lemmas which share syntactic properties also connect to these nodes. For example, all nouns link to the noun node and all verbs have a link to singular, plural, etc. Having activated the relevant syntactic nodes, the lemma sends activation to the word form stratum. In this way, syntactic information is stored at the lemma level and is accessed with the word lemma as necessary. For example, activation of the lemma for *give* might activate the nodes for verb, present tense, active voice, first person and singular. The first person and singular nodes might have been previously activated by activating the lemma for the pronoun *I*. Individual lemmas representing words access the same nodes representing abstract syntactic concepts.

This model provides a concrete representation of syntactic information and its activation from the lemma level. However, Levelt, Roelofs and Meyer's model does not account for constituent assembly and word order, the positional level proposed by Bock and Levelt previously (1994). It remains unclear how a syntactic structure may be selected after all the relevant syntactic information has been activated at the lemma stage, and there is no indication how this activation leads to a specific word order decision.

Pickering and Branigan (1998) addressed how to represent syntactic structures and extend this model of strata and nodes to include lemma nodes specifying combinatorial information. Once a lemma is selected it activates combinatorial nodes representing the syntactic structures permitted by that node. For example, the ditransitive verb 'give' permits either a structure with a noun

phrase followed by a prepositional phrase (NP, PP) 'the nun giving the jug to the monk' or a double noun phrase structure (NP,NP) 'the nun giving the monk the jug'. Other ditransitive verbs such as 'show' and 'send' allow these structures and will link to the NP,PP and NP,NP nodes as well. This model presents a possible solution as to how representations of syntactic structures may be stored but it does not specify how a specific structure is selected or why there may be a preference for a particular one. This representation of syntactic structures is compatible with models of language processing where syntactic structures or frames are stored in the lexicon or with models where syntactic structure specifies local trees which express dominance hierarchies (e.g. Chomsky, 1981, Ferreira, 2002).

Pickering, Branigan and McLean (2002) argued that constituent assembly occurs in one stage using evidence from a syntactic priming study. One model of syntactic formulation involves individual items being placed in a hierarchical syntactic tree structure distinct from actual word order. Hierarchical relations determine how and which constituents make up larger constituents. This is then manipulated to produce a final word order in the target language which is compatible with the hierarchy. The study found no evidence that word order involves initial positioning in an unordered hierarchical structure. Pickering et al. proposed that constituent assembly or structure selection takes place in a single stage process.

Pickering, Branigan and McLean (2004) proposed a model which integrates a word order mechanism with the combinatorial nodes of the Pickering and Branigan (1998) model. In this model, once a message has been created the combinatorial nodes which fit that meaning are activated and the processor starts building the possible syntactic structures in parallel. The processor starts building by selecting the first highly activated and available word that fits with at least one of the possible activated structures. Any structure nodes which are incompatible with this are inhibited. The processor continues to add words as they become available as long as they fit with an activated structure. As processing continues incompatible structures are discarded until a final structure is completed. This model allows for incremental

production. However, the model does not explain in detail how the processor itself is integrated into the lemma stratum and how conceptual information interacts with syntactic processing, either directly or indirectly. Also, the model does not specify how the word order mechanism links into the form level to the morphological and phonological processes and whether all words are positioned at that point or whether grammatical function words are added later with morphology. While this thesis does not address the interface of syntax with morphology and phonology, it will address the issue of which information may be available to the processor as combinatorial nodes are activated and while word order is selected.

A separate word order processing mechanism would be able to choose the most appropriate structure for each individual context. While the mechanism itself may not be influenced by factors such as animacy, verb subcategorisation and other such usage preferences, it is still possible for these factors to be reflected in the items the processor chooses. For example, a particular word may become highly activated because it has been used recently in the discourse or because it is a particularly salient item in the environment. For this reason, the word order mechanism will select the word for the earliest available position where it is permitted. Factors such as discourse salience, focus, animacy and lexical priming may all facilitate activation of an item or inhibit its competitors, thus leading to an indirect affect on word order.

The availability of individual lexical items does not necessarily explain overall preferences for certain structures. However, it is possible that activation levels for the syntactic structures themselves may differ, and that certain combinatorial nodes may become highly activated. Verbs which show subcategorisation preferences may have stronger links to or cause stronger activation of their preferred structure, although there may still be weak activation of neighbouring structures. For example, this would allow some ditransitive verbs to license both NP,PP and NP,NP structures, while others only permit one of these structures. There may also be variation within those verbs which permit both structures as to their preferences for one alternative over the other. For example, *show* permits both NP,PP and NP,NP structures but may have a preference for

occurring with the NP,NP structure.

In this model, the constituent assembly process remains blind to any non-syntactic information, but through activation levels these factors may influence its choices and by responding only to activation levels it is able to assign any order which is permitted legal by those structures available to it. This system also means that the processor does not necessarily privilege any particular type of information, but that these factors will compete through their influence on activation levels. If this is the case, we should expect to see that structure choice preferences are influenced by many factors such as verb subcategorisation, global syntactic complexity, recent activation and thematic role. The following experiments examine some of the factors that influence structure choice.

This section has considered current models of language production in regard to the issue of selecting syntactic structures. The spreading activation feedback model (Dell, 1986) provides a useful account as to how speech errors may occur through interaction with morphological and phonological stages, but does not address the selection of syntactic structure in great detail. Dell proposes the creation of syntactic frames and rules which license structural combinations, but there is little discussion of where the information and rules which build the syntactic structures come from and how they interact. The Independent Network model (Caramazza, 1997) omits a syntactic processing stage and suggests that syntactic rules exist elsewhere outside of the model of networks. The series of feedforward models from Levelt 1989 onwards do address the issues of which information is available to the syntactic processing stage and how syntactic processing takes places. Successive research has built upon this model to provide accounts for how syntactic information is stored (Levelt at al. 1999), how syntactic structures are stored (Pickering & Branigan 1998) and how they are selected (Pickering et al., 2002, 2004). In the remainder of this thesis, we will frame our discussion in terms of the general architecture proposed by such models.

1.5. Planning and units of production

Investigating planning behaviours and strategies provides information as to which information is available to the processor and when. One possible planning strategy is to select a structure at the outset so that the structure is selected before actual articulation occurs. An alternative strategy is for production to start during planning and before a final structure has been selected. This is a model of incremental production. In this model, the processor starts building a structure and final choice of structure is influenced by information that becomes available during the building of the structure. If the processor starts building before planning is complete then one possible strategy is to build several structures in parallel and for the structures to be in competition. As information becomes available during processing incompatible structures are abandoned and the successful candidate is the first or most compatible structure to reach completion.

As production involves several different levels of processing, planning could occur to differing degrees at different levels. For example, planning at the conceptual level might need to be completed before syntactic processing could start; equally, activation of a word might cause immediate activation of phonological features and the processor could start building phonological structures in parallel with syntactic structures as information became available. This latter suggestion employs cascading activation. Possible interactions between different levels of processing allow many and complex possible models of planning. This discussion will focus mainly on evidence for planning in the selection of syntactic structures but will briefly discuss evidence of other aspects of planning during production.

If it is not possible to plan an entire sentence before production starts, the processor must break up the utterance as a whole into more manageable parts and then integrate these into a large structure. For example, the processor could break a sentence into chunks dictated by the limits of working memory so that the processor handles a certain number of words at any one time. Alternately, a sentence could be divided into phrases according to syntactic preferences; it may be that holding onto

partially completed phrases also incurs memory costs. By examining features in production such as hesitations, pauses and repetitions, it is possible to distinguish where boundaries fall during production and what possible strategies may be adopted by the processor. The following studies using experimental and observational data look at evidence for serial or parallel processing in language production and the preferred unit of planning.

Evidence for serial lexical access in planning an utterance is shown in a study of speech onset times (Meyer, 1996). Speakers described a pair of objects using either a phrase (“The arrow and the bag”) or a sentence (“The arrow is next to the bag.”). An auditory distractor was presented with the picture, which was either related to the first or second noun by meaning or form, or unrelated to both. For both sentences and phrases, mean speech onset was longer when there was a semantic distractor for the first or second noun, but onset was shorter when the distractor was phonologically similar to the first noun but there was no effect for the second noun. These results suggest that lemma selection was occurring for both nouns before production and that phonological processing for the first noun was already underway.

Evidence for serial processing of clauses is demonstrated by manipulating syntactic complexity and its location in single and double clause utterances (Smith & Wheeldon, 1999). Mean speech onset times were longer for sentences starting with a complex phrase ("The dog and the kite move above the house.") than a simple phrase ("The dog moves above the kite and the house"), and also if the second clause was complex. A picture preview of nouns reduced onset delays for the first clause and, to a lesser extent, the second clause. Presumably, picture preview allows participants early access to the lemma representations. These findings suggest that processing of the first clause is initiated fully before production whereas only partial processing occurs for the second clause prior to initiating production.

Further evidence for serial processing of clauses comes from a reaction time study by Ford and Holmes (1978) who argue that ‘deep’ syntactic structures, i.e.

structures containing a verb and its arguments, are a planning unit during production. Surface structures could contain more than one deep structure clause, e.g. *when I finally decided to come to uni*, (‘deep’ clauses are underlined). Participants pressed a button in response to a tone while producing a sentence and reaction time was assumed to reflect processing load. Delays were longest at the end of clauses preceding deep structure (verb) clauses, but no difference was found for surface clauses or prosodic phrases. This suggests that the processing load was greater as planning was already underway for the next deep structure clause. The processor builds syntactic clauses in a series of processing bursts.

Ferreira and Swets (2002) demonstrated that speakers controlled serial planning and processing during ongoing language production where they also solved simple arithmetic problems. Speech onset times were delayed for harder problems when participants were free to speak when they were ready but utterance durations were constant. Both speech onset times and utterance duration were affected by the equation difficulty when participants were induced to speak incrementally by a deadline procedure. The results show that planning occurs both before and during the production of an utterance and that individuals can control the incrementality of an utterance and that it is not just dictated by architectural constraints.

Observation of natural language data provides evidence for ongoing piece by piece processing. Hesitations during speech can indicate difficulty during processing, which may represent difficulties encountered trying to retrieve vocabulary items, trouble with articulation or problems processing syntactic structures. Hesitation data from English and French speakers found that both groups produced output units that were sentences, surface clauses, basic clauses and phonological phrases (Holmes 1995), indicating that utterances were planned as syntactic and/or phonological units. This strategy is evident despite, as Holmes discusses, English and French speakers using different syntactic structures and devices to mark a topic during discourse, (e.g. left-detached topics and cleft sentences in French).

A study of English speakers found that fewer hesitations occurred before embedded clauses than clauses joined with a conjunction (Holmes, 1988). This is compatible with the view that partial planning occurs during the ongoing clause for embedded clauses in comparison to distinct clauses which occur later in the utterance. Across embedded and non-embedded clause types, hesitations occurred for both non-finite verb deep-structure clauses, e.g. infinitives and participles, and finite verb surface structure clauses, e.g. modal auxiliary verbs and verbs with past or present tense. Speakers consistently choose to process unembedded clauses after processing is initiated for the first clause, whereas embedded clauses appear to be processed with the ongoing clause.

Repetition and repair behaviours reflect a tendency to process language in serial units. By repeating an element of speech, speakers give themselves more time to plan an utterance. Clark and Wasow (1998) looked at two corpora of spoken speech observing patterns in the use of repetitions as a strategy for planning. The authors found that repetition of the first word was more frequent when the local constituent or constituent containing it was more complex. Speakers were also more likely to restart a constituent if the hesitation had severely disrupted it. Repetition can be seen to demonstrate the preferences for planning and production units as the speaker chooses to restart an utterance in the format preferred by them self and possibly also the listener.

Van Wijk and Kempen (1987) suggest two separate strategies for repairs made during an utterance: reformulation and lemma substitution. Participants described a visual display where an item was changed during the course of their utterance leading to self-correction. Corrections where new information was added resulted in a syntactic reformulation of the constituent. Corrections where one item in the picture had disappeared and was replaced with another item tended to result in a lemma substitution. When lemma substitution occurred, speakers tended to resume production of the utterance at a point based on morpho-phonological units rather than syntactic units. On receiving new information speakers tended to regenerate the syntactic unit to accommodate these new arguments. Lemma

substitution does not necessarily require a change in the planned structure and so speakers can just regenerate the morpho-phonological unit.

However, there is also evidence for parallel processing in language production. Bock and Cutting (1992) use planning data to support a parallel, architectural model of syntax generation. In an experiment designed to elicit agreement errors, participants produced sentences with discontinuous dependencies which were separated by a phrase or a clause. e.g. "The editor of the history books..." or "The editor who rejected the books...". There were more agreement errors after phrases than after clauses and longer phrases caused more errors but longer clauses did not. Bock and Cutting propose that this supports a model of processing where the initial controlling element is formulated with its clause which then occurs later, rather than a model where the controller is formulated and then the rest of the clause is formulated later. Without this ability it would be very difficult to process clauses which are embedded within another clause before the structure for the first clause has been completed.

Solomon and Pearlmutter (2004) also found evidence for a parallel-activation account of processing in a study of agreement error and semantic integration. Participants completed sentences which started with a phrase containing a head and a local noun, e.g. "The drawing of/with the flower(s)". The relations between head and local noun varied across conditions for local noun number, semantic relation and how closely the nouns were integrated semantically. There were significantly more errors when the local noun was mismatched in number with the head noun and after closely integrated noun pairs (e.g. "of"). One would expect integrated phrases to be easier for a serial model of processing than for a parallel activation model of processing. Parallel processing may be more susceptible to semantic interference because of the greater memory costs incurred as it builds all the phrases in parallel simultaneously.

A production study from Ferreira (1996) supports an parallel processing incremental model of production over one involving competition between possible structures. Participants produced utterances from words presented on a screen and

the time from presentation to onset of speech was measured. Speech onset was faster for verbs which permit multiple structures such as 'give' than for verbs such as 'donate' which permit one structure. Ferreira suggested that having multiple possible structures available facilitates faster processing than having only one possible structure as an incremental processor would be able to choose the most suitable structure as lexical items become available for processing.

In a picture description study manipulating topicality in Odawa (Christianson and Ferreira, 2005), speakers placed topicalized concepts as syntactic subjects rather than in the earliest available position. The native North American language Odawa uses flexible word order and verb forms to express utterances. Participants described pictures of transitive actions involving two human entities. Questions topicalized agent, patient or neither role, in order to manipulate topicalization in the descriptions. Topicalized and thus more accessible concepts were assigned as syntactic subjects and not the earliest available position. Clauses built in parallel allow the processor to select a structure that best matches semantic requirements.

The above studies present evidence for an incremental approach to language production where processing for clauses occurs in an overlapping serial fashion, but the processor builds alternative structures in parallel for a selected clause. However, the case of a clause embedded within another clause necessitates the ability to process two different clauses in parallel even if one clause only undergoes partial processing while the other clause structure is completed. Although evidence from repairs shows that the processor is capable of substituting a single noun phrase during production (Van Wijk & Kempen, 1987), most of the research demonstrates a clear tendency to plan and produce utterances at a clausal unit level. This is not to say that the processor is incapable of working with other units (see Ferreira, 2002), but that the strategy often found in normal production is that of allocating a large part of available resources to a particular clause under construction.

This may reflect how information is received from the conceptual level, as a clause would typically reflect a particular event or state, or it may reflect processing

strategies or costs. Maintaining unresolved argument structures over an extended period may incur high processing costs, or it may affect the cost of building or activating several alternate structures in parallel. By building structures in parallel, the processor is free to select the best fit (Christianson & Ferreira, 2005; Ferreira, 1996)) or the first completed structure all else being equal. As the brain is capable of parallel processing it is inefficient to process in a serial fashion only, but as articulation itself is serial, it is a more useful strategy for overall sentence processing to occur in a somewhat serial fashion.

1.6. Syntactic processing

The theories of grammar discussed previously make different predictions about how language is structured and therefore how it behaves. A number of psycholinguistic studies have investigated possible influences on the processing of syntactic structures, including conceptual, lexical, structural and articulatory factors. By examining whether these factors affect utterances produced, it is possible to find evidence for whether they provide input into the syntactic processing system. Methods used to investigate syntactic processing include description tasks, sentence recall and syntactic priming paradigms. Syntactic priming phenomena have played a particularly significant role in the psycholinguistic study of syntactic processing. The following section includes a brief explanation of syntactic priming before discussing evidence for possible influences on syntactic production. A more in depth discussion of syntactic priming studies relevant to language production issues appears in Chapter 4.

1.6.1. Syntactic priming

Syntactic priming (or syntactic persistence, as it is also known) is the tendency for speakers to repeatedly use a syntactic structure which they have previously

experienced, either through comprehension or previous production. Schenkein (1980) first noted the phenomenon in a piece of naturally occurring spoken discourse: the transcript of a bank robbery published in the Guardian newspaper shortly after the event. He found that the robbers, who were communicating using radios, exhibited a tendency to formulate replies using syntactic structures which they had heard their interlocutor use.

Levelt and Kelter (1982) reproduced these effects in a study using Dutch which included two versions of a question that were identical in meaning but differed slightly in the actual syntactic structure. Shopkeepers were asked on the telephone either *What time do you close?* or *At what time do you close?* to which it is possible to reply *At five o'clock.* or *Five o'clock.* In order to establish that this tendency was syntactic repetition and not merely an artefact of repeating semantic content, Bock (1986a) asked participants to view a sentence and then describe a semantically completely unrelated picture. The study found that there was a significant tendency to reuse the syntactic structures encountered in the previously viewed sentence when describing the pictures. Since these studies psycholinguistic research has been undertaken to understand syntactic priming, i.e. the processes underlying it, the extent to which it occurs and the factors which influence it, but knowledge of priming behaviour has also been used to further understanding of syntactic processing. In this chapter, we will review evidence from studies of syntactic priming and processing which examine possible influences on syntactic processing; in Chapter 4, we will focus on how syntactic priming studies can inform ideas about syntactic representation and mechanisms.

1.6.2. Conceptual influences on processing

According to the models of language processing discussed previously, language production begins when a message is created at the conceptual level and it is then mapped onto the lexical and syntactic levels. It is then possible that information and processing phenomena at the conceptual message level affect processing and choice

of structure at the syntactic level. Increased activation of a concept may cause increased activation of a relevant lexical item which may then be selected for a prominent or early word order position in a syntactic structure. Conceptual or semantic information can be expressed through factors such as animacy, thematic roles or event structure. The following studies investigate conceptual and semantic influences on syntactic processing, such as animacy, thematic roles and event structure.

Initially a study by Bock and Loebell (1990) indicated that conceptual event roles did not play a significant part in syntactic priming processes. Participants described pictures after viewing prime sentences that repeated phrase structure or phrase structure and one other factor, such as event structure, metrical structure or closed class items. There was significant priming between a prime sentence and target picture that shared syntactic structure but differed in event structure, e.g. "The wealthy widow gave her Mercedes to the church" primed "The wealthy widow drove her Mercedes to the church" where the preposition 'to' is being used in a locative phrase. This suggests that priming is purely syntactic because the preposition of transfer 'to' also primed the locative 'to'.

However, Hare and Goldberg (1999) suggested that the ditransitive alternation and the locative structure used by Bock and Loebell (1990) both entail transfer and are too conceptually similar to elicit different degrees of priming. In a picture description priming task, Hare and Goldberg found semantically motivated priming differences using the 'provide-with' and ditransitive structures. According to Hare and Goldberg the 'provide-with' structure, e.g. *His editor credited Bob with the hot story,* has the same syntactic structure as a PO ditransitive but the same thematic structure as a DO ditransitive. More DO responses occurred after a 'provide-with' prime than a PO prime, and DO and 'provide-with' primes primed DO responses to the same degree. This suggests that thematic role priming can occur.

Hare and Goldberg's observation that evidence for priming of thematic roles does not account for all on the findings in Bock and Loebell's data. Experiment 2 in Bock and Loebell (1990) still finds clear evidence of priming

occurring between sentences which share syntactic structure but have decidedly different thematic roles. For example, *The house is struck by the lightening*, where *house* is a patient and *lightening* is an agent successfully primes *The 747 was landing by the tower* where *the 747* is an agent and *the tower* is a location. This suggests that while there is evidence for thematic role priming there is still priming of independent syntactic structure as a separate phenomenon.

Furthermore, in a priming experiment using sentence recall, Potter and Lombardi (1998) found different degrees of priming for structures which are the same except for their event structures. Participants read and recalled a prime sentence followed by a target sentence. In the three conditions the prime and target sentences shared either the same structure and the same event structure (ditransitive dative), the same structure but different event structure (e.g. locative, double NP), or a different syntactic and different event structure in the control condition. After a PO prime, speakers were more likely to recall a DO dative target as a PO dative than after a locative structure. From a non-transformation grammar perspective, such as Construction grammar (Goldberg, 1995, 2006), or Incremental Procedural Grammar (Kempen & Hoenkemp, 1987), the PO dative and the locative share the same syntactic structure, but the PO prime shares the same event structure as the DO target and this facilitates priming of the PO structure when the target is recalled. Similar results were achieved with the DO prime, PO target and non-dative double noun structure. Priming also occurred from primes which shared syntactic structure and not event structure but to a lesser degree than when event structure was shared. This suggests that event structure is also being primed and facilitating production of the syntactic structure.

In two priming experiments using sentence recall, Chang, Bock and Goldberg (2003) again demonstrated thematic role priming but showed also that thematic role priming interacts with syntactic priming. An initial experiment showed priming of thematic roles using ditransitive primes specifing either a Theme-Location structure, e.g. *The maid rubbed the polish onto the table*, or a Location-theme structure, e.g. *The maid rubbed the table with polish* to targets with either a

Theme-Location or Location-Theme structure. A second experiment found syntactic priming only when comparing two types of dative with PO/DO syntactic alternation: the benefactive dative, e.g. *An artist drew /a sketch for the police captain/the police captain a sketch*, and the transfer dative, e.g. *An artist showed a sketch to the police captain/the police captain a sketch*. In this case, syntactic priming occurred even though thematic roles differed and thematic role priming did not occur. Thematic role processing interacts with syntactic processing but this influence is limited.

It is not only important which thematic roles occur but also how many thematic roles occur in an utterance. In a recall priming task, Griffin and Weinstein-Tull (2003) found differing degrees of priming for syntactically identical structures with differing numbers of thematic roles. The study compared production of finite complements of object-raising verbs like *John believed that Mary was nice*, and infinitive complements like *John believed Mary to be nice. Speakers produced more finite complements than infinitive complements* after finite and infinitive object raising utterances than after infinitive object control e.g. *Rover begged his owner to be more generous with the food* and infinitive subject control *Jenny actually intended to be a runner in the race* utterances which have the same syntactic structure but one more event role than the object-raising infinitives. Speakers produced more infinite complements, e.g. *John believed Mary to be nice,* after object-raising primes such as *A teaching assistant reported the exam to be too difficult* than object-control primes such as *Rover begged his owner to be more generous with the food* which have the same structure but a different number of thematic roles. A further experiment showed passive object raising sentences (e.g. *The problem was hypothesized to be in the programmer's search algorithm*) primed to the same degree as subject-raising infinitives (e.g. *Possums sometimes appear to be dead when they aren't*) with which they share syntactic structure only, but not to the same extent as active object-raising infinitives (*The programmer hypothesized the problem to be in his search algorithm*) with which they share thematic structure. Thematic role priming occurs but interacts with syntactic processing and structure preferences.

Thematic role and syntactic argument are both structural properties;

animacy however, is a property of individual nouns. In a priming study, Bock, Loebell and Morey (1992) found evidence that choice of syntactic structure can be influenced by animacy. Participants repeated transitive prime sentences which manipulated the animacy of the agent and patient, and then described a target picture. The pictures showed a transitive scene with an inanimate agent and an animate patient. There was an effect of animacy and of syntactic voice. Inanimate subject primes elicited inanimate subjects, and active primes elicited active targets. Structural priming was evident in this experiment, but animacy also affected the selection of syntactic structures. Animacy provides important information about possible actions so mapping animacy to syntactic representations may be particularly significant. Other evidence also suggests that animacy may determine the choice of grammatical function assignment and therefore syntactic structure (McDonald, Bock, & Kelly, 1993).

In sum, although the influence of thematic roles has been questioned (Bock & Loebell, 1990), increasing evidence shows choice of syntactic structure can be affected by the thematic roles specified (Hare and Goldberg, 1999), the number of thematic roles (Griffin & Weinstein-Tull, 2003) and the event structures (Potter & Lombardi, 1998). Thematic role can interact with structural preferences to boost syntactic priming effects (Chang, Bock & Goldberg, 2003). Finally, animacy, which is a conceptual property of the noun, can also affect choice of syntactic structure (Bock, Loebell & Morey, 1992) although it did not appear to interact with syntactic priming. The studies presented demonstrate that conceptual information can affect syntactic processing as the processor maps conceptual ideas to the best fit or easiest to produce available structure.

1.6.3. Lexical influences on syntactic processing

Syntactic information such as rules or structures may be stored at the lexicon. Individual lexical entries may store details of which structures they permit and further details such as preferences for different permitted structures. For example,

verbs can store information about which structures they occur with. This is referred to as verb subcategorisation. If syntactic structures and grammatical rules are accessed and processed entirely separately from the lexicon, there should be no effects of lexical preference upon the choice of syntactic structures. If the choice of verb does influence the choice of syntactic structure, this indicates that some information about syntactic structures and preferences is stored and accessed with the verb at the lexicon. The following studies examine the influence of individual verbs on the phenomenon of syntactic priming, where syntactic structures are activated and then optionally retrieved in subsequent production.

Ferreira (1996) found evidence that structure preferences specified by the verb affected processing during production. Participants produced utterances from words presented on a screen and the time from presentation to onset of speech was measured. Speech onset was faster for verbs which permit multiple structures such as 'give' than for verbs such as 'donate' which permit one structure. Ferreira suggested that having multiple possible structures available facilitated faster processing than having only one possible structure as an incremental processor would be able to choose the most suitable structure as lexical items become available for processing.

Pickering and Branigan (1998) demonstrated a clear lexical influence on syntactic selection. In a sentence completion priming task, participants completed ditransitive prime sentence fragments which allowed only a prepositional object (PO) or double object (DO) completion and then completed target fragments which permitted either alternation. Priming occurred when the verb was different but was stronger when the verb was repeated. Priming that occurs when there is no lexical overlap suggests that priming may be purely structural. However, the fact that verb repetition enhanced priming suggests that lexical factors such as verb-subcategorisation may still play an important role.

In a corpus study of written and spoken English, Gries (2005) found evidence for structural preferences at the level of individual verbs. Using the British section of the International Corpus of English (ICE-GB), Gries found syntactic

priming for the ditransitive alternation and verb-particle constructions. He also examined subcategorisation preferences for the verbs used in Pickering and Branigan (1998): *give, hand, lend, loan, offer, post, sell, send, show, throw*. Seven of the verbs occur in both dative constructions but *loan* and *thow* only occur as double object datives and *post* only occurs as a prepositional object dative. Individual verbs show preferences for certain structures and this varied between the individual verbs. This suggests that a lexical entry for a verb not only lists which structures are permitted but also the degree of preference for those structures.

Supporting experimental evidence for effects of verb-subcategorisation comes from Melinger & Dobel (2005), who found an influence of verb on structure choice in both German and Dutch. In a priming study, participants read a single ditransitive verb which selected for either a PO or DO structure and then described a target picture showing a ditransitive event. Priming occurred for both German, which has an overall DO preference, and Dutch, which prefers PO structures: speakers tended to produce the syntactic structures previously specified by the prime verb subcategorisation preferences. By using only the verb in isolation, this indicates that priming associated with verbs comes from features associated with the verb itself and not just from the word sequence it occurs with. In previous studies, these factors have occurred together so it has not been possible to observe their separate effects.

Using a picture description priming task, Schoonbaert, Hartsuiker & Pickering (2007) demonstrate cross-linguistic effects of verb-subcategorisation. Speakers of Dutch as a native language and English as a second language participated in a series of priming experiments in Dutch, English as well as between the languages. Repeating the verb between prime and target led to greater priming in monolingual Dutch and English priming experiments and using translation equivalent verbs increased priming from Dutch to English but not from English to Dutch. Syntactic structures received increased activation through compatible verb-subcategorisation preferences in two related languages. Failure to replicate increased priming from English to Dutch could indicate that verb-subcategorisation

preferences for the second language have not yet been reliably learned and preferences from the native language may override them.

Finally, evidence for verb-subcategorisation effects is also found in comprehension (Arai, van Gompel & Scheepers, 2007). Arai et al. found a priming effect in comprehension when the verb was repeated between prime and target sentences. Eye-tracking studies showed that when the verb was repeated between prime and target, there were more and longer anticipatory fixations at the onset of the target verb to the recipient, (as compared to the theme), when participants had previously read a DO prime sentences than a PO sentence, and more anticipatory gazes to the theme after reading a PO prime. There was no effect of priming when prime and target verbs were different. This suggests that syntactic structure activation associated with individual verbs resulted in increased activation of this structure in subsequent parsing of that verb relative to subsequent parsing of a different ditransitive verb for which the activated structure may be equally plausible.

To summarise, the evidence for the association of grammatical structures and the lexicon is quite clear and diverse. Effects of verb-subcategorisation, where structural preferences are specified at the verb, are found in research involving production, comprehension, corpus data, and cross-linguistically. If selection of syntactic structures were purely syntactic then there should be no effect of individual verbs upon the selection of structures. However, verbs are shown to dictate quite clearly which structures are subcategorised by the verb (Melinger & Dobel, 2005) and the degree of preference that exists for alternate structures (Gries, 2005). Furthermore, this strategy is also employed during processing of a second language (Schoonbaert, Hartsuiker & Pickering, 2007), and may even be a feature of advanced knowledge of the language.

1.6.4. Structural influences on syntactic processing

A number of structural priming studies have investigated the processing of syntactic

structures independent of verb preferences and other lexical influences. Syntactic persistence is found across a variety of structures and also for word orders within a specific syntactic structure. Cross-linguistic priming raises the question of whether abstract syntactic structures can also be shared across languages for a speaker using more than one language. In this way, a language learner can build upon syntactic knowledge already present or a bilingual speaker may store information more efficiently by avoiding the redundancy of storing the same structure separately for each language acquired. Syntactic priming can also examine whether the location of a structure within a larger complex utterance affects the choice of structure. Finally, factors affecting choice of syntactic structure can indicate possible processing strategies employed in language production and processing.

Priming has been observed for a variety of syntactic structures. Using a picture description task, Hartsuiker and Kolk (1998) investigated priming for a variety of syntactic structures in Dutch and found that priming occurred regardless of the frequency of a structure. They tested datives and passive structures. Dative primes included prepositional object, double object and medial datives, e.g. *De zeeman schrifft aan zijn vriendin een lange brief* (The sailor writes to his girlfriend a long letter), and passive primes included clause final by-phrase and sentence-final passive participle passives, e.g. *De wandelaar wordt door de modder bevuild* (The walker is by the mud dirtied). A series of experiments found priming effects for all three datives and both passives. Syntactic priming occurred over a variety of structures regardless of frequency. An individual verb can prime any of the structures that it occurs with, not just the structure for which it has the strongest preference.

Cleland and Pickering (2003) examined priming effects in noun phrase structure. Primes consisted of a simple noun phrase *the red square* or a complex noun phrase containing a relative clause *the square that's red*. Significant priming occurred for the complex noun phrases showing that relative clauses could also prime. This effect was enhanced if the prime and target contained semantically related nouns (e.g. *goat* and *sheep*), but it was not assisted if the nouns were phonologically similar (e.g. *ship* and *sheep*). One possibility is that the semantically related nouns increased

activation to the previously used nouns which increased activation to the structures used in the previous utterance, boosting the priming effect.

For languages with a fairly flexible word order such as Dutch, as well as choosing a syntactic structure the speaker must also select the word order within that constituent. Hartsuiker, Kolk and Huiskamp (1999) address this issue in a picture description priming study where participants described pictures using utterances with the same overarching structure but differing word orders, such as *On the table is a ball* and *A ball is on the table*. Participants repeated prime sentences and then described pictures. Hartsuiker at al. found a significant effect of priming for word order and propose that this supports a linearisation process whereby word order within the constituent is selected as opposed to the idea that when a structure is chosen it is already fully specified for all elements.

A further study of priming in Dutch word order (Hartsuiker & Westenberg, 2000) investigated priming of auxiliary verb and past participle in subordinate clauses. Participants were given a sentence completion task in both written and spoken forms. For the written form, participants completed sentence fragments in a booklet and for the spoken condition participants read fragments on screen and gave spoken completions. Prime fragments permitted only one plausible syntactic structure completion but target fragments allowed a choice. There was a significant effect of word order priming for both the spoken and written conditions which further supports a possible linearisation process within the choice of overall constituent structure itself.

However, in a study using spoken and written priming tasks that was discussed briefly above, Pickering, Branigan and McLean (2002) find different priming effects for structures which share the same syntactic dominance hierarchy but differ in word order structure. The study compared PO and DO distransitive structures with the shifted ditranstive construction, e.g. *The racing driver showed to the mechanic the extremely dirty and badly torn overall*. The PO and shifted ditransitive structures share underlying syntactic relations. In an experiment including PO, DO and shifted primes, PO responses occurred less after shifted primes than after PO

primes, but more than after DO primes. Despite sharing a dominance hierarchy, differing word orders affect the degree of priming. Pickering and colleagues propose that constituent structure is selected in one stage as opposed to first selecting syntactic relations and then selecting word order.

In order to test whether priming was a feature of short term memory activation or whether it could be a possible mechanism of long term learning, Bock and Griffin (2000) investigated the robustness of priming over extended intervals. Their study demonstrated that priming effects were robust even when other sentences appeared between the prime sentence and the target, whether there were two sentences or ten. This would suggest that the processing involved in priming occurs as part of underlying linguistic mechanisms and not just as short term memory processing. In this case, priming may be seen as a possible mechanism aiding the acquisition of language as the learner gradually picks up structures in everyday conversations and interactions.

Priming is also affected by the syntactic environment in which the target structure occurs. Scheepers (2003) uses complex Noun Phrases in German to find significant effects of priming for relative clauses with both high and low attachment. For example, in the noun phrase *the score of the candidate who,* the *who* refers to the candidate and is low-attaching, but in noun phrase *the score of the candidate which,* the *which* refers to the score and is high-attaching. Using a written sentence completion task, it was possible to prime both high- and low-attachment relative clauses. Primes containing anaphoric adverbial clauses, e.g. *The assistant announced the score of the candidate, when this…,* were unable to prime relative clause production, indicating that relative clause priming requires the syntactic overlap between prime and target.

In a spoken sentence completion task, Branigan, Pickering, McLean and Stewart (2006) found no effect of global syntactic structure on choice of local syntactic structure. The first six experiments investigated priming effects when global syntactic structure was not shared between prime and target. Ditransitive priming to a main clause target occurred from primes from a main clause, a main clause after an initial adverbial phrase and a main clause after a sentence initial

clause. Ditransitive priming in sentences with main and subordinate clauses found priming to a subordinate clause from primes in a subordinate clause or a main clause, as well as priming from a subordinate prime to a main clause. Further experiments demonstrated no difference in the degree of priming from main and subordinate clauses to a main clause or from main and subordinate clauses to a subordinate clause. Location of prime or target in an overall syntactic structure did not affect priming. This suggests that local syntactic structures are chosen without considering the global syntactic structure. We shall examine this issue further in Chapter 3.

Finally, psycholinguistic evidence suggests that syntactic structures can be shared across languages. Loebell and Bock (2003) asked German – English speakers to repeat aloud a sentence in either their first (German) or second (English) language and then to describe a picture in the other language. Significant effects of priming were found for the dative alternation (prepositional object and double object structures) from German to English and also from English to German. In contrast, there was no effect of priming from German to English or from English to German for passive voice structures which differed in their construction between the two languages. These results suggest that while syntactic priming between languages is possible, it is also necessary for the two languages to share a basic structural form for priming to occur.

Another study using the dialogue priming technique did find significant priming of passives between languages in the case of Spanish-English bilinguals (Hartsuiker, Pickering & Veltkamp, 2004). Hartsuiker et al. asked participants to describe pictures to each other; the confederate produced responses in Spanish and the naïve participant produced responses in English. Participants produced significantly more English passives after hearing a Spanish passive than after a Spanish active or intransitive utterance. Hartsuiker et al. argue that this supports a theory of shared syntactic structures between languages for a speaker of more than one language.

The above priming studies suggest that structures themselves play an

integral role in language processing. The phenomenon of syntactic priming can be found across a variety of structures such as passives (Hartsuiker & Kolk, 1998), noun phrases and relative clauses (Cleland & Pickering, 2003). Priming effects occur in different languages including Dutch (Hartsuiker & Kolk, 1998), German (Scheepers, 2003) and from Spanish (Hartsuiker, Pickering & Veltkamp, 2004). Priming can occur not only for the set of syntactic relations but for the linear word order within a syntactic structure (Hartusiker, Kolk & Huiskamp, 1999; Hartsuiker & Westenberg, 2000).

Evidence suggests that syntactic priming is not a feature of short term memory but part of a long term learning mechanism (Bock & Griffin, 2000), that priming is a feature of dialogue (Branigan, Pickering & Cleland, 2000), and that priming is dependent on the structure itself and not on the underlying hierarchy of syntactic relations (Pickering, Branigan, McLean & Stewart, 2006). It also appears that syntactic structures can be shared between languages such as between German and English (Loebell & Bock, 2003) and from Spanish to English (Hartsuiker, Pickering & Veltkamp, 2004).

These studies demonstrate clearly that syntactic processing is affected and informed by structural information that exists independently of individual lexical item, but the extent of this role remains unclear. Scheepers (2003) finds evidence that a relative clause and its syntactic relations within a larger structure can be primed (Scheepers, 2003), but a later study finds no evidence for an effect of global syntactic complexity on processing of a local syntactic structure (Pickering, Branigan, McLean & Stewart, 2006). It remains unclear whether information from the global syntactic structure affects the choice of a local syntactic structure.

1.6.5. Syntactic Processing Summary

Evidence from the psycholinguistic literature, in particular from syntactic priming experiments, presents a distinct picture of factors which influence syntactic processing during production. Influence on syntactic processing from the

conceptual level can be seen in the influence of thematic roles, event structure and animacy. As predicted there is considerable evidence that lexical information, specifically verb-subcategorisation, influences choice of syntactic structure. There is also extensive research on the influence of structural information on choice of syntactic structure independent of lexical items. This occurs for a variety of structures and languages, and even between languages. Both lexical and structural information contribute significantly to syntactic processing. This thesis will examine lexical and structural influence on choice of syntactic structure, the extent to which they influence choice of structure and how lexical and structural factors interact.

1.7. Unbounded Dependencies

Unbounded dependencies are a phenomenon where there is a dependency between two constituents that may in principle be separated by an arbitrary quantity of intervening linguistic material. Types of unbounded dependencies include relative clauses, *wh*-movement, clefts and topicalisation. In the example *The boy that the girl kissed was embarrassed*, the relative clause pronoun (*that)* which refers to the subject of the main clause (*The boy)* and is the object of the relative clause action (*the girl kissed*) appears in a clause initial position instead of in the canonical position after the verb. Another example is *wh*-movement/fronting in questions like *Which jug is the nun giving to the monk?*. In this case, the direct object (*jug*) does not occur in the usual position after the verb, i.e. g*iving the jug*, but appears in the sentence initial position with the question word *which*. It is only later in the sentence that the *wh*-direct object can be associated with its verb. These structures are of particular interest to linguists as some linguistic theories of grammar propose that unbounded dependencies are formed through movement, e.g. Chomsky, 1965. First, a structure denoting syntactic hierarchies is built and then an unbounded dependency structure is derived through movement.

From the psycholinguistic perspective, unbounded dependencies are of

interest because they require more than one syntactic clause structure to be processed at the same time. In the case of *wh-* movement the *wh-* element is processed outside of the rest of the clause. It is possible to insert other syntactic clauses between the *wh-* element and the rest of the clause, e.g. *Which jug, that had been donated by the Wedgewood family themselves, did the nun give to the monk?*. In this example, the *wh-* element is an argument of both the main clause verb *give* and the relative clause verb *donated*. Theoretically, it is possible to insert any amount of clauses and material between the unbounded dependency and its clause, there is no limit on the number of clauses or amount of material permitted. This raises interesting questions about how the language processor interprets or constructs unbounded dependency structures, and has particularly pertinent implications for an incremental model of processing. How much of the first clause structure is built before starting on the second clause structure? Does this create extra load during processing? If so, which aspects of language processing are affected by the extra processing burden? Are there any processing strategies or linguistic features which affect this process? By studying processing behaviour during this complex task it is possible to learn more about language processing and how various factors interact. The following sections will briefly discuss evidence from several comprehension studies and one production study about the processing of unbounded dependencies and possible theories of how this processing occurs. Detailed discussion of individual unbounded dependency phenomena will occur in later chapters.

1.7.1 Processing of unbounded dependency constructions

In this section, I discuss evidence from comprehension data which provides insight into how unbounded dependencies might be processed. A variety of online and corpora studies investigate how unbounded dependencies are processed, what information is available to the processor, where they are resolved and what elements of processing are involved. There is much debate as to how these findings can be interpreted according to underlying assumptions about what unbounded

dependencies really are in terms of representations and processing. This section examines some of the basic findings, but further discussion about gaps and empty categories can be found in Chapter 2.

Several studies address the question of how the processor resolves unbounded dependencies and where. These questions are linked and the following studies examine whether the processor adopts an incremental approach considering several different sites or whether the processor is limited to specified sites only. Traxler and Pickering (1996) demonstrated that readers assign a role to the unbounded dependency before encountering the gap site, i.e., the site where unbounded dependency would have occurred in a canonical sentence. In an eye-tracking study, participants read sentences where the unbounded dependency was either plausible or implausible (*That's the pistol / the garage with which the heartless killer shot the man yesterday afternoon*). Readers showed more difficulty after encountering the verb when the unbounded dependency was implausible than when it was plausible. A second experiment showed that readers accidentally misanalysed some sentences by treating *book* as the object of *wrote (We like the book that the author wrote unceasingly and with great dedication about while waiting for a contract)* but they did not make this analysis when the sentence involved an island-constraint which prohibits this analysis (*We like the book that the author who wrote unceasingly and with great dedication saw while waiting for a contract*). This supports a model of processing where the processor tries to form dependencies as soon as possible.

Further evidence for incremental parsing comes from a study of parasitic gaps and island phenomena (Phillips, 2006). A parasitic gap is a gap that is dependent upon the existence of another gap in the sentence. If the parasitic gap were to occur on its own it would constitute an illegal gap site, but when it occurs with a legal gap site it is then considered grammatical. The parasitic gap may only occur if there is a filler-dependency in the sentence which then controls the parasitic gap (Engdahl, 1983). For example, **What did the attempt to repair _ ultimately damage the car* is unacceptable but *What did the attempt to repair _ ultimately damage _?* is

acceptable. A word-by-word self-paced reading experiment investigated the effect of plausibility on parsing of parasitic gaps in infinitival subject islands like *The school superintendent learned **which high school students** the proposal to expand drastically and innovatively upon the current curriculum would motivate _ during the following semester* and finite relative clauses islands like *The school superintendent learned which **high school students** the proposal that expanded drastically and innovatively upon the current curriculum would motivate _ during the following semester*. Reading times were slower at the verb for infinitival subject islands in the implausible condition but there was no effect of plausibility for finite relative clause islands. This suggests that readers were trying to assign the *wh*-phrase to the first possible gap (i.e. at the first verb) but only for island structures which permit parasitic gaps.

Other evidence of incremental parsing includes the 'filled gap' effect in reading time experiments. The 'filled-gap' effect is the phenomenon where reading is disrupted when a noun is encountered in a sentence position which was hitherto a plausible site for resolving and positing a gap. Stowe (1986) demonstrated the filled-gap effect when comparing *wh-* filler-gap structures and *if*-structures, and showed also that readers do not posit gaps that would be ungrammatical. A word by word self-paced reading task compared reading times at the object for sentences with *wh-* fillers and for matching *if* -clause sentences like *My brother wanted to know if Ruth will bring **us** home to mom at Christmas.* Reading times were slower at the object (*us*) for prepositional *wh-* sentences compared with *if*-structures and subject *wh-* sentences where the gap had already been assigned, e.g. *My brother wanted to know who will bring **us** home to mom at Christmas*. The filled-gap effect will be discussed in more detail in chapter 2.

Data from an ERP study suggests that readers attempt to resolve a filler-gap at the earliest possible site that is encountered (Garnsey et al. 1989). Participants read sentences which contained a temporary syntactic ambiguity at the point after the verb where the noun could be initially interpreted as either the object of the verb (incorrectly) or the subject of a continuing clause (correctly). The incorrect analysis was either plausible like *The businessman knew which customer the secretary called at*

home or implausible like *The businessman knew which article the secretary called at home*. Readers showed a larger N400 effect at the second verb (*called*) after an implausible filler (*which article*) than after a plausible filler (*which customer*). N400 effects often occur at times of unexpected semantic content, which suggests that readers were trying to resolve the syntactic ambiguity as soon as possible by assigning the filler to the second verb.

Several studies have examined whether information from the verb such as verb subcategorisation preferences affect the processing of unbounded dependencies. A reading study used verb-subcategorisation preferences to test whether readers used a first resort approach, where the processor seeks to assign the filler as soon as possible, or whether two analyses were carried out simultaneously (Pickering & Traxler, 2001). In a self-paced reading study and an eye-tracking study, participants read sentences where the verb subcategorised for a direct object followed by a clause. The unbounded dependency relation involved either a plausible object of the verb or an implausible object (*That's the diver / the event that the coach persuaded the pupils to watch before the tournament*). Readers showed slower reading times after disambiguation when the unbounded dependency relation was plausible than when it was implausible, which suggests that speakers tended to adopt a direct object analysis. There was no evidence of processing difficulty at the critical verb (*persuaded*) when the unbounded dependency relation was implausible. These results suggest that readers considered both the direct object and the clause analyses simultaneously, but found it harder to reject the direct object analysis when the unbounded dependency relation involved a plausible direct object.

This confirms previous findings that readers tend to use verb-subcategorisation information to interpret a *wh*-phrase (Boland et al., 1995). In a word-by-word reading task, participants were asked to decide when the sentence stopped making sense and press a button indicating their decision. Participants read sentences with different verb subcategorisation preferences and a plausible or implausible *wh*-phrase: transitive verbs (e.g., *Which stone did the assistant watch all*

through the night?), object control verbs (e.g., *Which movie did the woman remind to watch the show?*), and dative verbs (e.g., *Which baby did the babysitter read in a funny voice?*). Transitive verb sentences with implausible *wh*-phrases were rated as not making sense at the verb. In object-control verb and dative verb sentences, implausible *wh*-phrases were judged as not making sense after the verb once other possible arguments had been considered. Readers try to resolve dependencies as soon as they can, but they draw upon relevant verb argument in doing so.

Pickering and Traxler (2003) subsequently demonstrated that readers form unbounded dependencies even when subcategorisation preferences suggest that this analysis is unlikely. Once again the sentences contained an unbounded dependency that was either a plausible or implausible direct object of the verb. In two phrase-by-phrase self-paced reading experiments and an eye-tracking study, participants read sentences containing a verb that preferred to take a prepositional phrase completion (*That's the cat that the dog worried compulsively about after going to the vet because of an injury*) or prefers a direct object completion (*That's the general that the soldier killed enthusiastically for during the war in Korea*). Readers showed greater processing difficulty at the verb if the unbounded dependency was a plausible direct object regardless of whether the verb preferred the prepositional phrase. Readers therefore appear not to use subcategorisation preferences when analysing unbounded dependencies. This might seem to contradict the findings of Boland and colleagues (1995) mentioned previously but they are not incompatible. Boland and colleagues showed that readers are aware of, and consider, which structures are possible, but here Pickering and Traxler showed that readers do not necessarily pay heed to which structures are preferred. Instead, readers try to assign the dependency as soon as possible.

Finally, an ERP study investigates whether the distance between the dependency and its resolution affects processing. In an ERP study, readers showed more difficulty processing unbounded dependencies where the gap between the dependency and the verb was long than when the gap was relatively short (Phillips, Kazanina & Abada, 2005). Participants read *wh*-dependency sentences where the

distance between the dependency and the verb was short like *The detective hoped that the lieutenant knew which accomplice the shrewd witness would recognize in the lineup* or long like *The lieutenant knew which accomplice the detective hoped that the shrewd witness would recognize in the lineup*. Readers showed a sustained anterior negativity arising at the *wh*-dependency and continuing while the dependency remained incomplete. A P600 effect occurred at the completion of the dependency which supports the suggestion that the effect is associated with assigning thematic roles and also syntactic processing. Phillips and colleagues also found an N400 effect in the long condition when readers encounter the verb in the first clause after the dependency, where the argument structure prevents completion of the dependency. While the ERP phenomena are affected by the long dependency distance with regards to the times and durations, the size of the effects do not increase with the amount of intervening material before the dependency is resolved. This suggests that there is not an increasing cost of holding the dependency in working memory, but that there is a fixed cost which may arise from the syntactic processing requirements or information of the dependency.

1.7.2 Processing models of unbounded dependency constructions

Any model of processing for unbounded dependencies must be able to account for known psycholinguistic findings and predict further behaviour. Furthermore, such a model must present sufficient motivation for their model in a way which is still compatible with overall language processing behaviour. Ideally, a simple solution should be able to predict complex effects. The following models consider incrementality and computational resources in their models of unbounded dependency processing.

Pickering (1994) proposed an incremental model of processing unbounded dependencies where the processor seeks to form the dependency relation as soon as possible and tries to make semantic interpretations of sentence fragments as soon as

possible. If there are two possible analyses which both form a constituent, the processor will compute both in parallel and then use non-syntactic information to select one analysis. Non-syntactic factors which influence this selection include plausibility, frequency, activation or other factors. Pickering called the imperative for the processor to form a constituent as soon as it is able the 'principle of dependency formation'.

A more computational approach was presented by Gibson (1998) who considered the resource costs. The Syntactic Prediction Locality Theory (SPLT) assumes that processing of unbounded dependencies is affected by two computational factors: integration cost and memory cost. During integration of new words, the processor identifies the syntactic category and relation, assigns a thematic role and adds discourse material, building this information into the relevant syntactic and discourse structures. It is assumed that this processing incurs a cost and that this cost increases when the distance between the elements being integrated increases. Memory costs increase as the number of syntactic categories required to complete a constituent structure increase. Thus, both these costs are heavily influenced by locality. The greater the distance between an incoming word and the nearest dependency, the greater the integration cost. The longer the duration that a syntactic category prediction needs to be held until the prediction is confirmed, the greater the memory cost.

The SPLT theory makes predictions as to which structures will be easier to process than others. For example, SPLT theory predicts that object relative clauses like *The reporter who the senator attacked admitted the error* will cause more processing difficulty than subject relative clauses like *The reporter who attacked the senator admitted the error*. This is verified in a number of reading experiments (Gordon, Hendrick & Johnson, 2001; Mak, Vonk & Schriefers, 2002; Traxler, Morris & Seely, 2002; Wanner and Maratsos, 1978). SPLT also predicts that the Heavy NP effect, where a longer, more complex noun phrase occurs at the end of a sentence, will be easier to process during comprehension than when a heavy NP occurs early in a sentence. Thus, a sentence where a long noun phrase occurs earlier such as *The*

young boy gave the beautiful green pendant that had been in the jewelry store window for weeks to the girl will be harder to process than sentences where the longer, complex noun phrase like *The young boy gave to the girl the beautiful green pendant that had been in the jewelry store window for weeks.* These predictions are verified in the psycholinguistic literature (Hawkins 1990). ERP data also confirms that readers have show greater processing difficulties when the distance between a dependency and gap is long (Phillips at al., 2005). While the SPLT theory is concerned with processing during comprehension, there is some production data which is also compatible with its predictions.

Evidence from production demonstrates a corresponding preference for heavy NPs to occur at the end of sentences during production (Temperley, 2007). A corpus study investigated occurrence of several syntactic structures in the Wall Street Journal and Brown corpus component of the Penn Treebank. Temperley investigated heaviness effects by examining the position of adverbial clauses. Premodifying adverbial clauses like *Because of the stress-reducing effect, she meditates* tended to be shorter than postmodifiying adverbial clauses like *She meditates because of the stress-reducing effects.* Another test investigated relative clauses modifying a main clause subject noun or object noun and found that relative clauses which modified the subject noun like *The stock I bought fell* tended to be shorter than relative clauses which modified the object noun like *She sold the stock I bought.* These and other findings from production (.e.g. Stallings, MacDonald & O'Seaghda, 1998) confirm the SPLT (Gibson, 1998) predictions that shorter distance dependencies are preferred over long distance dependencies. Using a production task, Yamashita & Chang (2001) demonstrated a preference for placing heavy NPs in sentence-initial position for verb final languages and argued that this arises from a preference for shorter distance dependencies. Further discussion of the issues and evidence concerning heavy NP can be found in Chapter 2.

1.7.3. Unbounded Dependencies Conclusion

Comprehension studies investigating unbounded dependencies reveal important information about how structures are processed. They show that during the processing of unbounded dependencies, the dependency is already assigned a syntactic role by the time the verb is encountered. Traxler and Pickering (1996) argue that this immediate association of dependency with verb could be compatible with a processing account where gaps are predicted once the verb has been encountered, or also an account where the dependency is directly associated with the verb itself and a gap is not necessarily required for its processing. This topic will be discussed further in chapter 2. However, it is worth noting at this stage that models of processing unbounded dependencies have focussed predominantly on comprehension, and that there is little evidence or discussion concerning how unbounded dependencies are produced. This is an issue which this thesis wishes to address.

This association of the dependency with a syntactic role occurs regardless of the subcategorisation preferences found at the verb itself, though when a verb subcategorises for more than one structure both possible structures may be considered in parallel. Furthermore, ERP studies show that that readers show evidence of sustained anterior negativity during the ongoing processing of an unbounded dependency which ends in a P600 effect at the point when the dependency is resolved. There is even a N400 effect when readers encounter a verb which does not allow the unbounded dependency to be resolved.

The theoretical models of unbounded dependency processing presented here argue that the processor seeks to resolve unbounded dependencies as soon as possible. Gibson (1998) highlights computational factors such as memory and integration costs which motivate the processor to resolve unbounded dependencies as soon as possible. Pickering (1994) suggests a processor capable of considering possible structures in parallel, and which then uses non-syntactic information to select between the options. These models seem to be well-supported by findings in

the literature. One possible problem for Gibson's model is the ERP study finding (Phillips, Kazanina & Abada, 2005) that while the distance of a dependency affects the timing and duration of activity, it does not affect the amplitude. This appears to counter the assumption that a longer dependency increases processing cost; however, this study does confirm a marked rise in activity during the processing of the unbounded dependency which maybe suggests that while the processing of an unbounded dependency does incur a processing cost this remains at a fairly constant level regardless of the length of time until the dependency is resolved. One can still argue that the total processing cost is still greater because of the sustained activity over a longer duration.

It is reasonable to assume that processing preferences and difficulties encountered during comprehension may also apply to production processing as well. Therefore, if shorter distance dependencies are preferred during comprehension, one could predict that shorter distance dependencies will be preferred in production also. The production data from corpora and experimental studies presented previously reflect the comprehension findings and fit with the behaviour predicted by the processing models. This thesis further investigates the processing of unbounded dependencies during production. The studies included in this thesis employ online spoken production methodologies in order to examine more closely the factors which affect online incremental production and the influence of global sentence structure on the selection of local structures in sentences containing unbounded dependencies. The following chapters will discuss and investigate specific instances of unbounded dependencies such as *wh*-questions and relative clauses.

Chapter 2

Heavy NP and the Production of Unbounded dependencies: Implications for Filler-Gap processing

2.0. Introduction

In the previous chapter, I discussed grammars and models of language production which assume incremental and parallel syntactic processing, and discussed evidence that lexical and structural syntactic constraints affect choice of syntactic structure. This chapter investigates the effect of increased processing load during syntactic processing on the selection of constituent structure in unbounded dependencies.

As we will see, a larger, more complex noun phrase increases the amount of material to process. A processor which works to build a structure incrementally will have a certain degree of flexibility to adopt a strategy or choose a sentence structure which makes the processing of large noun phrases easier or more efficient. For example, in English a complex noun phrase can sometimes be placed at the end of a sentence so that processing of the complex noun phrase can come after the main structure of the sentence is built, e.g. *The nun gave to the monk the blue spotted jug.* This is referred to as heavy noun phrase shift (heavy NP shift). By adopting the less frequent word order, the speaker delays the processing required for the noun phrase until the end of the main structure.

This phenomenon has radically different explanations in different theoretical linguistic grammars. Transformational grammars postulate that there is an underlying syntactic dominance hierarchy structure and that elements are moved within this structure to create a second structure which denotes the actual linear order of the elements (e.g. Chomsky, 1981). In this view, it is assumed that the

moved element leaves behind a trace or gap in the position it originally occupied. However, some alternate grammars, such as Construction Grammar (Goldberg, 1995, 2006), do not propose an underlying structure representing syntactic dominance hierarchies. The construction of syntactic structures involves only one stage and builds the structure which will then be articulated.

In a picture description experiment using unbounded dependencies, I manipulated noun complexity to look for evidence of a gap in *wh*-fronted questions, and to investigate the influences of noun phrase length and processing load upon choice of syntactic structure. First, I will discuss in more detail the existing psycholinguistic research and theories about Heavy NP shift and Filler-Gap theory.

2.1. Heavy Noun Phrase Shift

Many factors have been shown to affect structural choices in production. For example, production experiments show that people tend to prefer structures that place animate entities first (e.g.,*The girl was hit by the branch*) over structures that place inanimate entities first (e.g., *The branch hit the girl*) (e.g. Bock, Loebell & Morey, 1992; McDonald, Bock & Kelly, 1993). Equally, production experiments have shown that people tend to prefer structures that place Given animate entities first (e.g., *The cat caught a mouse*) over structures that place New entities first (e.g., *A mouse was caught by the cat*) (Arnold, Wasow, Losongco & Ginstrom, 2000). But another determinant may be the complexity of the noun phrases associated with different referents.

A speaker may produce a particularly lengthy or complex noun phrase such as *The incredibly articulate but infuriating dinner guest* or *The son of the Professor whose husband came to dinner last Tuesday.* In English, it is possible to choose a word order structure which allows the speaker to place this complex or 'heavy' noun phrase at the end of the sentence. In this way, the speaker can delay part of the syntactic processing load until later in the utterance once the overall sentence structure has

already been established. For example, instead of saying *The girl gave the rather dog-eared copy of the Dickens novel to the teacher,* one could say *The girl gave the teacher the rather dog-eared copy of the Dickens novel*. In the former example, a complex noun phrase is embedded within a ditransitive sentence structure and the speaker must process both structures in parallel to a certain degree or hold the long phrase in memory while building the rest of the sentence structure. First, the processor starts building the main clause initial fragment *The girl gave,* then it starts building the complex heavy NP in its entirety before resuming the completion of the main clause structure. While the processor directs its resources towards the heavy NP it must retain the structure of the main clause, holding both structures in memory simultaneously. In the latter example, the majority of the ditransitive structure can be built before processing of the complex or 'heavy' noun phrase is required. The term 'heavy NP shift' refers to the type of construction in which a complex NP appears clause-finally when it would usually occur immediately following the verb. This section discusses evidence for the phenomenon of Heavy NP shift and processing and theoretical linguistic motivations for this strategy, as well as other possible influences on choice of structure.

In a cross-linguistic corpus study, Hawkins (1990) showed evidence that word order is selected according to processing preferences. He proposes a strategy called Immediate Constituent Attachment (ICA) where structures which rule out structural ambiguity earlier in the structure are preferred to those where ambiguity is resolved later. Counting the number of words until disambiguation occurs provides an estimate of processing difficulty. Hawkins provides data from several languages including English, Japanese, and German. For SOV word order languages, like German and Japanese, complex noun phrases appear earlier allowing a smaller ICA counting left from the verb at the final position of the sentence. This strategy may help reduce memory load or processing load of building parallel structures. Parsing ambiguous structures requires the processor to build a number of possible structures in parallel which increases the processing load and possibly working memory load also. An early disambiguation strategy where a

complex NP is either processed before or after the main structure is built allows resources to be allocated to one structure at a time.

Processing complexity appears not to be the only influence on word order; animacy also affects word order (McDonald, Bock & Kelly, 1993). A series of recall experiments investigated the effect of animacy, metrical information and word length on word order in transitive sentences and conjunctions, e.g. *Salt and pepper*. Participants read blocks of eight sentences and then recalled them in the same order (Experiment 1 only) or in the order of their choice. Speakers tended to recall sentences in a form that placed the animate entity first in sentences and isolated conjunctions though not conjunctions within sentences. In contrast, word length did not affect word order. Prosody influenced word order for inanimate conjunctions, but there was no effect elsewhere. A preference judgement task also demonstrated a preference for animate first order. Evidence therefore suggests that animacy clearly affects word order choice.

Contrary to Hawkins' (1990) assumptions, an experimental study found no evidence that speakers avoided ambiguity in on-line production (Arnold, Wasow, Asudeh & Alrenga, 2004). Arnold et al. compared the prepositional attachment structure, e.g *Give the letter to Kim to me* with less ambiguous goal-early structures double-object G*ive me the letter to Kim* and prepositional shifted *Give to me the letter to Kim*. Speakers read sentences like *A museum received Grant's letters to Lincoln from the foundation* and were prompted with questions like *What did the foundation do?* requiring prepositional structure responses such as *The foundation sent a museum to Grant's letters to Lincoln* (goal-early) and *The foundation sent Grant's letters to Lincoln to a museum* (theme-early). There was no evidence that speakers avoided ambiguities even when explicitly instructed to be unambiguous.

The early disambiguation strategy proposed by Hawkins (1990) offers clear benefits for parsing and the listener, but Wasow (1997) argues that structure processing may be more influenced by the needs of the speaker and that production is easier if syntactic options are left open for as long as possible. Wasow examined the Aligned-Hansard corpus and found that longer, more complex constituents, i.e.

heavy NPs, tended to be shifted to the end of utterances and that this varied in accordance with the type of verb. An analysis of ditransitive verbs like *Pat brought a box to the party* and prepositional verbs like *Pat wrote something on the blackboard* showed that heavy NP shift occurred more for the prepositional verbs. Speakers chose structures which eased processing load during production through NP shift and this tendency also varied according to subcategorisation preferences.

These findings are supported by research from Stallings, MacDonald and O'Seaghdha (1998) where evidence for Heavy NP shift is found across a variety of methodologies. Stallings et al. investigated NP-PP and shifted PP-NP orders in the production of sentences using verbs which allow sentential complements, e.g. *Mary said that Bill would sing*, and verbs which do not, e.g. *Janet transferred the graphs*. Effects of verb type and heavy NP were found for production in a sentence construction task where participants read sentence fragments on a screen and pressed a key to indicate their word order choice, and a subsequent experiment where participants indicated readiness to speak. Participants were more likely to produce a shifted structure in the heavy NP condition or with verbs which can take either an NP or sentential complement. Finally, a recall experiment where participants read sentences and recalled them after seeing a subject and verb prompt found effects of verb type, length and an interaction between the two. Participants were more likely to use a shifted word order with a heavy NP or a sentential complement verb. This tendency increased further when participants recalled structures with both a heavy NP and a sentential verb. The first experiment also investigated animacy but found no effect on word order. The authors suggest that heavy NP and verb type effects on word order are a result of competition during processing.

Heavy NP effects on word order also interact with newness to discourse, as demonstrated in a corpus and experimental study from Arnold, Wasow, Losongco and Ginstrom (2000). In an analysis of the Aligned-Hansard corpus, Arnold and colleagues investigated evidence for heavy NP shift in ditransitive alternations such as prepositional object (PO) structures, *Chris gave a bowl of Mom's traditional cranberry*

sauce to Terry and double object (DO) structures *Chris gave Terry a bowl of Mom's traditional cranberry sauce*. Word order was affected by noun phrase complexity and also by whether the item was new to the discourse in ditransitive structures and structures with heavy NP shift. Newness effects were greater when the noun phrase was a mid-weight heavy NP. A NP was a mid-weight heavy NP when the heavy theme NP contained between one to three words more than the goal NP.

Experimental data confirmed the effects of heaviness and newness, in a task where participants instructed others to give objects to animals on sets of cards (e.g. *Give to the white rabbit the carrot*). Speakers tended to produce heavier noun phrases later in the sentence. This occurred more often with the complex noun phrases which contained four words than the simple noun phrases which contained only two words. This tendency increased if both noun constituents were given and did not differ in newness.

Data from a language with different typological characteristics, Japanese, provides more evidence that speakers choose structure to accommodate incremental production. Yamashita and Chang (2001) showed that longer noun phrases are shifted to earlier positions in the verb-final language Japanese (Yamashita & Chang, 2001). A recall task investigating transitives in Japanese found that longer noun phrases were shifted to the front of the utterance. Participants read sentence fragments before performing a mathematical task and then producing a sentence after being prompted by the verb. A second experiment repeated this procedure with ditransitive utterances and found a tendency to shift longer noun phrases, although longer noun phrases in DO structures tended to shift to sentence internal position rather than sentence initial position. SOV languages exhibit heavy NP shift by moving larger noun phrases to sentence initial or earlier positions in the utterance. Yamashita and Chang propose that shift reflects competition between factors during incremental production and that the verb final structure allows Japanese to place semantically rich heavy NPs earlier in the utterance.

Finally, Pickering, Branigan and McLean (2002) used a syntactic priming study with heavy NP shifted structures to argue that clause structures are selected

in one stage as opposed to first selecting syntactic relations and then selecting word order. This would suggest that heavy NP is just an alternate available structure as opposed to one created through movement or similar. The authors investigated whether priming occurred between sentences that shared dominance only, or whether priming only occurred between sentences that shared both dominance and precedence relations. The former would provide evidence for a two-stage model of language production where first the dominance relations are assigned as one stage and then in a second separate stage dominance relations are mapped onto precedence relations. The latter priming behaviour would provide evidence for a one-stage model of language production where dominance and precedence relations are processed during one stage where they produce a full constituent structure. The study compared PO and DO distransitive structures with the shifted ditransitive construction, e.g. *The racing driver showed to the mechanic the extremely dirty and badly torn overall*. The PO and shifted ditransitive structures share underlying syntactic relations. In an experiment including PO, DO and shifted primes, PO responses occurred less after shifted primes than after PO primes, and indeed did not differ significantly following shifted primes compared to a baseline (control) condition. Despite sharing a dominance hierarchy, differing word orders affect the degree of priming.

The data from studies of Heavy NP shift provides a helpful perspective on the choice of syntactic structures. A key question is that of the motivation and processing reasons for placing a complex noun phrase in either a sentence final or sentence initial position. One perspective suggests that heavy NP shift may help listeners by disambiguating sentences earlier. However, the assumption that speakers choose structures which are easier for their audience to parse is not uncontested (e.g. Ferreira & Dell, 2000). Indeed, another perspective argues that speakers choose heavy NP shift structures in order to make processing easier during production (Wasow, 1997). By delaying disambiguation, the processor is free to choose between structures and can choose the best fit to the processing circumstances in terms of available activated words.

Syntactic complexity is not the only factor which affects choice of structure. Verbs also differ in their subcategorization preferences and hence different verbs are more frequently associated with different syntactic structures (Stallings, MacDonald & O'Seaghdha, 1998). Choice of constituent structure is also affected by non-syntactic factors such as animacy (McDonald, Bock & Kelly 1993) and discourse newness (Arnold, Wasow, Losongco, & Ginstrom, 2000). There is no evidence that speakers select structures which avoid possible ambiguity (Arnold, Wasow, Asudeh & Alrenga, 2004), and evidence suggests that metrical factors only influence order within isolated constituents and not in full utterances (McDonald, Bock & Kelly, 1993).

This suggests that the factors which affect processing are related to conceptual or syntactic characteristics. It appears that complex noun phrases affect structure choice because of their increased processing cost and not because of ambiguity considerations for an audience. Awareness of ambiguity requires consideration of multiple alternatives; the syntactic processor may only be aware of immediate information such as levels of activation and available structures. Nevertheless, noun phrase complexity has a clear effect on structure choice which is observed across various languages, including verb final ones, and in various production tasks.

2.2. Filler-Gap/Empty Categories

The phenomenon of Heavy NP Shift sheds light on the factors which influence choice of constituent structure, whereas study of filler-gap dependencies or empty categories examines how constituent structures are processed, specifically in the case of unbounded dependency structures. The concept of gaps or empty categories arises from a theoretical account of language production that assumes two stages of formation: First, a hierarchical structure defining syntactic relations is built and then elements are moved to create the final word order structure. This is the assumption

common among transformational grammars (e.g. Chomsky, 1965) and, correspondingly, psycholinguists have searched for evidence of a processing analogue. However, alternate grammars such as Construction Grammar (Goldberg, 1995, 2006) do not require empty categories. This section discusses psycholinguistic evidence for gaps, processing of 'non-canonical' or 'unbounded' structures and the possible benefits or theoretical motivations for this processing behaviour.

Fodor (1978) presented a psycholinguistic account of how a parser might process unbounded dependencies using a 'filler-gap' strategy. When parsing a question with '*wh*-fronting' like *What do you want Mother to make for Mary?*, it is not possible to identify the role of the 'wh' word merely from its position at the start of the sentence. Instead, Fodor suggests that upon encountering a 'filler' such as a sentence initial *what*, the parser must then look for a plausible site for this relation to be resolved, a 'gap'. A gap is posited in the position where one would expect to see the noun phrase in a declarative sentence. For example, when parsing *Who did you expect to make a potholder?*, one might posit a gap after *expect*. However, while parsing *Who did you expect to make a potholder for?*, one might initially posit a gap after *expect* but on encountering further material which conflicts with this initial analysis posit a gap after *for.*

This approach corresponds well to popular theoretical linguistic transformational grammars which propose an underlying syntactic deep structure (e.g. Chomsky, 1965), although both Lexical Functional Grammar (Bresnan, 1978) and Head-Driven Phrase Structure Grammar (Pollard & Sag, 1994) present alternate grammars which use 'traces' but do not involve movement. In the transformational grammar model, an initial hierarchical structure is built or projected which outlines the syntactic dominance hierarchy, and the final surface syntactic structure is created though processes such as movement. Structures such as *wh*-fronted questions in English are created by moving the '*wh*-' noun phrase to a higher position in the tree and in their deep structure position they leave behind an empty node or trace. The gaps suggested in Fodor's filler-gap approach (1978) present a psychologically real representation of trace. The parser encounters a moved element

(filler) and as it parses the sentence it projects possible structures including a trace (gap) which is the assumed position of the moved element in the underlying deep structure. It is at this point that the parser is able to identify and fill the gap.

Psycholinguistic evidence suggests that the filler is lexically reactivated at the gap site. Using a lexical probe task, McElree and Bever (1989) showed that a variety of linguistically motivated gaps access their antecedents during comprehension. Participants read sentences a section at a time, then at the site of the gap and also several words later participants saw a probe word. Participants pressed a button to indicate whether they had seen the word before and reaction times were measured. At the later point, responses were faster for Pro-gap (*The stern judge who met with the defense adamantly refused to argue about the appeal*), NP-raising (*The stern judge who met with the defense is sure to argue about the appeal*), Tough NP raising (*The stern judge was difficult for the defense to argue with about the pending appeal*) and pronoun (*The stern judge who met with the defense thought he should argue about the appeal*) *conditions* than for a gapless control. An investigation of passives showed that at the later probe point, responses were faster for passives than for matched active or adjectival sentences. Response times suggest that there is lexical access of the antecedent during the processing of sentences with gaps which enables faster decision times.

Nicol and Swinney (1989) examined a number of on-line studies and conclude that antecedents are reaccessed at possible gap resolution locations. Typically, participants listened to sentences such as *The policeman saw the boy that the crowd at the party accused of the crime* and at various points were prompted to make lexical decisions in response to visual presentation of a word. Several studies demonstrated evidence that *wh*-traces reactivate their antecedent and that this occurs even in a position that is syntactically possible but not semantically plausible. On-line studies of passives suggested that some activation of the antecedent occurs but not significantly so. Reflexives like *herself* also activated their antecedent. In cases of Pro dropped pronouns, such as at the beginning of an infinitive structure, all possible antecedent candidates were activated and semantic or pragmatic

information was required to form the correct association. Thus evidence from different studies and different experiment techniques converge to suggest that there is lexical reaccess of the antecedent at gap sites.

Further evidence for this view comes from the 'filled gap' effect in reading time experiments. The 'filled-gap' effect is the phenomenon where reading is disrupted when a noun is encountered in a sentence position which was hitherto a plausible site for resolving and positing a gap. Crain and Fodor (1985) found that reading times were longer for a filled-gap in a *wh*-fronted question than in the corresponding declarative sentence. Using a self-paced word by word reading experiment, Crain and Fodor presented *wh*-questions where the gap was resolved at the sentence final position and an earlier possible gap position was filled by an NP like *us*, e.g. *Who could the little child have forced **us** to sing for?.* This delay was significantly longer than at the equivalent position in a declarative sentence: *The little child could have forced **us** to sing for Cheryl.* This suggests that readers identify the filler and look for possible gaps during parsing but are forced to reanalyse when they find a potential gap site already occupied by an NP. Also, they retain long distance fillers for consideration even when there is a potential competing filler in a nearer position, e.g. *the child* in the above examples.

Stowe (1986) demonstrated the filled-gap effect when comparing *wh*-filler-gap structures and 'if' structures, and showed also that readers do not posit grammatically incorrect gaps. A word by word self-paced reading task compared reading times at the object for sentences with *wh*-fillers and for matching 'if' clause sentences like *My brother wanted to know if Ruth will bring **us** home to mom at Christmas.* Reading times were slower at the object (*us*) for prepositional *wh*-sentences compared with if structures and subject *wh*-sentences where the gap had already been assigned, e.g. *My brother wanted to know who will bring **us** home to mom at Christmas*.

A second experiment found that a filled-gap effect occurred for a prepositional complement of a verbal phrase like *The teacher asked about **what** the team laughed about **Greg's older brother** fumbling* but not for a matched prepositional

complement of a noun phrase like *The teacher asked **what** the silly story about **Greg's older brother** was supposed to mean.* This suggests that readers did not posit a gap where it would be grammatically incorrect: a gap may appear as a prepositional complement of a verb phrase but not as a noun phrase prepositional complement. Filler-gap effects suggest that readers are using syntactic knowledge to posit gaps in syntactically plausible positions only.

In the verb-final language Japanese, Miyamoto and Takahashi (2000,2003) identified an equivalent phenomenon to the filled-gap effect which they called a `Typing Mismatch Effect'. In Japanese, the scope of a question is not dictated by the surface position of a *wh*-phrase, but by the question particle affixes appearing on either a main clause verb (direct questions) or on an embedded clause verb (indirect questions). Looking at the processing of *in situ wh*-phrases in Japanese using reading studies, Miyamoto and Takahashi demonstrated that after encountering a *wh*-phrase in situ, the processor started looking for a question particle on the verb in the same clause. Reading times were slower for verbs marked with the declarative compementiser *–to* than with the question marker *–ka.* For example, *Senmu-ga donna pasokon-o tukatteiru-**to** kakaricyoo-ga itta-no?* [What kind of computer did the supervisor say the director is using?] would be read slower than *Senmu-ga donna pasokon-o tukatteiru-**ka** kakaricyoo-ga itta* [The supervisor said what kind of computer the director is using].

Aoshima, Phillips and Weinberg (2004) demonstrated further evidence for filler-processing and the filled gap effect in the verb-final language Japanese. A self-paced reading study using a phrase by phrase moving window found that in a sentence with an embedded clause and a *wh*-phrase, readers showed delay if the embedded clause verb was marked declarative like *Dono-seito tannin-wa koocyoo-ga hon-o **yonda-to** tosyositu-de sisyo-ni iimasita-ka? [Which student did the class teacher say to the librarian at the library that the principal read a book for?]* but showed no delay if the embedded verb was marked with a question particle like *Dono-seito-ni tannin-wa koocyoo-ga hon-o **yonda-ka** tosyositu-de sisyo-ni iimasita [The class teacher said to the librarian at the library which student the principal read a book for].* This suggests that

readers try to associate the *wh*-phrase with the first verb encountered, i.e. the embedded verb as opposed to the sentence final main clause verb. A second self-reading experiment showed that the filled-gap effect occurred in Japanese when readers encountered an NP in the pre-verbal position which could potentially be a gap site e.g. *Dono-syain-ni semmu-wa syacyoo-ga kaigi-de* ***kacyoo-ni*** *syookyuu-o yakusokusita-to iimasita-ka?* [Which employee told the managing director that the president promised a raise to the assistant manager at the meeting?]. This suggests that readers do not wait until the verb to resolve the filler.

Finally, a sentence completion task using materials from the previous experiments showed a tendency (61%) for dative *wh*-fronted elements to be assigned to the embedded verb during production in comparison to a baseline control, although this tendency was greater (100%) for *wh*-in-situ. Overall, there appears to be a tendency to associate a filler with the earlier embedded verb rather than the sentence final main clause verb, and that this association occurs before the verb itself is encountered.

Lee (2004) provided evidence of a filled-gap effect in the subject position of a relative clause. In a word by word self-paced reading task, Lee presented readers with English relative clause sentences where the subject position gap was filled, e.g. *That is the laboratory* ***which Irene*** *used a courier to deliver the samples to.* This was compared with sentences where the filler was not compatible with the subject role, e.g. *That is the laboratory* ***to which Irene*** *used a courier to deliver the samples.* Reading time increased at the filler and relative clause subject positions for filled-subject sentences but not for the subject incompatible condition. Readers appear to be predicting a possible subject role for the unspecified filler which requires reanalysis once they encounter the existing subject noun. Readers also appear to be making use of filler role information to rule out the relative clause subject as a possible gap position.

However, Pickering and Barry (1991) argued that traces, which they refer to as an example of empty categories, are not necessary for a model of psycholinguistic processing and that evidence for their existence is insufficient. From a theoretical

linguistic standpoint, there are grammars which do not include a requirement for trace or movement, for example Construction Grammar as proposed by Goldberg (1995, 2006). Instead of a link between a filler and a gap, Pickering and Barry proposed an association between an extracted element, i.e. a filler, and a subcategoriser. The subcategoriser is that element at which the filler's role is disambiguated, this may be a verb or a preposition. There is no assumption or requirement for an extraction site or gap. They suggested that it is more parsimonious not to assume the existence of phonologically unrealised intermediary elements like gaps, and that less common constructions would not then require special processes such as movement.

In this alternate parsing model, fillers are resolved at subcategorisers and the parser is not required to wait until a gap site itself, although if the gap site is before the subcategoriser as in a verb-final language like Japanese (e.g. Aoshima et al., 2004) then the parser must make predictions. Pickering and Barry presented several examples where the benefit of this strategy is apparent. In a sentence with a verb which takes multiple arguments, the site of the gap may not occur adjacent to the subcategoriser but at a later point. For example, in the sentence *In which box did you put the cake?* the subcategoriser is the verb *put* but the gap site would not occur until the end of the sentence after *cake*. There can be a great distance between the subcategoriser and a gap site, e.g. *In which box did you put the very large and beautifully decorated wedding cake bought from the expensive bakery?*. A gap-filling strategy has to wait much longer and do a lot more parsing work before it can finally resolve the filler at the sentence final gap assuming a bottom-up model of parsing.

The hypothesis that gaps are located in the canonical position assumed in an unextracted sentence relies on the assumption that the unextracted form is stable or somehow obvious. However, word order varies even without extraction occurring so how can one decide the canonical order of even an unextracted sentence considering word order flexibility. For example, using NP shift a particularly complex noun phrase may be placed at the end of a sentence and the post-verbal argument order may be reversed: *I put in the box the very large and beautifully decorated*

wedding cake bought from the expensive bakery. If gaps were considered light then any full noun phrase would be considered heavy and the gap could be posited immediately after the verb in this case, but there are also non-flexible word orders where the gap must occur at the sentence final position. For example, *Which book did you give the woman in the heavy winter coat?* from the fixed word order *I gave the woman in the heavy winter coat the book*.

Adjuncts also present a problem for the idea of fixed canonical word orders. In a sentence where adjuncts can occur in various orders, where should the parser expect the gap to be located? For example, for the question *In which park did Bill meet Tom on Tuesday?* both *meet Tom in the park on Tuesday* and *meet Tom on Tuesday in the park* are possible. The assumptions of canonical orders and gaps are dependent upon adopting a theory of grammar which propose preferred canonical orders, which not all grammars do, or on notions of scope which dictate in which order operations occur when one operator occurs within the scope of another.

Finally, Pickering and Barry argued that a filler-gap account of processing accrues a high memory load processing cost. They proposed that it is more efficient to be able to resolve a filler at a subcategoriser rather than at a canonical gap site. For example, the following sentence is difficult because there is a long distance between the subcategoriser *gave* and its argument *the prize: We **gave** every student capable of answering every single tricky question on the details of the new and extremely complicated theory about the causes of political instability in small nations with a history of military rulers a **prize**.* However if the argument *the prize* occurs at the beginning of the sentence closer to the subcategoriser *gave* then the sentence becomes easier to read: *That's the **prize** which we **gave** every student capable of answering every single tricky question on the details of the new and extremely complicated theory about the causes of political instability in small nations with a history of military rulers*. Thus from a perspective of memory load, it seems that it is more efficient for the filler to resolve at the subcategoriser than at a canonical gap site regardless of the processing costs of the sentence.

However, Gibson and Hickok (1993) responded to Pickering and Barry's

(1991) claim that empty categories are unnecessary. They argue that while Pickering and Barry (1991) highlighted valid problems with a filler-gap account where gaps are only posited at the site of the gap itself and after all intervening linguistic material has been processed, this does not rule out the existence of empty categories per se. Instead, Gibson and Hickok proposed that the processor can assign the gap site at the subcategoriser and then continue to parse and build the structure to the left of the gap. This is possible because the gap is a non-lexical item, and thus doing this does not violate the conventional rules for building grammatical structures when parsing. This approach leads to equal performance to Pickering and Barry's category free account of processing for both prepositional *wh*-structures and for complex structures.

In response to Gibson and Hickok's (1993) comments, Pickering (1993) pointed out that while the Pickering and Barry (1991) data is compatible with a predictive gap account of processing, there is no processing reason why one should assume the existence of gaps. The data fails to disprove the existence of gaps but it does not provide any evidence for them either. Pickering argues that current models of processing which posit gaps are motivated by linguistic theories of grammar which include phenomena such as trace and movement, and instead proposes a flexible categorial grammar as one of a number of possible alternate grammars which do not propose gaps.

Pickering assumed the Direct Association Hypothesis (DAH) which claims that the filler associates with the subcategoriser directly without accessing an empty category. A competing model presumes that the filler projects the gap when it encounters the subcategoriser (Gibson and Hickok, 1993). He also assumed that the filler can be associated with the subcategoriser as soon as it reaches the subcategoriser, the Immediate Association Hypothesis (IAH), an assumption that Gibson and Hickok share. The data fails to distinguish the two approaches but Pickering argues that it is unnecessary to presume extra processing specifically for gap structures. If the relevant information can be acquired from the subcategoriser, why then is the gap location itself necessary?

The assumption of an underlying hierarchical syntactic structure also has implications for production behaviour and processing. For example, in a model of production based on transformational grammar, the processor must first build a deep structure of all the syntactic relations, and then manipulate this to build the surface structure which is finally articulated. This is a mediated mapping hypothesis. An alternate account proposes that there is no underlying deep structure and that syntactic properties are built directly into the surface structure. This is the direct mapping hypothesis and correlates with the direct association hypothesis in parsing as suggested by Pickering (1993).

In a priming production study of active and passive structures, Bock, Loebell and Morey (1992) used the tendency to place animates as subjects to investigate syntactic mapping. If passives are derived from an underlying syntactic structure through multiple stages of mapping, a passive prime with an inanimate surface subject has an underlying inanimate object and should facilitate production of an active structure with an inanimate object. In direct mapping, an inanimate subject passive should prime an inanimate subject active. Participants repeated transitive prime sentences which manipulated the animacy of the agent and patient, and then described a target picture. The pictures showed a transitive scene with an inanimate agent and an animate patient. The results showed no evidence of priming from an underlying deep structure, but there were priming effects of animacy and of syntactic voice. Inanimate subject primes elicited inanimate subjects, and active primes elicited active primes. These results found no evidence for deep structures and therefore multiple levels of mapping but suggests instead that direct mapping occurs during syntactic processing in production.

In a recent overview of psycholinguistic research regarding the processing of unbounded dependencies and gaps, Phillips and Wagers (2006) concluded that it is not possible to convincingly argue for or against the existence of gaps from the existing evidence. Reaction time studies can indicate that processing is occurring but cannot necessarily tell you what kind of processing is occurring. Gibson and Hickok (1993) argued that one cannot use processing behaviour at the verb to distinguish

between filler-gap and gap-free accounts of processing because a filler-gap parser may project its arguments at the verb and thus not wait for the gap site itself. Likewise, the data presented by Aoshima, Phillips and Weinberg (2004) on the filled-gap effect in the verb-final language Japanese can also be accounted for by a model where a gap-free parser projects the structure from the arguments it has already processed. Phillips and Wagers argued against the idea that parsimony favours a gap-free interpretation of parsing (Pickering and Barry, 1991). They suggested that syntactic processing still requires gaps and that eliminating this layer of syntactic processing will necessitate further complications in other processing levels to account for syntactic phenomena.

Considering the data presented, the issue of whether or not gaps are physically present during processing remains unresolved. However, there are interesting observations about the processing of filler-gaps or unbounded dependencies. The evidence suggests a model of processing where once the filler is encountered the parser actively seeks a possible site where the filler can be resolved. In particular, the filled-gap effect supports the idea that the parser makes predictions about gap sites and is forced to reanalyse if the initial predictions are incorrect. The processor uses syntactic information to make these predictions taking account of verb subcategorisation preferences and permitted structures to avoid allocating a gap site not permitted by the grammar. Filled-gap effects also occur in verb final Japanese and in other structures like relative clauses; it appears that the parser is able to draw upon a knowledge of syntactic structures and that this processing strategy works for different structures including verb final ones.

What remains unclear is how and where the association between filler and gap site or subcategoriser is formed. Some studies show evidence for lexical reaccess at the gap site, but Traxler and Pickering (1996) present evidence that a direct association is formed between the filler and the subcategoriser itself which can be a verb or a preposition. Evidence of gaps would fit theories of grammar including movement, such as transformational grammars, as well as non-transformational grammars which contain gaps such as some versions of Lexical Functional

Grammar (e.g. Bresnan, 1978) and Head-driven Phrase Structure Grammar (e.g. Pollard & Sag, 1994). However, there are also grammars which do not require movement and gaps, such as categorical grammars or construction grammars. Pickering (1993) argues that gaps or empty categories do not add to psychological accounts of processing. Comprehensions studies have so far struggled to prove or disprove the existence of gaps either way, but there is some evidence from production studies that suggest that syntactic structures are built with direct mapping to surface structures and finding no evidence for an underlying deep structure. The following production study attempts to examine the issue of empty categories and gaps by observing processing behaviour through choice of syntactic structure, thus avoiding the ambiguities found when interpreting comprehension studies of unbounded dependencies.

2.3. Experiment One

In a filler-gap account of language processing, the filler is accessed in full at the site of the gap. Although traces are generally assumed to be phonologically empty, it is perhaps possible that the complexity of a noun phrase may be reflected in the behaviour of the trace. This could be the case for a transformation model of syntactic processing where an underlying deep structure can be transformed through various syntactic operations to a different surface structure. A model where production of syntactic structures involves more than one stage would elicit a different structure to one where syntactic structures were produced in one stage.

For example, an interrogative sentence which includes a heavy NP might have an underlying structure such as *The nun is giving the jug with the red spots to the cowboy*. If the processor first applies a heavy NP shift operation moving the heavy NP to the end of the sentence (*The nun is giving the cowboy the jug with the red spots*) and then applies the 'wh' movement operation, the resulting surface structure will be an interrogative sentence with a Double Object (DO) structure (*Which jug with the*

red spots is the nun giving the cowboy?). Alternately, a transformational model where the 'wh' movement operation occurs first may not require the NP shift and would thus predict a final PO structure.

However, a one-stage model of language production does not predict structure preferences based on underlying movement preferences (Bock, Loebell & Morey, 1992). As the heavy noun phrase appears sentence initially and any extra processing involved in associating the filler with its role will have occurred before or at the verb, it is expected that any further processing will not be influenced by complexity of the filler noun phrase.

In a ditransitive interrogative where the patient is the filler, such as *Which jug with red spots is the nun giving to the cowboy?*, there are two possible underlying sentence structures. For an interrogative which derives from a prepositional object (PO) ditransitive, the gap would occur after the verb: *[...] is the nun giving _ to the cowboy?.* For an interrogative which derives from a double object (DO) ditransitive, the gap occurs in the sentence final position: *[...] is the nun giving the cowboy _ ?.* If the filler is moved after an initial underlying structure is built, then it may be possible to observe word order preferences as a result of heavy NP shift during movement.

In the following experiment, a picture description task using unbounded dependencies, noun phrase complexity is manipulated to look for evidence of gaps in *wh*-fronted questions, and to investigate the influences of noun phrase complexity and processing load upon choice of syntactic structure. Observing choice of syntactic structure in the production of filler-gap sentences provides a novel approach to investigating the factors involved in the processing of unbounded dependencies.

Participants produced sentences relating to pictures that involved ditransitive events. We manipulated whether the depiction of the patient or the beneficiary necessitated a complex heavy NP description by marking the patient or beneficiary with a coloured pattern such as green stars or red spots. Participants were asked to describe the picture using either a declarative statement like *The nun*

is giving the jug with the red spots to the cowboy or using an interrogative statement like *Which jug with the red spots is the nun giving to the cowboy?*. Participants could choose to use either a double object (DO) structure like *giving the cowboy the jug with the red spots* or a prepositional object (PO) structure like *giving the jug with the red spots to the cowboy*.

If production of unbounded dependencies involves a two stage transformational processing model with gaps, then there may be a tendency to choose a DO ditransitive structure during production. In a declarative sentence, when the patient is a heavy NP there is a tendency to place the heavy NP in a sentence final position thereby requiring selection of the DO structure. If the unbounded dependency structure is derived through movement or accesses the entire heavy NP at the gap site, then it is assumed that the unbounded dependency should share this preference for the DO structure. But if production of unbounded dependencies does not involve a two stage transformational model with gaps, then we would not expect to find a preference for the DO structure.

2.3.1. Method

2.3.1.1 Participants

Twenty-six members of the University of Edinburgh community were paid to participate. Participants were native speakers of English. Two participants' data were excluded owing to technical failure. A further four participants were excluded because of missing data in some conditions.

2.3.1.2. Materials

The materials consisted of a set of 128 simple outline cartoon style pictures. There were 32 experimental items and 96 filler items. The 32 target images showed a ditransitive action involving an agent, a patient and a beneficiary. The agent and

beneficiary were always human and the patient was always an object. Human characters and the objects were chosen to be easily recognised. There were 16 character entities of different professions (e.g. doctor, cricketer). There were also 16 objects taken from the Snodgrass and Vanderwart (1980) collection of easily recognisable images, which were edited to allow for patterns and reduced to fit the proportions of the character images. There were three images for each of eight verbs capable of taking either dative structure (give, hand, offer, sell, show, throw, lend, pass). We prepared four conditions for each item. In two conditions (the Patient conditions), the target picture included a coloured pattern on the object thus prompting for a response where the patient noun phrase comprised a determiner, colour adjective, pattern adjective and noun, and the beneficiary noun phrase comprised a determiner and noun. In the other conditions (the Beneficiary conditions), the target picture included a coloured pattern on the recipient of the object thus prompting for a response where the beneficiary noun phrase comprised a determiner, colour adjective, pattern adjective and noun, and the patient noun phrase comprised a determiner and noun. An experimental item consisted of a declarative or an interrogative prompt, and then the target picture to describe. Below are listed the four possible responses for the target card with the verb 'give', the agent 'nun', the patient 'jug' and the beneficiary 'cowboy'.

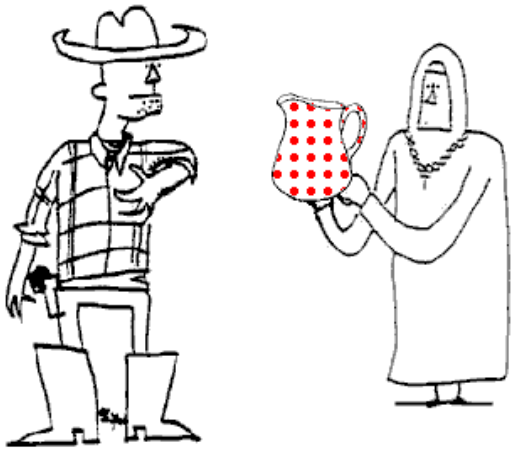
1a. The nun is giving the jug with red spots to the cowboy (Dec., Pat.)
1b. Which jug with red spots is the nun giving (to) the cowboy (Int., Pat.)
1c. The nun is giving the jug to the cowboy with red spots (Dec., Ben)
1d. Which jug is the nun giving (to) the cowboy with red spots (Int., Ben.)

Target picture: nun give jug (patient) cowboy (beneficiary)

The remaining 96 images were filler images depicting either a transitive or intransitive action with a human character as the agent. There were 64 images depicting a transitive action with a human agent and an inanimate object. There

were 16 transitive verbs which were used three times each. There were also 32 images depicting an intransitive action and containing only a human agent. The 8 intransitive verbs were used three times each.

Figure 5: Experiment 1 Target Picture



GIVE

Some of the images contained coloured patterns. There were four colours (red, yellow, green and blue) and four patterns (stripes, spots, checks/squares and stars). These were combined to create a total of 16 unique patterns. The coloured patterns appeared on the inanimate patient in the Patient condition or on the human beneficiary in the Beneficiary condition. The human agent remained blank with no pattern in all conditions and fillers. Inanimate entities displayed the pattern throughout their body but human agents only displayed the pattern on their clothing to remain naturalistic. Half of the transitive fillers included coloured patterns on the inanimate object, which was always the patient. The intransitive fillers did not include any coloured patterns so as to be consistent with the experimental stimulus where the human agent in the agent role was always blank.

For all images, the relevant verb was shown below each picture. Images were balanced as to orientation with actions occurring from left to right and vice versa.

There were also two 'prompt' images which indicated whether the participant should produce a declarative or an interrogative. The declarative prompt presented the participant with the sentence initial fragment "The…" and the interrogative prompt presented the participant with the sentence initial fragment "Which…". These were presented at font size 36 and using the font type Arial Western.
The experiment used four lists containing 32 experimental items, including eight from each condition, and 96 filler items. The items were randomised so that at least two fillers were present between each experimental item. One version of each item appeared in each list. In this way, the two conditions of Sentence Type (Declarative vs. Interrogative) and Heavy Noun Phrase (Patient vs. Beneficiary) were manipulated within subjects and items.

2.3.1.3 Procedure

The participant sat at a desk with a computer, monitor and button box in front of him or her. The experiment used the ePrime program, which displayed images or prompt screen files to the participant. Each participant in the experiment experienced a different ordering of items.

Participants were instructed to describe the image that they saw on screen using a full sentence or by formulating the sentence into a question. When the participant was forming a question, they were instructed to ask about the object if there was an object present. Participants were reminded to include descriptions of colours and patterns if they were present. First the participant received a set of written instructions with examples of pictures and possible descriptions. The examples included one transitive image, one transitive image with colour and pattern and one intransitive.

After confirming that the participant had understood the written instructions, the participant then started the experiment on the computer. First the participant was presented with brief instructions on screen and then they started a practice trial. The practice trial consisted of 16 practice items. The participant saw a

prompt screen indicating whether a interrogative or declarative sentence was needed. The prompt screen was displayed for 1500ms and then the target image would appear. The practice set consisted of eight transitive filler images, four intransitive filler images and four ditransitive practice images which did not occur in the actual experiment. When the participant had finished producing a descriptive utterance, they would press any button on the button box to call up the next prompt and picture.

The participant then proceeded on to the actual experiment which was the same procedure as the practice trial. The participant would see a prompt screen for 1500ms indicating that either a declarative or an interrogative phrase was required. The image would then appear on screen and the participant would produce a sentence verbally. The image remained on screen until the participant pressed any button on the button box to bring up the next prompt and image. The experimental session lasted about 30 minutes.

2.3.1.4. Scoring

The experimental session was recorded on audio tape and transcribed. The first response that the participant gave was coded and scored. Responses were coded as: PO when a prepositional object construction with 'to' was used (NP, PP) e.g. "The nun is giving the jug to the cowboy", or DO when a double object construction (NP, NP) was used, e.g. "The nun is giving the cowboy the jug".

Responses were coded as 'Other' when a different syntactic structure or preposition was used, such as a passive or patient-first passive construction, e.g. "The cowboy is being given the jug by the nun" or "The jug is being given by the nun to the cowboy". A response was coded as 'other' if the patient appeared first in a declarative sentence, e.g. "The jug is given to the cowboy by the nun.", or if in the interrogative condition the participant asked about the beneficiary instead of asking about the patient as instructed, e.g. "Which cowboy is the nun giving the jug to?". Producing a response in the wrong condition, e.g. a declarative instead of an

interrogative, was coded as 'Other'. Responses where thematic roles were switched, e.g. 'nun gives cowboy' becomes 'cowboy gives nun', were categorised as others. Responses were also coded as Other when a different verb was used from that given, or when description was improvised or attributed to the wrong noun phrase, e.g. "The nun gives the red spotted jug to the dangerous looking cowboy", as this would affect the relative weights of the noun phrases.

2.3.1.5. Design and data analysis

This study used a 2x2 within-participants and -items factorial design with the factors Sentence Type (declarative vs. interrogative) and Heavy Noun Phrase (patient vs. beneficiary), Heaviness was defined by whether a noun phrase included a description involving a coloured pattern, e.g. "the jug with the red spots".
The data was analysed using proportions so that analyses would not be affected by any missing data. For example: the proportion of Declarative Patient-heavy PO responses was calculated by dividing the number of Declarative Patient-heavy PO responses by the number of Declarative Patient-heavy PO, Declarative Patient-heavy DO and Declarative Patient-heavy Other responses, the proportion of Declarative Patient-heavy DO responses was calculated by dividing the number of Declarative Patient-heavy DO responses by the number of Declarative Patient-heavy PO, Declarative Patient-heavy DO and Declarative Patient-heavy Other responses, and the proportion of Declarative Patient-heavy Other responses was calculated by dividing the number of Declarative Patient-heavy Other responses by the number of Declarative Patient-heavy PO, Declarative Patient-heavy DO and Declarative Patient-heavy Other responses.

2.3.2 Results

In total 640 (100%) of Production/Experiment trials were completed, of these 495 (77%) were followed by PO target sentences and 45 (7%) were followed by DO

target sentences, and the remaining 100 (16%) were Others. Proportions of target response in the different conditions are reported in Table 1. The two factors in the analysis were Sentence Type (declarative vs. interrogative) and Heavy Noun Phrase (patient vs. beneficiary). Analyses were conducted treating participants (*F*1) and items (*F*2) as random factors. Separate analyses were carried out for PO target responses, DO target responses and Other responses; all were analysed by participants and by items.

Two-way ANOVA analyses were performed on the proportions of PO target responses in each condition. There was no significant effect of Sentence Type (Fs < 1). There was no significant effect of Heavy Noun Phrase (Fs < 1). There was no significant interaction between Sentence Type and Heavy Noun Phrase (Fs < 1). Simple main effects showed no effect of priming for Declarative sentences (Fs < 1) or Interrogative sentences (Fs < 1).

Two-way ANOVA analyses were performed on the proportions of DO target responses in each condition. There was no significant effect of Sentence Type (Fs < 2). There was no significant effect of Heavy Noun Phrase (Fs < 1). There was no significant interaction between Sentence Type and Heavy Noun Phrase (Fs < 1). Two-way ANOVA analyses were performed on the proportions of Other target responses in each condition. There was a significant effect of Sentence Type with more Other response occurring in the Interrogative condition than in the Declarative condition ($F1(1,19) = 6.185$, $p < .05$, partial $\eta^2 = 0.246$; $F2(1,31) = 15.393$, $p < .001$, partial $\eta^2 = 0.332$). There was no significant effect of Heavy Noun Phrase (Fs < 2). There was no significant interaction between Sentence Type and Heavy Noun Phrase (Fs < 1).

Table 1: Mean proportions of target responses by condition (By participants analysis)

Sentence Type	Heavy Noun Phrase	Target Description		
		PO	DO	Other
Declarative	Patient	.79	.11	.11
	Beneficiary	.79	.09	.12
Interrogative	Patient	.76	.05	.20
	Beneficiary	.73	.04	.23

PO = prepositional object, DO = double object

Table 2: Number of target responses by condition (By participants analysis)

Sentence Type	Heavy Noun Phrase	Target Description		
		PO	DO	Other
Declarative	Patient	129	17	14
	Beneficiary	128	15	17
Interrogative	Patient	122	6	32
	Beneficiary	116	7	37

PO = prepositional object, DO = double object

2.3.3. Discussion

Experiment 1 investigated heavy noun phrase shift in the production of declaratives and unbounded dependencies. In this experiment, participants produced declarative and interrogative sentences relating to pictures depicting ditransitive events in which either the patient or the beneficiary had to be named using a

complex NP. If participants preferred to place complex NPs in sentence-final positions, we would have expected a greater tendency to produce one preferred structure reflecting this preference in each condition. In the case of a heavy patient noun phrase, e.g. *the jug with the red spots*, we would expect a tendency in the declarative to produce DO structures where the heavy NP occurs at the end of sentence: *The nun is giving the cowboy the jug with the red spots*. Assuming an account of movement in syntactic production, one would predict that interrogatives with a heavy patient NP would also select a DO structure. In contrast, for declarative sentences with a heavy beneficiary NP, e.g. *the cowboy with the red spots*, one would predict a tendency to produce PO structures: *The nun is giving the jug to the cowboy with red spots.* Similarly, a movement account predicts a tendency to produce PO structures for interrogative sentences with a heavy beneficiary NP.

However, there were no significant effects or interactions for either PO or DO ditransitive responses, which suggests that the materials failed to elicit a heavy NP effect and there was no difference in the ditransitive structures produced for the two sentence types, i.e. interrogative or declarative. Overall, speakers produced mostly PO structures for both the declarative and interrogative utterances, 79% and 74.5% respectively. However, analysis of the Other responses reveals a significant effect of Sentence Type: More Other responses were produced in the Interrogative condition. This finding shall be discussed in more detail later in this section.

The failure to produce an effect of heavy NP suggests that our heavy NPs may not have been heavy enough for this context or that heaviness may not affect the choice of PO/DO structures. Heavy NP shift in ditransitive sentences has been demonstrated in experimental conditions in both English (Arnold, Wasow, Losongco & Ginstrom, 2000) and Japanese (Yamashita & Chang, 2001), so it is certainly possible to elicit heavy NP shift with this structure. If heavy NP shift had occurred in the declaratives but not in the interrogative sentences, other possible explanations would have been eligible for consideration. It might have been possible to infer that movement did not take place during production of interrogatives, thus supporting the direct association gap-free account of processing. There is also the

question of which ditransitive structure is assumed to be the underlying default. Both PO and DO declaratives are possible, but the DO structure could be interpreted as derived from the PO declarative through movement. Unfortunately, as heavy NP shift did not occur in either condition, this suggests that these issues cannot be addressed with this data.

However, analysis of the Other responses revealed an effect of Sentence Type, whereby significantly more Others were produced in the Interrogative condition. This suggests that speakers were having difficulty with either the structure or the task. A number of the Others were produced in the passive voice, e.g. *Which jug is being given by the nun to the cowboy with the red spots?, Which jug with the red spots is being given to the cowboy by the nun*. In the interrogative conditions 44% (54) of Other responses were passive and 56% (68) were active or errors, whereas in the declarative conditions 13% (9) of responses were passive and 87% (63) were active or errors. If speakers had simply found the task difficult then one would expect the Other responses to consist of incomplete or error responses. As speakers chose to produce an alternate syntactic structure with the same semantic content, a passive, this might suggest that speakers possibly found the Interrogative ditransitive structures harder to process than the Declarative ditransitive structures or showed a strong aversion to producing them.

Passives are a dispreferred structure in English (Svartvik, 1966) and people show more difficulty in the comprehension of passive structures than actives (Ferreira, 1994). Speakers were more likely to make errors identifying the agent of an action in a passive sentence such as *The cowboy challenged the sheriff*. It is therefore both interesting and unusual that speakers in Experiment 1 often chose to produce passive voice sentences in preference to the active voice interrogatives. One possible relevant factor is that passives allow the object patient or theme of the action to occur in the subject position, e.g. *The girl was frightened by the painting*. This kind of structure brings the patient or theme into focus. This may be necessary to fulfil pragmatic requirements.

In the interrogative condition of the experiment, participants were asked to

always enquire about the object in the picture, e.g. *Which jug with the red spots is the nun giving to the cowboy?*. Participants may have interpreted this request as placing particular importance or emphasis on the object, or it may have seemed more natural to them that a question where the theme was the focus of the enquiry should be produced with a passive structure. Therefore, it is possible that either the nature of the task or the complexity of the structures which they were asked to produce led to a tendency to produce passive structures as a better possible thematic and pragmatic fit.

The tendency towards passive voice cannot be attributed to a verb-subcategorisation preference in this case, as it occurred more in the Interrogative conditions than in the Declarative conditions, whereas one would expect a verb-subcategorisation preference to be evident in both. These findings suggest an influence of syntactic complexity or the processing associated with a larger complex structure upon the choice of syntactic structure independently of verb-subcategorisation preferences.

2.3.4. Conclusion

This chapter has discussed the phenomenon of heavy NP shift and evidence for a filler-gap account of two-stage syntactic processing. Previous studies trying to ascertain the existence or otherwise of gaps have been inconclusive. The research in this chapter examined effects of heavy NP shift in the production of unbounded dependencies to look for evidence of movement in syntactic structures. An experiment using a picture description methodology investigated the effect of heavy NP shift in the production of declarative and interrogative sentences. The experiment failed to elicit a heavy NP shift in any condition, and thus provided no relevant data for the analysis of heavy NP shift and evidence for movement. However, scrutiny of the Other responses suggested that participants produced a surprisingly high proportion of passive structures (almost half of all Other

responses) in the interrogative conditions, though they produced the expected low proportion of passive structures in the declarative conditions. Speakers sometimes chose to produce the usually dispreferred passive voice structure (Svartvik, 1966) instead of producing active voice interrogative ditransitives. We suggested that syntactic processing complexity or structure preferences might have influenced the choice of syntactic structure independently of lexical verb-subcategorisation preferences. This issue will be investigated further in the following chapter.

Chapter 3

Lexical and Structural determiners of syntactic structure in the recall of simple and complex sentences

3.0. Introduction

In the previous chapter we unexpectedly observed that speakers sometimes produced passive structures. It is not clear in current models of production why such a preference should occur. While current models of language production such as Levelt, Roloefs & Meyer (1999) and Pickering & Branigan (1998) present models of how syntactic information is accessed during production, they give little explanation as to how a particular set of information or a particular structure is selected. The suggestion that relevant syntactic information becomes highly activated and is selected still leaves the question of how this activation occurs and what factors influence it. This chapter looks at why a speaker might choose to use a normally dispreferred structure such as the passive, and which factors might influence this choice, such as verb-subcategorisation preferences and preferences arising from structural constraints. Verb-subcategorisation preferences are lexically determined and arise from the individual verbs themselves whereas structural constraints are associated with the syntactic structure.

Preference for a syntactic structure may come from the verb which may specify particular roles and arguments. For example, the verb *love* requires two arguments, an experiencer *The girl* and a theme *the boy*. This can result in corresponding preferences for syntactic roles and structures. For example, experiencer-theme verbs may show a preference for the active structure as the experiencer appears in the subject role such as *The girl loves the boy*. This would suggest that the preferred structure for that verb would be selected whether the verb

appeared in a matrix clause or a different type of clause such as a relative clause.

Alternately, there may be general structural constraints, but these might differ in different syntactic contexts, resulting in different structural preferences for different types of clauses. For example, active voice structures are generally preferred in matrix clauses such as *The girl kissed the boy*, but there may be different structure preferences for a relative clause such as *The boy that the girl kissed was embarrassed* or *The boy that was kissed by the girl was embarrassed*. Differing structural constraints could be an effect of possible increased complexity of the relative clause compared to the matrix clause. Whereas the matrix clause sentence involves only a single clause, the relative clause is also integrated into a larger complex sentence structure and this may affect how it is processed. This may be thought of in terms of an overall global structure of a sentence. If structural constraints affect choice of structure, then we could predict that choice of structure would be different depending on whether the structure appeared in a matrix clause or a relative clause.

Two recall experiments investigate the choice of syntactic voice structure (passive vs active) by manipulating structural constraints and verb-subcategorisation preferences. The experiments compare syntactic structures in matrix clause sentences and sentences including a relative clause. A second experiment introduces the factor of verb-subcategorisation using experiencer-theme verbs which belong to the psychological state category of verbs. Data from these experiments suggest that both verb-subcategorisation preferences and preferences from structural constraints affect the choice of a local syntactic structure and that these factors interact. First, this chapter will discuss the processing of relative clauses in comprehension and first language acquisition, as well as considering passive voice structure and the role of experiencer-theme and theme-experiencer verbs in syntactic production.

3.1. Processing of relative clauses

Relative clauses are clauses which modify a noun, e.g. *The boy that the girl kissed was embarrassed.* This chapter focuses on two ways that the relative clause can modify a matrix clause noun. In a subject relative clause, the matrix clause noun that is modified is the subject of the relative clause, e.g. *The boy that kissed the girl was embarrassed.* In an object relative clause, the matrix clause noun that is modified is the object of the relative clause, e.g. *The boy that the girl kissed was embarrassed.* The following section discusses comprehension and first language acquisition data on the processing of different types of relative clause structures in order to identify which aspects of relative clause structure are associated with differences in processing difficulty.

Comprehension studies can provide valuable insight into the processing issues associated with particular structures such as relative clauses. Structures and factors that cause processing difficulties during comprehension may correspond to processing difficulties encountered during production. Evidence from comprehension suggests that there are overall differences in processing difficulty associated with subject versus object relative clauses (Wanner & Maratsos, 1978), but that these are mitigated by a variety of non-syntactic factors, suggesting that overall preferences are not immutable. This finding is robust across reading time measures (ibid.), eye-tracking studies (Traxler, Morris & Seely, 2002) and ERP studies (Weckerly & Kutas, 1999). Evidence from first language acquisition showing that children produce object relative clauses later than subject relative clauses supports this view (Diessel & Tomasello, 2001). Processing difficulty of relative clauses during comprehension cannot be attributed to working memory load as high working memory span does not appear to facilitate production of relative clauses(Traxler, Williams, Blozis & Morris, 2005). Also, when animacy and other semantic factors are manipulated, object relative clauses cause no more processing difficulty than subject relative clauses (Mak, Vonk & Schriefers, 2002). The processing of relative clauses appears to involve an interaction between syntactic

complexity and thematic role or semantic considerations.

In a self-paced word by word reading experiment, Wanner and Maratsos (1978) found that people showed more difficulty processing object relative clauses than subject relative clauses. Participants read sentences containing either a subject or object relative clause, but at some point they were interrupted and given a list of five names to remember. At the end of the sentence they were asked either to answer a comprehension question about the sentence or to recall the list of names. There four possible interruption points: *[1] The witch who despised [2] sorcerers/whom sorcerers [2] despised frightened [3] little children [4].* There were more errors after object relative clauses than subject relatives, and this was greatest at the second interruption point compared to the other positions. Wanner and Maratsos suggested that the position within the relative clause and also object relative clauses in particular carry a greater processing and memory load as the role of the relative pronoun must be held in memory (see also King & Just, 1991; Just & Carpenter, 1992; and Waters & Caplan, 1992; but I refer the reader to later discussion of Traxler, Williams, Blozis & Morris, 2005, in later paragraphs).

However, the processing difficulty of relative clauses can be affected by non-syntactic factors such as animacy. Mak, Vonk and Schriefers (2002) demonstrated animacy effects of relative clause processing in corpora and experiments. Studies of the Dutch language newspaper *Trouw* and German language newspaper *Die Welt* showed that for both languages object relative clauses almost exclusively occurred with an inanimate sentential noun and an animate clause noun like *the stone that the boy threw*. Experimental data from Dutch including a self-paced word-by-word moving window reading task and an eye-tracking study found that the difference in reading times between object relative and subject relative clauses disappears when the sentential subject is inanimate and the clause subject is animate. For example, *Vanwege het onderzoek moet de bewoner, die de inbrekers beroofd hebben, nog een tijdje op het politiebureau blijven* [Because of the investigation, the occupant, who the burglars robbed, had to stay at the police station for some time]. This suggests that syntactic complexity interacts with other factors during processing.

Further experimental work manipulating animacy of sentential and clause nouns in Dutch relative clauses suggested that the subject roles are associated with particular thematic roles (Mak, Vonk & Schriefers, 2006). In a self-paced word-by-word reading task, reading times were longer for object relative clauses than subject relative clauses when both sentential and clause noun were inanimate. For example *`de lekkages, die de gel verhelpt'* [`the leakages, that the gel remedies'] (object relative clause condition). A further self-paced reading task and an eye-tracking experiment confirmed that reading times are the same for subject and object relative clauses when the sentential subject is inanimate and the clause subject is animate. For example, *'de rots, die de wandelaars weggerold hebben'* [`the rock, that the hikers have rolled away '] (object relative clause condition). However, when the sentential subject is animate and the clause subject is inanimate, reading times are longer for object relatives than subject relatives. For example, *`de wandelaars, die de rots verpletterd heeft'* [`hikers, that the rock has crushed'] (object relative condition). Mak and colleagues propose that these animacy effects reflect a tendency to assign as subject in a relative clause a noun which is already the topic of the preceding main clause.

Eye-tracking data confirmed the processing difficulty associated with object relative clauses, but found that comprehension is facilitated when the object relative clause subject is highly plausible, which supports the view that there are particular thematic and semantic qualities associated with relative clause structures (Traxler, Morris & Seely, 2002). Gaze duration was measured while participants read sentences like *The lawyer that irritated the banker filed a hefty lawsuit* and *The lawyer that the banker irritated filed a hefty lawsuit*. A second experiment found that the difficulty processing object relative clauses was reduced when only one referent is a plausible agent for the action, e.g *The thief that the policeman arrested was known to carry a knife.* A final experiment manipulating animacy showed processing difficulty was reduced for object relative clauses with an inanimate sentential subject and an animate clause subject like *The movie that the director watched received a prize at the film festival, although early measures still showed increased difficulty processing object relative*

clauses during first pass gazes. Traxler and colleagues demonstrate that readers show more difficulty processing object relative clauses but that non-syntactic factors can reduce this difficulty.

Evidence from event-related brain potentials (ERPs) examined the ongoing processing for object relative clauses and further confirmed the effect of animacy (Weckerly & Kutas, 1999). Participants read sentences presented a word at a time, and answered comprehension questions on some trials. The materials manipulated animacy of subjects in object relative clauses. Sentences with animate sentential subjects and inanimate clause subjects like *The novelist that the movie inspired praised the director for staying true to the complicated ending* showed more processing difficulty at the main clause verb, than sentences with inanimate sentential subjects and animate clause subjects. There were effects of both Left-Anterior negativity (LAN), which is associated with working memory operations, and P600 activity, which is associated with syntactic processing. This suggests that conceptual information is integrated during ongoing incremental syntactic processing of object relative clauses which may in effect, lead to a lexical influence.

One proposed explanation of processing difficulty during object relative clauses is working memory load. In a self-paced word-by-word reading task, Gordon, Hendrick and Johnson (2001) found that noun phrase type affects processing difficulty for relative clauses and attributed this effect to an increased working memory load. Participants showed longer reading times and more comprehension errors for object relative clauses than subject relative clauses, but this difference disappeared if the clause subject was an indexical pronoun, e.g. *The barber that you admired climbed the mountain* or a proper name, e.g. *The barber that Joe admired [...].* Gordon and colleagues propose that object relative clauses are susceptible to memory interference effects because they require that two nouns be held in memory, whereas subject relative clauses store one. Thus when nouns differ distinctly this reduces the memory interference and eases processing of object relative nouns. This could increase difficulty during production also. The processor must select two different nouns, both of which are assigned a subject position but in

different clause structures. The processor must retain information for both structures and both nouns, and also integrate the two structures.

Further research shows that type of pronoun itself affects processing of relative clauses in a study using corpus and self-paced reading studies (Reali and Christiansen, 2007). Reali and Christiansen investigated relative clauses in the American National Corpus (ANC) which occurred with first, second and third person personal pronouns, third person impersonal pronoun *it* and nominal pronouns like *someone.* Object relative clauses were more frequent than subject relative clauses when the clause noun was a personal pronoun, but subject relatives were more frequent when the clause noun pronoun was impersonal or nominal. A series of self-paced reading word-by-word moving window tasks revealed longer reading times for subject relative clauses when the clause noun was a first (*I, me)*, second (*you*) or third (*they*) person personal pronoun, but longer reading time for object relatives with the impersonal third person pronoun *it*. The semantic properties on the pronoun affect the syntactic processing preferences for relative clauses.

Gordon, Hendrick and Johnson (2004) found that only certain semantic properties affect processing of object relative clauses. A word-by-word self-paced reading task found no influence on the reading times of relative clauses regardless of definiteness (*the* vs. *a)* or generic (*accountants* vs. *the accountants*) properties of the nouns. In an initial study of corpora (Brown, Switchboard and Childes) Gordon and colleagues showed that object relatives occurred more with definite clause nouns than indefinite clause nouns, and that generic clause nouns occurred in subject relatives more than in object relatives. They investigated whether this tendency in production was mirrored by ease of processing in comprehension. Reading times were not affected by whether the clause noun contained a lot of semantic information like a role description (*the accountant*) or little semantic information like a pronoun (*the person*). Reading times for object relatives were closer to subject relative reading times when the clause noun was a quantifed pronoun (*everyone*). These findings suggest that only certain semantic properties of the noun interact

with the structural processing of relative clauses.

The role of working memory was explored further in an eye tracking study manipulating animacy and verb class (Traxler, Williams, Blozis & Morris, 2005). Working memory capacity was measured using a close variant sentence span task (Daneman & Carpenter, 1980). Reading times were slower for object relative clauses but this was not related to working memory span. Processing of object relative clauses was easier when the sentential subject was inanimate and the clause subject was animate, e.g. *The accident that the musician witnessed caused a lot of injuries* than when the sentential subject was animate and the clause subject inanimate, and reading times were faster for those with high working memory capacity. A final experiment replicated the second but excluded theme-experiencer verbs like *frighten* which could provide extra animacy cues and found the same animacy effects. Although readers with high working memory spans benefited more from animacy cues, processing difficulty during object relative clauses cannot be attributed to working memory load only.

A recent comprehension study investigated how choice of structure influences the processing of relative clauses. Gennari and MacDonald (2008) found effects of grammatical voice and animacy in the processing of object relative clauses in comprehension and production. In a gated sentence completion task, participants read object relative sentence fragments which had either an animate or inanimate sentential noun and occurred in either active or passive voice. There were varied completion points for the active sentences: *The director that / the / movie..., The movie that / the / director...* The completion points for the passive sentences occurred after the clause verb: *The director that was pleased..., The movie that was watched...* At the first active completion point, animate sentential nouns tended to be completed with subject relative clauses (e.g. *The director that…killed the actor*), and inanimate sentential nouns tended to be completed with object relatives (*The movie that…the critics loved*). Thereafter, all active completions were object relative nouns (e.g. *The director that the / movie /… appalled was dismissive*.)

At the second active completion point animate sentential nouns were

frequently interpreted as either patients of agent-patient verbs, or themes of experiencer theme verbs, but inanimate sentential nouns were assigned agent or experiencer roles. For both inanimate and animate sentential nouns, most often an animate clause noun was used. Where both nouns were given, animacy was contrasted to give one animate and one inanimate noun in each fragment. At the third completion point, fragments with an inanimate sentential noun and animate clause noun, were mostly completed with a single verb before continuing the main sentence and the sentential noun was assigned a theme role and the clause noun an agent role. However, animate sentential noun and inanimate clause noun fragment were completed with passives, single verbs or verb plus prepositions where sentential nouns received a goal, theme or experiencer role and the clause noun was a theme. The passive fragment was completed with either no further addition to the relative clause or a prepositional phrase was added, e.g. *by, as* the sentential noun role was already assigned by the given relative clause verb. Results from the object relative clause completions showed that choice of voice structure was affected by animacy and that thematic roles tended to be associated with specific animacy conditions. Inanimate nouns tended to associated with theme roles, but animate nouns were associated with agent and experiencer roles.

Finally, a word-by-word moving window self-paced reading experiment looked at grammatical voice and animacy effects during comprehension of object relative clauses. Animacy was always contrasted so that each sentence contained one animate and one inanimate noun. Reading times were longer for active object relatives where the sentential noun was animate (e.g. *The musician that the accident terrified was in the headlines the next day*) than in all other conditions, but especially in comparison with active object relatives with an inanimate noun *(e.g. The accident that the musician caused was in the headlines the next day*). Reading times were quicker for the passive object relatives with little difference between the animacy conditions. Gennari and MacDonald (2008) provide a detailed picture of production preferences and processing preferences for object relative clause and the interaction with animacy. Additionally, they incorporated grammatical voice into this investigation

and found that in this case grammatical voice structure interacts with both animacy and structure preferences such that the usually dispreferred passive structure eases processing.

Production data from first language acquisition demonstrates when and how structures are first used. This can indicate which structures may be less common or harder to acquire or process, and inform views on adult processing competence. Early studies have not directly addressed the production of relative clause types in first language acquisition but Slobin (1986) compares relative clauses production in English and Turkish speaking children and Menyuk (1969) and Limber (1973) broach the topic in their broader studies of children's production of sentences. However, recent studies provide a valuable insight into when and how relative clause types are first produced.

Diessel and Tomasello (2001) looked at acquisition of relative clauses in English. They used data from the CHILDES corpus from four children aged 1;9 to 5;2 years of age. Most of the earliest relative clauses produced (the first ten from each child) used intransitive verbs (67.5%). It is unsurprising then that 72.5% of the relative clauses produced are subject relative clauses and only 22.5% are object relatives. However, use of subject relatives reduces from 63 percent at age three to 26 percent at age five, likewise, use of object relatives increases from 24 percent at age three to 42 percent at age five as children start using more transitive verb relative clauses. This suggests that object relatives may be more complex because they require a transitive construction, whereas subject relatives enter a child's knowledge earlier as they can be used with intransitives and thus not requiring the complexity of another argument.

A sentence repetition experiment supports these findings, with children showing greater difficulty producing object relatives for both English and German. Children, 4 years of age played a game where they had to repeat sentences the experimenter said to them. English-speaking children produced more correct repetitions for subject relative clauses than for object relative clauses. Some of the errors involved children producing one type of relative clause as another. More

object relatives were misrecalled as subject relatives than subject relatives misrecalled as object relatives. Both of these results were found in the German data as well. At 4 years of age, children still find object relative clauses harder to process than subject relative clauses.

Psycholinguistic evidence suggests that object relative clauses are generally more difficult to process than subject relative clauses. Data from first language acquisition shows that object relative clauses are produced later than subject relative clauses which supports this hypothesis. It appears that difficulty processing object relative clauses cannot be attributed to working memory load as high working memory span does not facilitate their production. Findings that animacy and other semantic factors reduce processing difficulty associated with object relative clauses to levels similar to subject relative clauses suggests an interaction between syntactic complexity and thematic role or semantic considerations. Syntactic complexity increases processing load, but integration of syntactic structures and thematic structures may be another consideration for processing.

3.2. Passives

When producing a transitive sentence, the speaker has the choice whether to use the active or the passive voice. A speaker may choose an active voice structure *The girl kissed the boy* or a passive structure *The boy was kissed by the girl*. While both structures describe the same event, the passive structure can place a different emphasis. The passive allows the role of patient or theme which undergoes the action to be placed as the syntactic subject, where in the active role they would occur in the position of syntactic object. This section discusses the use of the passive in English and how it is processed.

In English, passive structures occur less frequently than active structures (Svartvik, 1966). Svartvik looked at the occurrence of passive and active sentences in a corpus consisting of two extracts from novels and a scientific text. Across the three

texts, there was a considerable preference for active voice (88%) compared to passive voice (12%). There is a higher level of passive voice in the scientific text (32%), but the active voice is still more common (68%). In the two novel extract corpora, use of the passive voice is much rarer: 93% vs. 7% in text M1, and 95% vs. 5% in text M2. Passive voice occurs less than active voice in general English usage and in this way may be considered a dispreferred structure.

Psycholinguistic evidence shows that people experience more difficulty understanding passives. Ferreira (2003) found that participants made more errors in comprehension of passive voice in comparison to equivalent sentences in the canonical active voice. Participants listened to sentences and were asked to identify thematic roles i.e. who performed the action. Ferreira found that participants were more likely to incorrectly identify *the man* as the agent of the action in a passive sentence like *The man was visited by the woman* than in an active sentence like *The woman visited the man*, especially if the correct passive interpretation was implausible. Further experiments with cleft structures showed that ease of processing could not be attributed to frequency, but that object- relatives and clefts were in some way harder to process. If passives are difficult to process during comprehension, they may also be difficult to produce and this could account for their infrequency in English.

However, Ferreira (1994) showed that production preferences for active or passive voice can be affected by verb type and animacy factors. Participants were visually presented with two nouns and a verb and produced sentences using these items. Ferreira compared normal agent-patient verbs like *paint* and theme-experiencer verbs like *frighten* where the experiencer of the action is the grammatical object. Speakers produced more passives with a theme-experiencer verb than with normal agent-patient verbs. Furthermore, speakers produced more passives with theme-experiencer verbs when the utterance contained one animate and inanimate verb. As verb type and animacy effected the proportion of passives produced, this suggests that verb type and animacy can affect overall preferences for the passive structure or that these semantic factors make passives easier to produce.

Evidence shows that the English passive voice is less frequent than active voice, more often misunderstood and causes processing difficulty during comprehension. However, for certain animacy conditions and verb-subcategorisation preferences, the passive voice provides a better syntactic fit than the active voice, especially if use of the active voice places thematic and syntactic roles in conflict. For example, for theme-experiencer verbs, where the usual object of the verb is the experiencer of the psychological state depicted by the verb, use of the passive structure allows the experiencer role to be placed in the more prominent syntactic subject position. Furthermore, if the noun in the theme role is inanimate (*The horror movie)* and the experiencer is animate (*The child*), use of the passive voice allows the animate noun to be placed in the position of syntactic subject. Choice of grammatical voice structure during production may arise from a competition between normal processing preferences for active voice and thematic role preferences which are best satisfied by a passive structure.

The two experiments presented in this chapter investigate the production of object relative clauses and whether choice of structure is influenced by structural constraints or verb-subcategorisation preferences. Speakers recall matrix clause sentences and sentences containing relative clauses (object and subject relative clauses). Choice of active or passive voice structures represent processing preferences specified by structural constraints or verb-subcategorisation preferences.

3.3. Experiment 2

The first experiment in this chapter examines whether choice of syntactic structure is affected by the type of clause the structure appears in and the structural constraints associated with that clause. The study compares choice of syntactic structure in simple matrix sentences and in complex sentences containing a relative clause, where the target structure occurs in the relative clause. Two types of relative

clauses are presented: passive subject relative clauses like *The boy that was kissed by the girl was embarrassed* and active object relative clauses like *The boy that the girl kissed was embarrassed.* Participants heard a series of sentences which they were then asked to recall. Choice of syntactic structure produced reflected processing preferences.

Previous research shows that messages are regenerated anew from the conceptual level during recall (Potter & Lombardi, 1990). When participants hear a message, they process words and syntactic structures to interpret a conceptual message. When participants recall sentences, they do so by recalling the conceptual message and content, but they do not appear to retain the specific structures or lexical items they encountered in comprehension. In recall, participants retrieve the conceptual message but they select lexical items and generate the syntactic structure anew (Lombardi & Potter, 1992). Sentence recall allows control of conceptual content but structures are generated in accord with natural production biases.

Because sentence recall controls conceptual content but allows new production of syntactic structures, sentence recall tasks are particularly suited to studying syntactic mechanisms involved in production (Bock, 1996). Recall studies have been used in production studies investigating issues such as syntactic priming (Potter & Lomabardi, 1998) and listener oriented production (Ferreira & Dell, 2000) for example. Sentence recall is less suited to investigating conceptual and thematic factors, but by manipulating verb subcategorisation preferences in the verbs used it is possible to investigate thematic role arguments.

It is also possible to use pictures to provide conceptual content with which to elicit production in a picture description task. However, participants may misinterpret pictures and the verb may need to be presented with the picture to ensure that the intended message is produced. It is also harder to portray the events in a complex sentence. For example, a sentence containing a relative clause involves two events such as *the girl kissed the boy* and *the boy was embarrassed*. A recall task is able to clearly and easily communicate complex messages involving multiple events, but it may be hard to highlight the relevant information and events in a

picture or action sequence. The sentence recall paradigm provides a means for the semantic content of an utterance to be specified beforehand but still allows free choice of syntactic structure in production.

Speakers can choose to avoid producing a dispreferred object relative clause such as *who the girl kissed*. If the speaker chooses to use the passive voice, then they can produce a passive subject relative clause like *who was kissed by the girl*. In this way, the speaker can choose to produce the preferred relative clause structure, the subject relative clause, which is easier to process than the dispreferred object relative clause. However, in doing this, the speaker is selecting the dispreferred passive grammatical voice, which causes more processing difficulties than the preferred active voice. The current experiment places the preference for active voice structures in competition with the preference for subject relative clause structures.

Another consideration is that of thematic roles. In the active structure *who the girl kissed*, the agent (*the girl*) is the syntactic subject and the relative pronoun patient (*who*) is the syntactic object. However, the object does not occur after the verb but at the beginning of the relative clause, yielding a different surface order of subject and object as in an unextracted clause. In the passive structure *who was kissed by the girl*, the agent (*the girl*) is the object and the relative pronoun patient (*who*) is the subject, yielding the same surface order of subject and object as in an unextracted clause. Furthermore, in the current example *The boy who the girl kissed was embarrassed*, using the passive structure means that the relative pronoun patient (*who*) shares the subject syntactic role with the main clause noun (*The boy*) that it refers to. Processing may be easier when the relative pronoun and antecedent share a syntactic role.

Whether the speaker produces an active object relative clause or a passive subject relative clause depends on whether preference for grammatical voice or preference for ease of structural processing is stronger, which may also be related to how the syntactic roles in the relative clause integrate with the syntactic roles assigned in the main clause.

Whether or not structural constraints are involved in choice of syntactic structure leads to two distinct predictions. If the structural constraints do not

influence local syntactic choice, then there should be an overall preference for active voice structures in all conditions in agreement with verb-subcategorisation preferences. However, if structural constraints influence the processing of local syntactic structures, choice of structure should vary with condition: In the relative clause conditions, where speakers are producing complex sentences, there should be a tendency for speakers to produce passive structures, because object relative clauses are harder to process but using the passive structure allows the speaker to produce subject relative clauses which are preferred and easier to process. It is assumed that speakers will still tend to produce simple matrix sentences in the active voice across both matrix conditions.

If choice of syntactic structure varies according to structural constraints, then this has implications for how language is produced. If choice of syntactic structure is influenced by structural constraints such as where the clause appears in a larger complex structure, this suggests that the processor is, to a certain degree, building the two structures in parallel or at least that the processor must be sensitive to the syntactic information for both clauses and its significance for their integration. It also supports the view that choice of structure arises from a competition between different preferences such as verb-subcategorisation preferences, structural constraints and possibly also thematic role preferences. Structural constraints could arise from an incremental approach where the processor is trying to integrate the relative clause with the main clause as it builds them both in parallel. An effect of structural constraints on choice of structure also challenges the Tree-Adjoining Grammar assumption (Ferreira, 2002) that verb-subcategorisation preferences are fundamental to building syntactic structures as Fereirra's model does not allow an initial noun phrase to be encoded until the verb is known.

3.3.1. Method

3.3.1.1. Participants

Thirty-two members of the University of Edinburgh community were paid to participate. Participants were native speakers of British English. One additional participant was not included owing to technical failure. Six additional participants were replaced as they were unable to complete the task. In these cases, three out of the four conditions were missing more than half of the data.

3.3.1.2. Materials

The materials consisted of audio files of sentences and sentence initial phrases, and two screen images which accompanied the audio presentations. An example of one of the items is given below:

1a. Before the lesson, the boy that was kissed by the girl was embarrassed.
rel. clause, passive

1b. Before the lesson, the boy that the girl kissed was embarrassed.
rel. clause, active

1c. Before the lesson, the boy was kissed by the girl.
matrix clause, passive

1d. Before the lesson, the girl kissed the boy.
matrix clause, active

The 32 experimental items each occurred in four possible conditions: matrix clause with active voice, matrix clause with passive voice, object relative clause with active voice, and subject relative clause with passive voice. In all conditions, the experimental item consisted of a transitive verb with a human agent and a human patient. There were 64 different agents and patient characters and these were

specified by occupation or similar, e.g. student, footballer. There were 32 different transitive verbs e.g. kick, kiss. Each item had a short sentence initial phrase indicating an event relevant to the item, which preceded the experimental sentence, e.g. "*Before the lesson*"'. This introductory phrase was used as the cue to recall the item. There were also 16 fillers. The fillers consisted of simple matrix clauses preceded by an eventive phrase, e.g. "*Despite the cat, there were many fat mice.*". The fillers featured different entities to those in the experimental items. A complete list of the items can be found in Appendix 2.

The materials consisted of 192 audio files in total. There were 32 experimental items presented in each of the four conditions (128 experimental files in total) and 16 filler items. There were 144 sentence files and 48 files containing sentence initial phrases. A native speaker of British English was recorded reading out the sentences and fragments using natural intonation. Sentences and sentence initial phrases were recorded separately and the speaker tried to keep intonation as natural as possible. Audio files were recorded as Microsoft wave files (.wav) at 44kHz and converted to 22kHz 16 bit mono channel .wav file.

The experiment used four lists containing 32 experimental items, including eight from each condition, and 16 filler items. The items were randomised so that there were eight blocks of six sentences. Each block contained four randomly assigned experimental items and two randomly assigned fillers. One version of each item appeared in each list. In this way, the two conditions of clause type (Matrix vs. relative clause) and grammatical voice (Active vs. Passive) were manipulated within participants and items. Each item was seen by eight participants in each condition, and each participant saw eight items in each condition. The four lists were randomised to create six randomised versions of each list, so that each participant in the experiment experienced a different individually randomised list.

3.3.1.3. Procedure

The participant sat at a desk with a computer, CRT monitor and button box in front

of him or her. The experiment used ePrime software, which presented audio and screen image files to the participant.

Participants were instructed to listen to a series of sentences and to memorize all. They were told that after they had memorised all the sentences there would be cues to recall the sentences and that the cues would occur in a different random order to that of the presentation. When the participants heard the cue, which was the first part of the sentence, they were to recall the appropriate sentence and say it aloud. The participants were reassured that occasional mistakes and silences would not invalidate the experiment but they were requested to keep trying to complete the experiment as best they could and not to feel discouraged. As the task was quite difficult, it was felt that if participants felt discouraged or nervous then performance would deteriorate.

After confirming that the participant had understood the oral instructions, the participant started the experiment on the computer. First the participant was presented with brief instructions on screen and then they started a practice trial. The practice trial consisted of one block of six practice items consisting of the six full sentences followed by the six cues in a random order. The participant pressed a button to start playing the audio files for that block. After each sentence there was an 8 second pause for the participant to review and memorise the material. Immediately after the block of six sentences and six 8 second pauses, the cues for that block were presented. After each cue phrase there was a 10 second pause for the participant to recall the relevant sentence and say it aloud.

While the audio stimuli were being presented, the participant was presented with experiment screens indicating which stage of the experiment was taking place. There were two distinct screens: a presentation screen and a silence screen. The presentation screen appeared simultaneously with audio stimuli and consisted of three asterisks presented in the centre of the screen [* * *]. The silence screen appeared after audio stimuli had been presented during the silences and consisted of three dots in the centre of the screen [. . .]. These screens functioned as a visual cue to confirm which stage of the experimental procedure was presently occurring.

Symbols were used in order to avoid interference to the language processing system that would occur if these screens contained written instructions.

When the practice trial was completed, the participant saw a break screen and was instructed to proceed to the main part of the experiment when they were ready. The experimenter was present for the practice trial but left the room for the actual experiment after allowing an opportunity for questions. The experiment trial blocks were of identical format to those in the practice trial. A break screen was presented between each block and participants pressed a button to proceed with the next trial when they were ready so that they could complete the experiment at their own pace.

3.3.1.4. Scoring

The experimental session was recorded on audio tape and transcribed. Valid responses were coded as relative clause passive voice ("The boy that was kissed by the girl was embarrassed"), relative clause active voice ("The boy that the girl kissed was embarrassed"), matrix clause passive ("The boy was kissed by the girl") voice and matrix clause active voice ("The girl kissed the boy"). A response was considered valid if it contained the same overall meaning and thematic structure as the original stimulus. The actual verb and noun were not required to be perfectly recalled but would be accepted if the word produced was in the same semantic area and featured the same syntactic argument properties. For example, a 'pupil' may be recalled as a 'student' or 'hit' may be recalled as 'punched'. A response was considered invalid if it was incomplete, semantically ambiguous or inaccurate.

A response was scored as a relative clause passive if: it included a relative clause headed by the sentence subject that had the patient role in the relative clause, the auxiliary "be", a verb with passive morphology and a prepositional phrase expressing the agent headed by the preposition "by". A response was scored as relative clause active if: it included a relative clause headed by the new subject that had the agent role in the relative clause, a verb with active voice morphology and

the sentence subject that had the patient role in the object position. A response was scored matrix clause passive if: the sentence subject had the patient role, a verb with passive morphology and a prepositional phrase expressing the agent headed by the preposition "by". A response was scored as matrix clause active if: the subject had the agent role, a verb with active voice morphology and the object had the patient role.

Responses scored as errors included: passives produced with no 'by' phrase ("The boy was kissed"), absent or fragmented utterances ("The boy, that the girl…"), thematic roles incorrectly assigned ("The boy kissed the girl"), incorrectly recalled semantic content ("The boy kissed the boy") and incorrectly recalled syntax such as omitting a relative clause ("The boy was embarrassed").

3.3.1.5. Design and data analysis

Log-linear models were chosen to analyse this data because there was a relatively large amount of missing data. Missing data occurs in recall studies because participants can find it hard to remember the relevant semantic content. Log-linear models are particularly suited to the analysis of categorical frequencies and make no assumptions about the dependent variable such as homogeneity of variance and factor levels are not required to be linearly independent. Response is treated as a factor in log-linear analysis.

This study used a 2x2 (clause x voice) within-participants factorial design. The Clause factor was the type of sentence used: a simple matrix clause or a complex sentence including a relative clause. This could be either a subject relative clause or an object relative clause. The other experimental factor was grammatical voice, either active or passive. In the matrix clause condition the sentence was presented as past tense in either active or passive voice. In the relative clause condition, the relative clause itself was presented in either active or passive voice, but the matrix clause always appeared as active voice in the past tense.
Analyses were carried out on the trials where the grammatical voice was inverted

on recall, for example, if a relative clause active was recalled as a relative clause passive. After data collection was completed it was discovered that two of the verbs were each repeated in two items. For this reason, the two items where these verbs occurred for the second time were excluded from the analysis..

3.3.2. Results

In total 659 (69%) of recall trials were completed; of these 328 (34%) were recalled as passive voice sentences, 331 (34%) were recalled as active voice sentences, and the remaining 301 (31%) were others. Total numbers of recall responses in the different conditions are reported in Table 3. Cell counts were adjusted to factor combinations of Clause Type (MC vs. RC), Voice Type (Active vs. Passive), and either participants (N = 32) or items (N = 30). Effects in the context of participants are reported as LCRS1, and effects in the context of items are reported as LCRS2. Analyses were carried out for responses where grammatical voice was inverted between the presentation and the recall, and were analysed by participants and by items. Responses coded as 'other' were excluded from the analysis.

Log-linear analyses were performed on the responses where grammatical voice was inverted between presentation and the recall in each condition. There was a main effect of Clause Type (LCRS1 = 3.880, df = 1, $p < .05$; LCRS2 = 3.880, df = 1, $p < .05$). There was more inversion of grammatical voice in relative clauses than in matrix clauses. There was also a significant interaction between Clause Type and Voice Type (LCRS1 = 36.855, df = 1, $p < .001$; LCRS2 = 28.165, df = 1, $p < .001$). There were more actives recalled as passives in the relative clauses and more passives recalled as actives in the matrix clauses. There was no significant effect of Voice Type ($Fs < 1$).

Table 3: Numbers of inverted responses by condition (By participants analysis)

Clause Type	Voice Type	Inverted voice in recall
Matrix	Pass. to active	44 (9.2%)
	Act. to passive	13 (2.7%)
Relative	Pass. to active	27 (5.6%)
	Act. to passive	53 (11.0%)

Pass. = passive voice, Act. = active voice

3.3.3. Discussion

The experiment investigated whether structural constraints affected choice of syntactic structure. There was a clear difference in the processing of matrix clauses and relative clauses: There was more inversion of grammatical voice in the relative clauses. Furthermore, there was a tendency to recall matrix clauses as active structures and to recall relative clause structures as passive structures. This supports the prediction that structural constraints affect choice of syntactic structure. Whereas generally passive structures are dispreferred in English, one possible interpretation is that speakers in this experiment tended to choose the passive voice structure in order to produce passive subject relative clauses instead of active object relative clauses.

This experiment establishes that structural constraints affect choice of structure during production. Speakers produced different syntactic structures depending on whether they were producing a main clause (more active voice structures) or a relative clause (more passive voice structures). This could possibly suggest that some processing of the overall sentence structure is occurring while the processor selects the constituent structure. Choice of a constituent structure may be affected by the structural constraints associated with different types of clause,

increased load of processing the overall sentence structure or by some kind of relevant information concerning the integration of the relative clause structure into the overall sentence structure. A model of processing where structures can be built in parallel, and there is integration of clauses during ongoing processing, could be compatible with the finding that the type of clause and its place within a larger complex sentence structure can influence the choice of structure of that local clause.

A second experiment uses experiencer-theme verbs to investigate whether verb-subcategorisation preferences affect choice of structure in relative clauses and if so, how this interacts with structural constraints.

3.4. Experiment 3 and Norming Study

Experiment 2 establishes that structural constraints can affect choice of structure. However, as mentioned previously, verb type can affect the choice of grammatical voice structure (Ferreira, 1994). The following experiment investigates whether verb-subcategorisation preferences interact or override structural constraints. It replicates the Experiment 2 but replaces the verbs with experiencer-theme verbs, where the subject of the verb is the one experiencing the action. The following section discusses the syntactic and thematic properties of psychological state verbs like experiencer-theme and theme-experiencer verbs.

Ferreira (1994) found that theme-experiencer verbs elicited more use of the passive structure than normal agent-patient or experiencer theme verbs. Speakers were more likely to say *The artist was frightened by the lightning* than *The guidebook was painted by the artist*. For theme-experiencer verbs the object of the verb is the experiencer of the action and the passive structure allows the object of the verb to be assigned in the subject position. This reconciling of thematic roles and syntactic roles presents a plausible explanation of the verb type's effect on choice of syntactic structure. We have seen earlier in this chapter that animacy affects the likelihood for a noun to be selected as subject, so a preference for thematic roles would be another

example of a tendency to map conceptual information to relevant syntactic roles. From this, one might also predict that experiencer-theme verbs would prefer structures using the active voice in which the experiencer role is assigned as the syntactic subject.

Comprehension data shows that readers prefer to associate experiencer-theme verbs with active structures (Cupples, 2002). In combination with self-paced word-by-word reading, participants judged the plausibility of sentences containing experiencer-theme and theme-experiencer verbs active in or passive voice. Reading times were longer for active theme-experiencer verb sentences like *The remark encouraged the dancer* than for actives with experiencer-theme or action transitive verbs like *refuse*. In contrast, there were shorter reading times and fewer errors for passive sentences with theme-experiencer verbs like *The dancer was encouraged by the remark* than for passive experiencer-theme like *The threat was imagined by the suspect*. Thematic role preferences can interact with syntactic structure preferences to facilitate or increase difficulty for syntactic processing. Thus, a generally dispreferred structure such as the passive can become the preferred structure with facilitated ease of processing.

Belletti and Rizzi (1988) investigated psychological state verbs , e.g. experiencer-theme verbs, in Italian and proposed a model of syntax where syntactic representations are built upon thematic representations that are stored in the lexicon. The lexical entry for each verb contains thematic role information which is marked for the preferred subject, and also case information for the verb. This may be linked to the thematic role information but during production the actual case is selected through syntactic processing operations. Thematic role and case information are mapped onto syntactic representations, and in this way thematic prominence may be encoded into structural prominence. Belletti and Rizzi provide a linguistic motivation for the observed interaction of thematic role information associated with verbs and subsequent choice of syntactic structure.

The previous experiment established that choice of constituent structure is affected by structural constraints associated with the type of clause in which the

structure occurs. The second experiment in this chapter examines whether verb-subcategorisation preferences affect choice of structure in the relative clause structure. To do this, we replicated the first experiment but replaced the agent-patient transitive verbs with experiencer-theme verbs. As demonstrated previously, experiencer-theme verbs strongly tend to occur with active utterances where the experiencer is assigned the subject role. If experiencer-theme verbs have a strong subcategorisation preference for active structure then we may expect to see speakers produce active structures in relative clauses as well as in the matrix clauses. The experiment places structure information and verb-subcategorisation preferences in direct competition for choice of structure.

Although Ferreira (1994) had demonstrated that theme-experiencer verbs elicited more passives when compared to agent-patient and experiencer-theme verbs, it needed to be ascertained that experiencer-theme verbs elicit active voice structures. For this reason, we ran a norming study to observe voice structure preferences in the production of agent-patient, experiencer-theme and theme-experiencer transitive verbs. The norming study also investigates whether verb class influences choice of constituent structure during production, allowing for a direct comparison of three different verb types and their thematic roles.

3.4.1. Norming study

A simple production study investigated grammatical voice structure preferences for different types of transitive verbs including agent-patient, experiencer-theme and theme-experiencer verbs. Participants were visually presented with verbs and were then asked to create a sentence using two people, where two people interact. We predicted that speakers would tend to produce active sentences with agent-patient verbs as would reflect general processing preferences. Speakers would produce more passive sentences with theme-experiencer verbs then with agent-patient or experiencer-theme verbs because of the thematic role preferences. Finally, we predicted that speakers should show a tendency to produce active voice structures

with experiencer-theme verbs because of the thematic role preferences, where the subject of the verb is the experiencer of the action.

3.4.1.1. Method

3.4.1.1.1. Participants

Sixteen members of the University of Edinburgh community were paid to participate. Participants were native speakers of English.

3.4.1.1.2. Materials

The materials consisted of a list of 96 verbs. These verbs consisted of transitive verbs with different thematic role preferences/arguments: 32 experiencer-theme verbs, 32 theme-experiencer verbs and 32 agent-patient transitive verbs. These were presented at font size 24 and using the font type Arial Western. The experiment used 16 lists containing 96 items. The items were randomised separately for each list so that each participant saw a unique random sequence.

3.4.1.1.3. Procedure

The participant sat at a desk with a computer, monitor and button box in front of him or her. The experiment used the ePrime program, which displayed single words to the participant. The lists had been randomised to create sixteen randomised versions, so that each participant in the experiment experienced a different list.

Participants were instructed to read the action word on the screen and to create a simple sentence using that action (verb) and two human characters. Participants were asked not to use pronouns or real names but could create characters using occupations or nationalities, e.g. “the Mexican” or “the doctor”. The instructions also specified that both characters couldn’t be used together in the same noun phrase, e.g. “The nun and the monk”. Once they had created a sentence

and said it aloud, the participant pressed any button on the button box and the next word would appear onscreen. Participants were instructed that they were not under time pressure and were free to complete the experiment at their own pace.
After the instructions were given orally, the participant was presented with brief instructions on screen before the experimenter left the room and then they started the experiment. When the participant had finished producing an utterance, he or she would press any button on the button box to call up the next word. The experimental session lasted about 30 minutes on average.

3.4.1.1.4. Scoring

The experimental session was recorded on audio tape and transcribed. The first response that the participant gave was coded and scored.
A response was scored as matrix clause active if: the subject had the agent role, a verb with active voice morphology and the object had the patient role. For example, *The nun kicks the cowboy*. A response was scored matrix clause passive if: the sentence subject had the patient role, a verb with passive morphology and a prepositional phrase expressing the agent headed by the preposition "by". For example, *The cowboy was kicked by the nun*. Responses were coded as 'Other' when a different syntactic structure was produced to that specified, e.g. a noun phrase with more than one noun "The nun and the cowboy kicked", an inanimate agent "The nun kicked the ball", or a complex sentence with more clauses "The nun, who was clumsy, kicked the cowboy". Responses were also coded as Other when a different verb was used from that given.

3.4.1.1.5. Design and data analysis

This study had an independent factor of Verb Type (experiencer-theme, theme-experiencer, agent-patient transitive) in a within-participants design. The dependent variable was the proportion of responses in active or passive voice.

The data was analysed using a one-way ANOVA on proportions of responses in each condition so that analyses would not be affected by any missing data. For example: the proportion of Experiencer-Theme active responses was calculated by dividing the total number of Experiencer-Theme active responses by the number of Experiencer-Theme active responses and Experiencer-Theme passive responses; and the proportion of Experiencer-Theme passive responses was calculated by dividing the number of Experiencer-Theme passive responses by the number of Experiencer-Theme active responses and Experiencer-Theme passive responses.

3.4.1.2. Results

In total 1536 (100%) of production trials were completed of these 82 (5%) were produced as passive voice sentences, 1115 (73%) were produced as active voice sentences, and the remaining 339 (22%) were others. Proportions of responses produced in the different conditions are reported in Table 4. The independent factor in the analysis was Verb Type (experiencer-theme, theme-experiencer and agent-patient transitive) and the dependent variable was Voice Type (Active vs. Passive). Others were excluded from the analysis. Analyses were carried out for passive responses as the active responses were complementary, and were analysed by participants.

A one-way ANOVA analysis was performed on Passive responses. There was a significant effect of verb type ($F(2,93)=34.932$, $p < .001$, $MSe = 39.885$, partial $\eta^2 = 0.429$). There were more passive responses produced after a theme-experiencer verb than after an experiencer-theme verb or agent-patient transitive. Planned comparisons found that the proportion of passives produced with theme-experiencer verbs was greater than with experiencer-theme and agent-patient verbs ($F(2,93)=40.60$, $p < .001$, $MSe = 0.28$). But there was no difference in proportion of passives between experiencer-theme and agent-patient verbs ($Fs < 1$).

Table 4: Mean proportions of responses by condition (By participants analysis)

Verb Type	Responses	
	Active	Passive
Experiencer-theme	.99	.01
Theme-experiencer	.80	.20
Agent-patient transitive	.97	.03

3.4.1.3. Discussion

The norming study examined choice of grammatical voice structure in matrix clause sentences and the effects of thematic role. The results show a clear tendency for speakers to produce most simple matrix sentences with experiencer-theme verbs as active voice sentences (99%) as opposed to passive voice (1%). In this respect, experiencer-theme verbs behave similarly to agent-patient verbs which show a strong preference for active voice structures (97% vs. 3%). This is in contrast to theme-experiencer verbs which show a stronger tendency to produce passives (20%) than agent-patient (3%) and experiencer-theme verbs (1%).

These findings demonstrate that overall preference for actives is affected by thematic roles. Agent-Patient verbs and Experiencer-Theme verbs both displayed an overall preference for actives. Theme-Experiencer verbs showed a significant tendency to produce more passive structures. For both Experiencer-Theme verbs and Theme-Experiencer verbs there was a tendency to place the theme in the object position, and participants chose structures in which that occurred: Theme-Experiencer verbs were produced with more passives than were Experiencer-Theme verbs.

There was no significant difference in the preference for active voice between the Agent-Patient and Experiencer-Theme verbs, but this could be attributed to ceiling effects. Other factors such as animacy and other structural influences could results in the two verb types producing different degrees of active structures under

different conditions. The second experiment tested voice structure preferences for matrix structures and with two animate nouns using Agent-Patient verbs; the third experiment replicates these conditions using Experiencer-Theme verbs. The third experiment contrasts structural constraints and verb-subcatgorisation preferences in the choice of local noun structure using Experiencer-Theme verbs which we have shown to elicit active voice structures.

3.4.2. Experiment 3

This experiment investigates whether verb-subcategorisation preferences affect choice of structure in the relative clause. The experiment replicates the first experiment but replaces the agent-patient transitive verbs with experiencer-theme verbs. As previously observed, experiencer-theme verbs show a strong tendency to occur with the experiencer as syntactic subject in an active clause. In this experiment, there are two conflicting preferences for choice of grammatical voice structure at the local level of the relative clause. As demonstrated in the previous experiment, there is a tendency for the active object relative clause structure to be produced as a passive subject relative clause, possibly to avoid processing difficulties associated with the object relative clause. Choice of relative clause structure is influenced by structural constraints which differed from those found in matrix clauses. However, experiencer-theme verbs show a strong subcategorisation preference for active voice structures. In the third experiment, structural constraints compete with verb-subcategorisation preference to influence the choice of syntactic structure. If speakers tend to produce passive voice structures in the relative clauses, this suggests that the structural constraints are dominant; if speakers produce active voice structures, this suggests that verb-subcategorisation information also plays a role in choice of syntactic structure at the local level.

3.4.2.1. Methods

3.4.2.1.1. Participants

Thirty-two members of the University of Edinburgh community were paid to participate. Participants were native speakers of British English. Thirteen participants were replaced as they were unable to complete the task. In these cases, three out of the four conditions were missing more than half of the data.

3.4.2.1.2. Materials

The materials were the same as those used in Experiment 2, but the transitive verbs in the experimental items were replaced with experiencer-theme verbs. The initial phrases, argument noun phrases and, for relative clauses, the sentence final clause remained the same. New items were recorded using the same speaker. An example of one of the items is given below:

1a. Before the lesson, the boy that was adored by the girl was embarrassed.
rel. clause passive

1b. Before the lesson, the boy that the girl adored was embarrassed.
rel. clause active

1c. Before the lesson, the boy was adored by the girl.
matrix clause passive

1d. Before the lesson, the girl adored the boy.
matrix clause active

The fillers were those used in Experiment 2.

3.4.2.1.3. Procedure

The procedure was identical to that in Experiment 2.

3.4.2.1.4. Scoring

The scoring used was identical to Experiment 2 except that only verbs expressing experiencer-theme roles were accepted as valid responses, e.g. “adore” might be recalled as “love” or “admire”.

3.4.2.1.5. Design and data analysis

The design was as specified in Experiment 2. Proportions and analyses were performed as described in Experiment 2. However, all 32 items were included in the current analysis as the verbs used in Experiment 3 were all unique to each item, thus avoiding the previous problem in Experiment 2 with repeated items.

3.4.2.2. Results

In total 606 (59%) of recall trials were completed; of these 233 (23%) were recalled as passive voice sentences and 373 (36%) were recalled as active voice sentences, and the remaining 418 (41%) were others. Total numbers of recall responses in the different conditions are reported in Table 5. Cell counts were adjusted to factor combinations of Clause Type (MC vs. RC), Voice Type (Active vs. Passive), and either participants (N = 32) or items (N = 32). Effects in the context of participants are reported as LCRS1, and effects in the context of items are reported as LCRS2. Analyses were carried out for responses where grammatical voice was inverted between the presentation and the recall, and were analysed by participants and by items. Other responses were excluded from the analysis.

Log-linear analyses were performed on the proportions of responses where grammatical voice was inverted between presentation and the recall in each condition. There was a significant effect of Clause Type (LCRS1 = 9.179, df = 1, p < .005; LCRS2 = 9.179, df = 1, p < .005). There was more inversion of grammatical voice in relative clauses than in matrix clauses. There was a significant effect of Voice Type (LCRS1 = 24.838, df = 1, p < .001; LCRS2 = 24.838, df = 1, p < .001). There were more passive to active voice inverted responses than active to passive inverted responses. An interaction between Clause Type and Voice Type was marginal by participants and significant by items (LCRS1 = 3.648, df = 1, p < .056, LCRS2 = 7.242, df = 1, p < .05). There were more active to passive inverted responses in relative clauses than in matrix clauses.

Table 5: Total number of recall inverted responses by condition (By participants analysis)

Clause Type	Voice Type	Inverted voice in recall
Matrix	Pass. to active	42 (8.2%)
	Act. to passive	8 (1.6%)
Relative	Pass. to active	54 (10.5%)
	Act. to passive	31 (6.1%)

Pass. = passive voice, Act. = active voice

3.4.2.3. Discussion

Experiment 3 used experiencer-theme verbs to investigate whether verb-subcategorisation preferences affected choice of structure in relative clauses and how this interacted with structural constraints. In a norming study, experiencer-theme verbs showed a preference for active structures where the experiencer role is

assigned the syntactic subject position. This conflicts with the tendency to produce object relative actives as subject relative passives demonstrated in the previous experiment. As in Experiment 2 speakers inverted the grammatical voice of the structures more in the relative clause condition than in the matrix clause condition. However, for both matrix and relative clauses, more passives were produced as active structures than there were active structures recalled as passive structures. This supports the prediction that verb-subcategorisation preferences can affect choice of structure in relative clauses. While Experiment 2 demonstrated that structural constraints for the relative clause elicit more passive structures, in this experiment the verb-subcategorisation preferences have elicited more active structures, suggesting that in this case, the verb-subcategorisation preference for active structures was stronger than the structural constraint preference for passive. However, an interaction between clause and voice was significant by items and marginal by participants as more actives were produced as passives in relative clauses (6.1%) than in matrix clauses (1.6%).

This overall difference in voice preference can be attributed to the use of experiencer-theme verbs and their preference for active structures. In the norming study, experiencer-theme verbs and agent-patient verbs elicited similar levels of active structures and this is confirmed in the matrix condition for this experiment. However, only the experiencer-theme verbs retain their preference for active structures in the relative clause conditions, whereas the agent-patient verbs in Experiment 2 tended to occur as passives in the relative clause conditions. Experiencer-theme verbs appear to have a stronger preference for active structures than the agent-patient verbs used in Experiment 2. This suggests that in Experiment 3 the experiencer-theme preference for active structures was a stronger competing influence on choice of structure than the structural constraint preference for passive. In order to examine these findings in more detail, findings for the two experiments were compared using log-linear analysis.

3.4.2.4. Comparison: Experiments 2 and 3: Production of voice in relative and matrix clauses with experiencer-theme verbs and agent-patient verbs

The two within participants factors in the analysis were Clause Type (Relative vs. Matrix) and Voice Type (Active vs. Passive) and the between participants factor was Experiment (Experiment 2 vs. 3). Analyses were carried out for responses where grammatical voice was inverted between the presentation and the recall. Cell counts were adjusted to factor combinations of Clause Type (MC vs. RC), Voice Type (Active vs. Passive), Experiment (2 vs. 3), and either participants (N = 32) or items (N = 30). Effects in the context of participants are reported as LCRS1, and effects in the context of items are reported as LCRS2. Other responses were excluded from the analysis. In order to perform a direct comparison between the two experiments, for the two items removed from Experiment 2 the corresponding two items were removed from Experiment 3 for the analysis.

Log-linear analyses were performed on the total numbers of responses where grammatical voice was inverted between presentation and the recall in each condition. There was a significant effect of Clause Type (LCRS1 = 10.923, df = 1, $p < .005$; LCRS2 = 10.923, df = 1, $p < .005$). There was more inversion of grammatical voice in relative clauses than in matrix clauses. There was a significant effect of Voice Type (LCRS1 = 13.559, df = 1, $p < .001$; LCRS2 = 13.559, df = 1, $p < .001$). There were more passive to active voice inverted responses than active to passive inverted responses. There was a significant interaction between Clause Type and Voice Type (LCRS1 = 41.411, df = 1, $p < .001$; LCRS2 = 29.649, df = 1, $p < .001$). There were less active to passive inverted responses in the matrix clause than in the relative clause. There was a significant interaction between Voice and Experiment (LCRS1 = 13.105, df = 1, $p < .001$; LCRS2 = 12.772, df = 1, $p < .001$). There were more grammatical voice inversions from passive to active in Experiment 3 than in Experiment 2. There was no interaction between Clause Type, Voice type and Experiment (Fs < 3).

3.4.2.5. Discussion

Log-linear analyses compared Experiments 2 and 3. Speakers inverted grammatical voice more often in the relative clauses than in the matrix clauses. Across both experiments, there was more inversion of passive to active structures than active to passive structures. Speakers produced more passive to active inverted responses in Experiment 3 which included experiencer-theme verbs than in Experiment 2. Finally, speakers were less likely to produce active to passive inverted responses in matrix clauses than in relative clauses across both experiments. These comparisons confirm the individual experiment findings that structural constraints influence choice of syntactic structure as speakers were more likely to invert grammatical voice preference in relative clauses than in matrix clauses.

The influence of verb-subcategorisation preferences is confirmed in the finding that more actives were produced in Experiment 3 than in Experiment 2. This is a particularly interesting finding considering that the norming study found no difference between the behaviour of the experiencer-theme and agent-patient verbs. One possible explanation is that the test was not sensitive enough to detect degrees of preference. It may be that both experiencer-theme verbs and agent patient verbs have a preference for active structures but that in this case it was not possible to see the stronger preference of the experiencer-theme verbs because of ceiling effects. Previous studies have shown that animacy can affect preference for passive structures with agent-patient verbs. Evidence from a priming study (Bock, Loebell & Morey, 1992) and a recall study (McDonald, Bock & Kelly, 1993) showed that the agent-patient verb preference for active structures over passive structures can be either reduced or reversed when the patient is animate. This suggests that the agent-patient verb preference for active structure can vary with context.

Finally, the finding that more active structures were produced than passives over both experiments supports the findings from corpora that active structures are preferred to passive structures. However, there was no significant difference between the number of passives produced in the relative clauses in Experiments 2

and 3. Given the experiencer-theme verb preference for active structures, one might expect there to be less passives in the relative clauses in Experiment 3 than in Experiment 2.

3.4.3. General discussion

The two experiments investigated the production of object relative clauses and whether choice of structure is influenced by structural constraints or verb-subcategorisation preferences. The first experiment showed that structural constraints can affect choice of local syntactic structure: Speakers chose to produce passive subject relative clauses in preference to active object relative clauses. However, Experiment 3 showed that verb-subcategorisation preferences also affected choice of local syntactic structure as speakers tended to produce active voice object relative clauses with experiencer-theme verbs. These findings demonstrate that both syntactic and lexical-semantic factors can affect the choice of syntactic structure at the local level. This confirms observed effects in the comprehension literature, where animacy, pronoun type and verb type influence ease of processing for relative clauses and passive structures, and support a model of production where choice of syntactic structure is the result of competition between various factors.

The influence of structural constraints on choice of structure could suggest that different structural constraints are associated with different clause structures or that syntactic structures are built in parallel to some extent. In this model, processing for the main clause starts and then processing for the relative clause occurs before processing of the main clause has finished, or some processing of the relative clause may have already begun as the speaker starts producing the main clause. Choice of structure in the relative clause is affected by structural constraints for the relative clause itself. Whether this is simply because of the extra processing load or as a result of integrating the relative clause into the overall sentence

structure is unclear. Furthermore, this could support an incremental view of processing where the processor tries to integrate the relative clause structure and the main sentence structure as soon as possible, as type of relative clause (*subject vs object*) affects the type of structure selected (*active or passive*). It could also be that object relative clauses are strongly dispreferred and so speakers choose to produce passive subject relative clauses in order to avoid having to produce the dispreferred object relative clause.

Choice of syntactic structure is affected by both syntactic and conceptual-semantic information during production. If possible structures are built in parallel and there is competition between the possible structures then structures could receive more activation as a result of influences from structural constraints or from verb-subcategorisation preferences. Although agent-patient transitive verbs commonly occur in active voice structures, speakers chose to produce passive voice structures when the alternative was a difficult to process active voice object relative structure. This could be possibly to avoid a mismatch between the syntactic role of the relative pronoun and its antecedent in the main clause so that both were syntactic subject. Structural constraints had a greater influence than the agent-patient verb preference for the active voice. In Experiment 3, the experiencer-theme verb preference for active voice structures had a greater influence than the structural constraint preference for passive voice as speakers tended to produce active voice object relative clauses.

Another possible aspect of choice of structure is the conflict of syntactic structure with thematic structure. As discussed earlier, the passive is a dispreferred structure in English, but can be an appropriate choice if the speaker wishes to emphasise or highlight the role of, for example, the patient by placing it in the syntactic subject position. In Experiment 2, there was a tendency to produce passive structures in accordance with structural constraints, but in Experiment 3 there was a tendency to produce active structures with experiencer-theme verbs. Use of the passive structure would conflict with the thematic preferences of experiencer-theme verbs, which prefer the experiencer to be placed into the syntactic subject position.

The comprehension data on animacy, pronoun and verb type suggest that when syntactic role structure and thematic role structure conflicts, this incurs some kind of processing cost. Conflict of syntactic and thematic roles may cause processing difficulties during production as well.

The idea that verb-subcategorisation preferences and thematic role arguments affect choice of structure is compatible with all of the grammars discussed in the first chapter. Tree-Adjoining Grammar (TAG) proposes the existence of propositional representation, the Incremental Parallel Formulator (IPF) suggest a case frame specifying roles and the mapping of form and meaning is an integral principle of Construction Grammar. However, TAG argues that the verb and its subcategorisation preferences are a fundamental part of structure generation to the extent that initial roles cannot be assigned until it has been licensed by the verb of that structure. This may not be entirely compatible with a model of processing where structures are produced in parallel and incrementally so that structures are integrated as soon as possible. A parallel and incremental model of processing would work most efficiently if it starts building structures as soon as any information becomes available, whereas the processor may have to wait before receiving information about the verb.

3.4.4. Conclusion

Choice of syntactic structure can be affected by both structural constraints and lexical preferences specified at the verb. The interaction of structural constraints and lexical preferences suggests that there is competition between these preferences during the production of a syntactic structure. When viewed together with previous research examining animacy, verb type and grammatical voice in comprehension, these results could also suggest that some processing cost may be incurred when syntactic structure conflicts with thematic role structure. Having established that structural constraints associated with type of clause influence choice of syntactic

structure, the next chapter examines to what extent syntactic processing mechanisms are shared between simple matrix clauses and unbounded dependencies such an interrogatives.

Chapter 4

Processing of structures in matrix clauses and unbounded dependencies

4.0. Introduction

The previous chapter established that global syntactic structure at the sentence level can affect choice of syntactic structure at the local clause level. Choice of grammatical voice and hence syntactic structure was affected by whether the local structure occurred in a matrix sentence or in a relative clause. In this chapter, I will look at the processing involved when selecting a structure in a matrix sentence or in a sentence containing an unbounded dependency. A series of three priming studies will investigate whether syntactic processing mechanisms are shared between matrix declarative sentences and interrogative sentences which contain an unbounded dependency. First I will discuss previous psycholinguistic evidence examining syntactic processing in the production of complex sentences.

4.1. Previous studies of syntactic processing in complex sentences

Psycholinguistic findings regarding the processing of clauses as part of complex sentence structures have so far been mixed. Scheepers (2003) showed that attachment preferences for relative clauses could be primed, which suggests that some kind of syntactic representation of how the phrase is incorporated into the sentence structure is stored and accessed during subsequent production. The study

used complex Noun Phrases in German which contained relative clauses with either high or low attachment. In the sentence fragment *the score of the candidate who…*, the *who* refers to the candidate and is therefore low-attaching, but in the sentence fragment *the score of the candidate which* the *which* refers to the score and is high-attaching (note that the corresponding German fragments used in the experiments had analogous properties). In a written sentence completion task, participants received booklets with sentence fragments such as *The assistant announced the score of the candidate that…* and were asked to provide a written grammatical sentence completion. Prime sentence fragments could only be completed with one kind of attachment but were followed by target sentence fragments where the sentence could be completed with either a low or a high attachment. There was priming of both high- and low-attached relative clauses. Primes containing anaphoric adverbial clauses, e.g. *The assistant announced the score of the candidate, when this…*, did not prime relative clause production, indicating that relative clause priming requires the syntactic overlap between prime and target.

Further evidence for the priming of attachment of relative clauses has been shown in Dutch and there is also evidence that these syntactic structures can be primed between languages as demonstrated from Dutch to English. In a written completion task, participants completed prime sentences with high-attachment such as *De politie ondervroeg de veroorzaakster van het ongeval die…* ('The police interrogated the causer of the accident that…') and low-attachment such as *De politie ondervroeg de veroorzaakster van het ongeval dat…*('The police interrogated the causer of the accident that…'). Priming occurred from Dutch primes to Dutch target phrases such as *De boer voederde de kalfjes van de koe die…*('The farmer fed the calves of the cow that…') and, in a second experiment, English target phrases such as *The tutor advised the students of the schoolmistress that….* A third study found that syntactic priming effects could not be attributed to priming of discourse structures.

A study in English also found that relative clauses could be primed although it did not examine the attachment preferences. Cleland and Pickering (2003) examined priming effects in noun phrase structure. Primes consisted of a simple

noun phrase *the red square* or a complex noun phrase containing a relative clause *the square that's red*. Note that despite the difference in syntactic structure, the two alternatives have the same denotational meaning. Participants were more likely to produce a complex noun phrase after hearing a complex noun phrase than after hearing a simple noun phrase. Priming the complex noun phrase involves not only creating a representation of a noun with an adjectival position but creating a representation for the noun and the syntactic structure which modifies it, in this case, a relative clause. Speakers reactivated this representation of 'noun modified by relative clause structure' during subsequent production.

However, when Branigan, Pickering, McLean and Stewart (2006) examined global syntactic structures and simple matrix structures in a spoken sentence completion task, they found no effect of global syntactic structure on choice of local syntactic structure. This is a surprising result considering that Scheepers (2003) had observed an effect of priming which appeared to rely on a clear representation of how the relative clause attached itself to the main clause (high vs. low attachment). Knowledge of the attachment relation necessitates some kind of representation of the structure as a whole or at least the relation of the relative clause to a larger structure. As Scheepers (2003) had demonstrated that some syntactic information about overall sentence structure is available when processing a local clause structure, Branigan and colleagues (2006) wanted to investigate whether this information might be available or affect choice of local structure when processing a clause within a larger complex structure or whether overall structure information only influenced selection of local clause structures when their integration into the overall structure carried significance for high or low attachment or for assigning thematic and syntactic roles..

In the study of Branigan and colleagues, the first six experiments investigated priming effects when global syntactic structure was not shared between prime and target. Ditransitive priming to a main clause target (*The patient showed…*) occurred from primes from a main clause (*The racing driver showed the torn overall…*), a main clause after an initial adverbial phrase (*As Anne claimed, the racing driver*

showed the torn over all…) and a main clause after a sentence initial clause (*The report claimed that the racing driver showed the torn overall…*). Ditransitive priming in sentences with main and subordinate clauses found priming to a subordinate clause (*The rumours alleged that the patient showed…*) from primes in a subordinate clause (*The report claimed that the racing driver showed the helpful mechanic…*) or a main clause (*The racing driver showed the helpful mechanic…*), as well as priming from a subordinate prime to a main clause. Further experiments demonstrated no difference in the degree of priming from main and subordinate clauses to a main clause or from main and subordinate clauses to a subordinate clause. Location of prime or target in an overall syntactic structure did not affect priming. This suggests that local syntactic structures are chosen without considering the global syntactic structure.

Branigan and colleagues proposed the following possible reasons why their study found no influence of global sentence structure during priming, whereas the Scheepers (2003) study clearly demonstrates an example of global structural information used during processing. The results from Branigan at al.'s study are in keeping with the idea of combinatorial nodes, where nodes which represent particular syntactic structures are accessed during production. For example, in their experiments a main clause was primed by a structure within a main clause or within a subordinate clause. This suggests that the representation for that structure is shared and accessible during processing of either a main clause or a subordinate clause. This would be more efficient than storing the same representation multiple times in accordance with all the possible contexts where it may occur.
Considering the findings of the Scheepers study (2003), Branigan and colleagues suggested that the influence of global structure might be weaker than the influence of local structure. The processor may require global structural information sometimes, but local structural information is the most relevant at the time when the structure is being built. Furthermore, they suggest that the priming of relative clause attachment to the main clause (high vs. low) may arise from its semantic content or thematic role relations. The syntactic mechanism which attaches the relative clause

to the appropriate noun is dictated to by the content of the semantic message. It may be this semantic distinction which boosts the priming of relative clauses attachment to the main structure, whereas processing of a structure within a main or relative clause appears unaffected by its location within the sentence as a whole.

According to Branigan and colleagues, the contrasting evidence for the influence of global structure could provide insight into syntactic processing. They argued that speakers first create a functional representation, where roles are assigned but no specific order is assigned. This functional representation is then directly mapped onto a constituent structure representation. When building a structure, the syntactic processes only refer to the elements that are immediately relevant and make up that structure. Thus, when attaching a relative clause, the processor accesses global structure information which informs the processor how the elements in the relative clause structure relate to the main structure. The materials in the Scheepers (2003) study actively required that the processor accesses global structural information for syntactic and semantic reasons.

I propose that it is not impossible to reconcile these two studies, one which shows a global structural influence and one which does not, with a consistent model of syntactic processing. In Scheepers (2003), how the relative clause attaches to the main clause is important because it indicates which noun the relative clause modifies. This is important for successful communication and interpretation of an utterance. However, the main clauses which occurred in the materials of Branigan et al. (2006) tended to be a belief statement with a sentential object, e.g. *The report claimed that the racing driver....* The role of the target phrase structure within the global utterance did not change within an experiment and was not as much of a marked distinction as assigning a relative clause to a noun.

Furthermore, in German, the word order in a relative clause is different to that of a main clause: The verb occurs in second position in a main clause, and in final position in a subordinate clause. This may mean that subordinate clauses are more marked in German than in English, where the structure remains the same whether it occurs in a main clause or a relative clause. For this reason, it seems

highly plausible that the same mechanism would be used in the Branigan et al. comparison of main and subordinate clauses. In order to know which structure to use, a speaker of German needs to know where a structure occurs in the global sentence structure. This requires reference to a representation of global sentence structure, whereas a speaker of English may not need to access this as often or expect to find such a strong activation or influence. Hence I suggest that these differences may reflect cross-linguistic differences in processing.

Branigan and colleagues (2006) found no evidence for an influence of global syntactic structure, concluding that processing mechanisms were shared between main clauses and subordinate clauses in English and that overall global structure was not a significant influence during the production of local clause structures. In this chapter, a series of three experiments investigates priming between matrix clauses and unbounded dependencies to see whether the same processing mechanisms are used for both. The structure of a sentence containing an unbounded dependency. E.g., *Which jug is the nun giving to the monk?* varies markedly from that of its unextracted matrix analogue, e.g., *The nun gives the jug to the monk*. However, both sentences involve the prepositional object (PO) ditransitive structure (in contrast to the double object (DO) structure, demonstrated by *to the monk*. Comparing priming between an unbounded dependency and a matrix clause allows a comparison of which mechanisms may be shared between the two structures and to what degree this may be affected by a global structural difference.

There is good reason to believe that differences in word order could affect priming even if both matrix and unbounded dependency clauses involve the same constituents. In Chapter 1, we discussed evidence that word order can be primed as well as hierarchical constituent structure. In a picture description priming task Hartsuiker, Kolk and Huiskamp (1999) found that word order could be primed for sentences with the same syntactic relations structure but differing word orders, such as *On the table is a ball* and *A ball is on the table*. Further evidence from Dutch showed that the auxiliary verb and past participle in subordinate clauses could be primed (Hartsuiker & Westenberg, 2000). Subordinate clause word orders included past

participle-final order such as *De man belde de politie omdat zijn portemonnee **was gestolen*** or auxiliary final such as *De man belde de politie omdat zijn portemonnee **gestolen was*** ('The man called the police because his wallet **was stolen/stolen was'**). However, using spoken and written priming tasks, Pickering, Branigan and McLean (2002) found different degrees of priming for structures with the same syntactic dominance hierarchy but different word order. There were more PO responses produced after a shifted ditransitive structure such as *The racing driver showed to the mechanic the extremely dirty and badly torn overall* than after a DO structure but fewer than after a PO structure, and indeed no reliable priming compared to a baseline condition.

The three experiments in this chapter look at priming between matrix clause declarative ditransitives like *The nun is giving the jug to the monk* and unbounded dependency interrogative ditransitive clauses like *Which jug is the nun giving to the monk?*. If the two types of sentence structure (matrix vs. unbounded dependency) involve the same syntactic processing mechanisms then priming should occur between the two sentence types; if they do not share the same mechanisms then there should be less or no priming in comparison to the degree of priming between identical clauses. Assuming a processing model based on a transformational account of grammar, one would predict that priming would occur between matrix clause declarative structures and interrogatives containing unbounded dependencies because both share an underlying declarative deep structure representation. However, the level of priming may be different depending whether priming is from declarative to interrogative or from interrogative to declarative. Priming may even be limited to one direction. When an interrogative sentence is produced, the processor first builds a declarative deep structure and then transforms this to an interrogative surface structure which is subsequently produced by the speaker. For this reason, priming from declarative sentences to interrogative sentences is quite likely as priming may take place while the processor builds the underlying declarative deep structure. However, priming from an interrogative to a declarative target may be less likely as the deep structure and surface structure of a declarative

are the same and so the interrogative structure may elicit less or no priming even though it has an underlying declarative deep structure because its surface structure is not shared with the declarative. A non-transformational model of syntactic processing would not necessarily predict differences between ditransitives produced in a matrix clause or a clause with an unbounded dependency.

The three priming experiments use the alternation of prepositional object (PO) ditransitive such as *give the jug to the monk* and double object (DO) ditransitive like *give the monk the jug*. The experiments investigate priming from matrix clause and unbounded dependency clause sentences to a matrix clause target, an unbounded dependency target and a matrix clause target with the verb repeated between prime and target.

4.2. Experiment 4

The first experiment examines priming using the PO/DO ditransitive alternation from matrix clause and unbounded dependency clause sentences to a matrix clause target. If syntactic mechanisms are shared between declarative matrix clauses and interrogative unbounded dependency clauses, we would expect to see priming from interrogative primes to declarative targets, as well as the established priming from declarative primes to declarative targets. If no mechanisms are shared between declarative matrix clauses and interrogative unbounded dependency clauses, then we could expect to see priming between declarative primes and targets but no priming between interrogative primes and declarative targets. If some mechanisms are shared between declarative matrix clauses and interrogative unbounded dependency clauses, we would expect to see priming between declarative primes and targets and some degree of priming between interrogative primes and declarative targets.

The experiment used a priming paradigm where the participant is asked to perform a matching task and a describing task. In the match task, the participant

read a sentence aloud and then chose the matching picture from two similar pictures presented on screen. In the describing task, the participant described a picture using a full sentence. Prime sentences were presented as part of the match task and followed by a describing task which included the appropriate target picture for that item. Fillers appeared in both the match task and the describing task.

4.2.1. Methods

4.2.1.1. Participants

Twenty-eight members of the University of Edinburgh community were paid to participate. Participants were native speakers of English. Two participants were excluded for being non-native speakers and one was excluded because of familiarity with priming techniques. A final participant was excluded because they did not follow the instructions and all responses were others

4.2.1.2. Materials

The materials consisted of a set of simple outline cartoon style pictures. There were 180 pictures in total consisting of 72 experiment pictures and 108 fillers. An example of one of the primes is given below.

1a.	Which jug is the nun giving to the monk?	*interrogative, PO*
1b.	Which jug is the nun giving the monk?	*interrogative, DO*
1c.	The nun is giving the jug to the monk.	*declarative, PO*
1d.	The nun is giving the monk the jug.	*declarative, DO*

Target picture: nun give jug (patient) monk (beneficiary)

The experiment pictures included 24 prime match, 24 prime non-match and

24 target pictures. The prime non-match pictures were identical to the prime match pictures except for a non-match element. These were evenly distributed so that there were eight images with the agent replaced, eight images with the patient replaced and eight images with the beneficiary replaced. The 72 experiment images showed a ditransitive action involving an agent, a patient and a beneficiary. The agent and beneficiary were always human and the patient was always an object. Human characters and the objects were chosen to be easily recognised. There were 24 character entities of different professions (e.g. *doctor, cricketer*). There were also 24 objects taken from the 'Snodgrass' collection of easily recognisable images, which were edited to allow for clarity and reduced to fit the proportions of the character images. There were three images for each of eight verbs capable of taking either dative structure (*give, hand, offer, sell, show, throw, lend, pass*).

The remaining 108 images were filler images depicting either a transitive or intransitive action with a human character as the agent. There were 72 images depicting a transitive action with a human agent and an inanimate object. These included 24 match, 24 non-match and 24 describe images. The non-match pictures were identical to the match pictures except for a non-match element. There were six images with the agent replaced and six images with the patient replaced. There were 16 transitive verbs which were used three times each. There were also 36 images depicting an intransitive action and containing only a human agent. These included 12 match, 12 non-match and 12 describe images. The non-match pictures were identical to the match pictures except for the agent which was replaced. The 8 intransitive verbs were used three times each.

For all images, the relevant verb was shown below each picture. Images were balanced as to orientation with actions occurring from left to right and vice versa. In the match task, images were balanced so that the match image appeared on the right for half of the match tasks and on the left for half of the match time.

The experiment used four lists containing 24 experimental items, including eight from each condition, and 72 filler items. The items were randomised so that at least two fillers were present between each experimental item. One version of each item

appeared in each list. In this way, the two conditions of Sentence Type (Declarative vs. Interrogative) and Prime Type (PO vs. DO) were manipulated within subjects and items.

4.2.1.3. Procedure

The participant sat at a desk with a computer, monitor and button box in front of them. The experiment used the ePrime program, which displayed images to the participant. The four lists had been randomised to create six randomised versions of each list, so that each participant in the experiment experienced a different list.

Participants were instructed to perform two tasks: a matching task and a describing task. A sentence was presented on screen and participants were asked to read it aloud, remember it, and press any button on the button box when they were ready. This would present a screen with either one or two images. If the screen displayed two images, the participant had to choose the image which best matched the sentence they had just read, pressing the leftmost button if the left image matched and the rightmost button if the right image matched. If the screen displayed only one image then the participant had to describe the picture in a complete sentence using the verb given and including all characters and objects. The instructions were given orally and then the participant received a set of written instructions with examples of pictures and possible descriptions. The examples included one transitive image and one intransitive image.

After confirming that the participant had understood the written instructions, the participant then started the experiment on the computer. First the participant was presented with brief instructions on screen and then they started a practice trial. The practice trial consisted of 6 practice items presented in a random order. There were three match tasks and three description tasks. These consisted of two transitive and one intransitive match tasks and two transitive and one intransitive describe tasks. After the practice trial had been completed, a break screen appeared. The participant was given an opportunity to ask questions and

then the experimenter left the room for the remainder of the experiment. The participant proceeded onto the main experiment by pressing any button on the button box. The experimental session lasted about 30 minutes.

4.2.1.4. Scoring

The experimental session was recorded on audio tape and transcribed. The first response that the participant gave was coded and scored. Responses were coded as: PO when a prepositional object ditransitive construction with 'to' was used e.g. *The nun is giving the jug to the monk*, or DO when a double object ditransitive construction was used, e.g. *The nun is giving the monk the jug*.

Responses were coded as 'Other' when a different syntactic structure or preposition was used, such as a passive or patient-first passive construction, e.g. *The monk is being given the jug by the nun* or *The jug is being given by the nun to the monk*. A response was coded as 'other' if the patient appeared first in a declarative sentence, e.g. *The jug is given to the monk by the nun*. Producing a response in the wrong condition, e.g. an interrogative instead of a declarative, was coded as 'other'. Responses where thematic roles were switched, e.g. 'nun gives monk' becomes 'monk gives nun', were categorised as others. Responses were also coded as others when a different verb was used from that given.

4.2.1.5. Design and data analysis

This study used a 2x2 (sentence x prime) within-participants and -items factorial design. One experimental factor was the type of sentence used: a declarative sentence or an interrogative sentence. The other experimental factor was the syntactic structure of the prime sentence: Prepositional Object (PO) prime, or Double Object (DO) prime.

The data was analysed using proportions so that analyses would not be affected by any missing data. An initial analysis of Other responses showed no

significant effects and the percentage of Other responses was quite low. The analyses for PO and DO responses were carried out using proportions calculated including PO and DO responses only and excluding Others. For example: the proportion of Declarative, PO responses was calculated by dividing the number of Declarative,PO responses by the number of Declarative,PO and Declarative,DO responses, and the proportion of Declarative, DO responses was calculated by dividing the number of Declarative,DO responses by the number of Declarative,PO and Declarative,DO.

4.2.2. Results

In total 576 (100%) of Prime trials were completed. Of these 387 (67%) were followed by PO target sentences and 176 (31%) were followed by DO target sentences, and the remaining 13 (2%) were others. Proportions of target response in the different conditions are reported in Table 6. The two factors in the analysis were Sentence Type (Declarative vs. Interrogative) and Prime Type (PO vs. DO). Analyses were conducted treating participants (*F*1) and items (*F*2) as random factors. Other responses were excluded from the analysis.

T wo-way ANOVAs on the proportions of PO target responses in each condition revealed a significant interaction between Sentence Type and Prime Type ($F1(1,23) = 5.59$, $p < .05$, MSe = 0.136, partial $\eta^2 = 0.195$; $F2(1,23) = 7.97$, $p < .05$, MSe = 0.140, partial $\eta^2 = 0.257$). There was a higher level of priming after a Declarative prime than after an Interrogative prime. There was a near significant effect of Prime Type ($F1(1,23) = 3.70$, $p = .067$, MSe = 0.185, partial $\eta^2 = 0.139$; $F2(1,23) = 3.29$, $p = .083$, MSe = 0.202, partial $\eta^2 = 0.125$). There was no significant effect of Sentence Type (Fs < 2). Simple main effects showed a significant effect of priming for Declarative sentences ($F1(1,23) = 7.359$, $p < .05$; $F2(1,23) = 7.304$, $p < .05$) but no effect for Interrogative sentences (Fs < 1).

Table 6: Mean proportions of target responses by Prime condition (By participants analysis)

Sentence Type	Prime Description	Target Description	
		PO	DO
Declarative	PO	.79	.21
	DO	.62	.38
Interrogative	PO	.68	.32
	DO	.67	.33

PO = prepositional object, DO = double object

4.2.3. Discussion

The first experiment examined priming from matrix clause and unbounded dependency clause sentences to a matrix clause target using the PO/DO ditransitive alternation. Priming for a declarative matrix clause target only occurred after a declarative matrix clause prime. There was no evidence that priming occurred after an interrogative unbounded dependency prime. The experiment reproduced the established priming effects between a declarative prime and target, so the finding that no priming occurred between the interrogative prime and the declarative target is less likely to be plausibly attributed to the materials but most likely to be a result of the interrogative priming condition. This suggests that the syntactic mechanisms when processing an interrogative unbounded dependency clause may be different to those used when processing a declarative matrix clause, despite the common ditransitive feature, or that priming draws upon surface word order, which is different between the matrix clause and the unbounded dependency clause in this case. It is possible that thematic or conceptual representations of the ditransitive are shared, but the syntactic mechanisms are differing owing to the different global

syntactic structures. In the next experiment, we investigate priming from declarative matrix clauses and interrogative unbounded dependency primes to an interrogative unbounded dependency target. This will allow us to confirm whether it is possible to prime between declarative matrix clauses and interrogative unbounded dependencies, and also whether it is possible to prime an interrogative unbounded dependency structure.

4.3. Experiment 5

The second experiment investigates whether priming occurs from declarative matrix clauses and interrogative unbounded dependency clause sentences to interrogative unbounded dependency targets like *Which jug is the nun handing to the monk?*. The previous experiment found no evidence of priming from interrogative unbounded dependency clauses to declarative matrix targets but it may still be possible that declarative targets may prime interrogative targets, which would indicate some mechanisms may yet be shared by the declarative and interrogative sentences. If declarative matrix clauses and interrogative unbounded dependency clauses share some of the same mechanisms, then we would expect to see some degree of priming from declarative matrix clauses to interrogative unbounded dependency clause targets. If no mechanisms are shared between declarative matrix clauses and interrogative unbounded dependency clauses, then we would expect to observe priming between interrogative unbounded dependency primes and targets, but no priming between declarative matrix primes and interrogative unbounded dependency targets.

4.3.1. Methods

4.3.1.1. Participants

Twenty-four members of the University of Edinburgh community were paid to participate. Participants were native speakers of English.

4.3.1.2. Materials

The materials were the same set that was used in Experiment 4.

4.3.1.3. Procedure

The procedure was identical to that used in Experiment 4 except for the instructions for the description task. If the screen displayed only one image then the participant had to describe the picture by forming a question using the verb given, including all characters and asking about the object.

4.3.1.4. Scoring

The experimental session was recorded on audio tape and transcribed. The first response that the participant gave was coded and scored. Responses were coded as: PO when a prepositional phrase with 'to' occurred after the verb e.g. *Which jug is the nun giving to the monk?*, or DO when only the beneficiary occurred after the verb e.g. *Which jug is the nun giving the monk?* Responses were coded as 'Other' when a different syntactic structure or preposition was used where a PO/DO alternation was not possible, e.g. a passive such as *Which jug is being given by the nun to the monk?* A response was coded as 'other' if the question asked about the agent or the beneficiary, e.g. *Which nun is giving the jug to the monk?,* or *Which monk is the nun giving the jug to?* Producing a response in the wrong condition, e.g. a declarative

instead of an interrogative, was coded as 'other'. Responses where thematic roles were switched, e.g. 'nun gives monk' becomes 'monk gives nun', were categorised as others. Responses were also coded as others when a different verb was used from that given.

4.3.1.5. Design and data analysis

The design was identical to Experiment 4. The data was analysed using proportions as described for Experiment 4.

4.3.2. Results

In total 576 (100%) of Prime trials were completed, of these 365 (63%) were followed by PO target sentences and 185 (32%) were followed by DO target sentences, and the remaining 26 (5%) were others. Proportions of target response in the different conditions are reported in Table 7. The two factors in the analysis were Sentence Type (Declarative vs. Interrogative) and Prime Type (PO vs. DO). Analyses were conducted treating participants (*F*1) and items (*F*2) as random factors. Other responses were excluded from the analysis.

Two-way ANOVAs were performed on the proportions of PO target responses in each condition. There was a main effect of Prime Type ($F1(1,23) = 11.954$, $p < .005$, $MSe = 0.650$, partial $\eta^2 = 0.342$; $F2(1,23) = 29.042$, $p < .001$, $MSe = 0.563$, partial $\eta^2 = 0.558$). More PO targets were produced after a PO prime than after a DO prime. There was no significant effect of Sentence Type ($Fs < 1$). There was no significant interaction between Sentence Type and Prime Type ($Fs < 2$). Simple main effects showed a significant effect of priming for Declarative sentences ($F1(1,23) = 4.967$, $p < .05$; $F2(1,23) = 8.957$, $p < .01$) and for Interrogative sentences ($F1(1,23) = 15.662$, $p < .01$; $F2(1,23) = 14.724$, $p < .01$).

Table 7: Mean proportions of target responses by Prime condition (By participants analysis)

Sentence Type	Prime Description	Target	
		PO	DO
Declarative	PO	.73	.27
	DO	.60	.40
Interrogative	PO	.76	.24
	DO	.57	.43

PO = prepositional object, DO = double object

4.3.3. Discussion

The second experiment investigated whether priming occurs from declarative matrix clauses and interrogative unbounded dependency clause sentences to interrogative unbounded dependency targets like *Which jug is the nun handing to the monk?*. Speakers were more like to produce a PO target after having previously produced a PO prime sentence than a DO prime sentence. This was observed for both declarative and interrogative prime types. These findings contrast with the observations in the first experiment where no priming occurred between the interrogative unbounded dependency clause prime and the declarative matrix clause target. One possible explanation for these results is that priming only occurs from a declarative prime to an interrogative target but it does not occur for an interrogative prime to a declarative target. This seems oddly asymmetrical. If priming occurs due to shared structures or mechanisms then why would this mechanism or structure only be able to prime in one direction? It could be that declarative prime structures cause greater activation of corresponding interrogative structures but that interrogative prime structures provide little or no activation of

the corresponding declarative structures. Rather than no priming occurring from interrogative structures to declarative structures, it is perhaps more likely that priming can occur from an interrogative prime to a declarative target but the level of priming is very weak and therefore was not detected in the previous experiment.

4.3.4. Comparison: Experiments 4 and 5 - Unbounded dependency priming to declaratives and interrogatives

The two within-participants factors in the analysis were Sentence Type (Declarative vs. Interrogative) and Prime Type (PO vs. DO) and the factor Experiment was treated as a between-participants and within-items factor. Analyses were conducted treating participants (*F*1) and items (*F*2) as random factors. Others were excluded from this analysis.

Mixed ANOVAs were performed on the proportions of PO target responses in each condition. There was a main effect of Prime Type ($F1(1,46) = 14.637$, $p < .001$, $MSe = 0.764$, partial $\eta^2 = 0.241$; $F2(1,46) = 17.793$, $p < .001$, $MSe = 0.718$, partial $\eta^2 = 0.279$). More PO targets were produced after a PO prime than after a DO prime. There was no significant effect of Sentence Type ($Fs < 1$). There was no significant interaction between Sentence Type and Prime Type ($Fs < 1$). There was no significant interaction between Sentence Type and Experiment ($Fs < 1$).There was no significant interaction between Prime Type and Experiment ($Fs < 2$). There was a significant interaction between Sentence Type, Prime Type and Experiment ($F1(1,46) = 6.683$, $p < .05$, $MSe = 0.140$, partial $\eta^2 = 0.127$; $F2(1,46) = 5.550$, $p < .05$, $MSe = 0.128$, partial $\eta^2 = 0.108$). There was more priming in Experiment 5 which contained Interrogative targets than in Experiment 4 which contained Declarative targets.

4.3.5. Discussion

A mixed ANOVA analysis compared experiments 4 and 5. Over both experiments, speakers were more likely to produce a PO target after previously producing a PO

prime than a DO prime, and also more likely to produce a DO target after previously producing a DO prime than a PO prime. There was also a three-way interaction where speakers produced more PO declarative responses after a PO declarative prime than after a PO interrogative prime, DO declarative or DO interrogative prime in the first experiment, whereas in the second experiment speakers produced more PO interrogative targets after either a PO declarative prime or a PO interrogative prime than after either DO prime. The same three way interaction occurred for DO priming as well. This confirms the findings in the individual experiments that priming appears to be different when priming from interrogative primes to declarative targets than from declarative primes to interrogative targets.

This suggests that either priming can occur between interrogative and declarative structures but only in one direction, or that priming from interrogatives to declaratives is possible but was too weak to be detected in Experiment 4. If so, then it might be detectable if a stronger priming manipulation were used. There may also be a factor of baseline preferences. It could be that sentences such as '*Which jug is the nun giving the monk?'* are dispreferred because the patient (*the jug*) has been placed in the subject position. If this is the case, then there may be weak activation or inhibition of sentences with this structure which would affect subsequent activation and thus production of that structure. Experiment 6 therefore replicates Experiment 4, but in this experiment the verb is repeated between prime and target. Previous research has shown that repeating the verb between prime and target consistently boosts the level of priming: the lexical boost effect found by Pickering and Branigan (1998). By exploiting this lexical boost effect, we hope to observe priming from an interrogative prime to a declarative target, the same manipulation as in Experiment 4.

4.4. Experiment 6

Evidence from the previous two experiments found mixed evidence for whether declarative matrix clauses and interrogative unbounded dependency clauses share syntactic processing mechanisms for ditransitive structures (PO vs DO). The first experiment showed priming to declarative matrix clauses from declarative primes only and no effect of priming from interrogative clause primes. The second experiment showed priming to interrogative clauses from both declarative and interrogative clause primes. This suggests that some syntactic mechanisms are shared between declarative matrix clauses and interrogative unbounded dependency clauses. It may be that priming can occur from interrogative unbounded dependency clauses to declarative matrix primes, but that the priming effect is weak. Like Experiment 4, Experiment 6 investigates priming between declarative matrix and interrogative primes and interrogative unbounded dependency targets, but unlike Experiment 4 examines this effect when the verb is repeated between prime and target. By boosting priming levels using a repeated verb, it should be possible to establish if priming can occur between interrogative primes and declarative targets and whether previous null effects can be attributed to an undetected weak priming effect.

The predictions are similar to those for Experiment 4. If syntactic mechanisms are shared between declarative matrix clauses and interrogative unbounded dependency clauses, there should be an effect of priming for interrogative primes to declarative targets, and a high level of priming from declarative primes to declarative targets. If few mechanisms are shared between declarative matrix clauses and interrogative unbounded dependency clauses, we should expect similar findings to the results of the first experiment with boosted levels of priming between declarative primes and declarative targets and no reliable effect of priming between interrogative primes and declarative targets.

4.4.1. Method

4.4.1.1. Participants

Twenty-five members of the University of Edinburgh community were paid to participate. Participants were native speakers of English. One participant was excluded because of technical failure.

4.4.1.2. Materials

The materials were identical to those in Experiment 4, except for the verb in the target pictures. The target images were changed so that the verb was repeated between the prime pictures and the target pictures. The fillers were arranged so that in half of the cases a match task was followed by a description task using the same verb.

4.4.1.3. Procedure

The procedure was identical to that described in Experiment 4.

4.4.1.4. Scoring

The scoring was identical to that described in Experiment 4.

4.4.1.5. Design and data analysis

The design was identical to Experiment 4. The data was analysed using proportions as described for Experiment 4.

4.4.2. Results

In total 576 (100%) of Prime trials were completed, of these 368 (64%) were followed by PO target sentences and 195 (34%) were followed by DO target sentences, and the remaining 13 (2%) were others. Proportions of target response in the different conditions are reported in Table 8. The two factors in the analysis were Sentence Type (Declarative vs. Interrogative) and Prime Type (PO vs. DO). Analyses were conducted treating participants (*F*1) and items (*F*2) as random factors. Other responses were excluded from the analysis.

Two-way ANOVAs were performed on the proportions of PO target responses in each condition. There was a main effect of Prime Type ($F1(1,23) = 61.619$, $p < .001$, $MSe = 4.098$, partial $\eta^2 = 0.728$; $F2(1,23) = 82.481$, $p < .001$, $MSe = 4.022$, partial $\eta^2 = 0.782$). More PO targets were produced after a PO prime than after a DO prime. There was a significant interaction between Sentence Type and Prime Type ($F1(1,23) = 35.460$, $p < .001$, $MSe = 0.825$, partial $\eta^2 = 0.607$; $F2(1,23) = 38.152$, $p < .001$, $MSe = 0.859$, partial $\eta^2 = 0.624$). There was no significant effect of Sentence Type ($Fs < 3$). Simple main effects showed a significant effect of priming for Declarative sentences ($F1(1,23) = 66.801$, $p < .001$; $F2(1,23) = 142.992$, $p < .001$) and for Interrogative sentences ($F1(1,23) = 24.517$, $p < .001$; $F2(1,23) = 14.108$, $p < .001$).

Table 8: Mean proportions of target responses by Prime condition (By participants analysis)

Sentence Type	Prime Description	Target Description	
		PO	DO
Declarative	PO	.93	.07
	DO	.33	.67
Interrogative	PO	.79	.21
	DO	.56	.44

PO = prepositional object, DO = double object

4.4.3. Discussion

Experiment 6 investigated priming between declarative matrix clause and interrogative unbounded dependency clause primes and interrogative unbounded dependency targets when the verb was repeated between prime and target. In contrast to Experiment 4, Experiment 6 did show an effect of priming from declarative matrix clauses to interrogative unbounded dependency targets as well as from interrogative unbounded dependency primes to interrogative unbounded dependency targets. Hence, speakers produced more PO declarative targets after a PO declarative or interrogative prime than after DO declarative or interrogative primes. However, there was greater priming for Declarative primes (60%) than for Interrogative primes (23%). These results demonstrate that priming can occur from interrogative unbounded dependency clauses to declarative matrix clauses as well as from declaratives to interrogatives. This suggests that some syntactic mechanisms are shared by the two types of clause but that the priming level was very weak in the first experiment and thus not detected until the repeated verb boosted priming levels in the present experiment. Although Experiment 6 found reliable priming from interrogative unbounded dependency clauses to declarative matrix clauses, it again found a substantial (and significant) difference in the magnitude of priming between matrix and unbounded dependency clauses. This suggests that the overall structure of a sentence does affect processing during selection of a local syntactic structure.

4.5. General Discussion

This chapter examined the processing involved when selecting a structure in a matrix sentence or in a sentence containing an unbounded dependency. A series of three priming studies investigated whether syntactic processing mechanisms are

shared between matrix declarative sentences and interrogative sentences which contain an unbounded dependency. The first experiment found no evidence that priming occurred from an unbounded dependency interrogative sentence to a matrix declarative sentence. However, the second experiment showed a clear effect of priming from matrix declarative sentences to unbounded dependency interrogative sentences. The third experiment investigated priming from unbounded dependency interrogative sentences and matrix declarative sentences when the verb was repeated between prime and target, and found that priming from unbounded dependencies to matrix clauses did exist but the effect was weak; this suggests that priming might not have been detected in the first experiment because overall levels of priming were too low.

These results suggest that matrix clauses and unbounded dependencies do share certain syntactic mechanisms as priming was found between matrix clauses and unbounded dependencies in both directions. However, the degree of priming, and thus the amount of shared syntactic processing between the two global structure types, shows that the syntactic information shared is different depending on whether priming occurs between the same type of clause and different types of clause and also on the direction of the priming between clauses of different types. More priming occurred from a declarative to an interrogative than from an unbounded dependency to a matrix clause. The difference in global sentence structure affected the processing of the local structure choice.

One possible analysis for these results draws upon a model of structural representation as proposed by derivation theories of syntax such as that proposed by Chomsky (1981). In a transformational model of language production, an underlying core representation or deep structure is produced. In this case, this is assumed to be the declarative structure. The interrogative structures in the experiment are assumed to be derived from the underlying declarative structures through the process of *wh*-movement. The movement operations produce the final derived structure also known as the surface structure. This is the form which the speaker finally produces.

As regards the results of the experiments presented here, the derivational model of syntactic structures provides a possible explanation for the asymmetry found in the priming between declarative structures and interrogative structures. These results present a picture where priming occurs from the deep structure to the deep structure and also to the surface structure, the interrogative structure. However, priming from the surface structure (the interrogative structure) to the deep structure (the declarative structure) is weak, whereas priming from interrogative to interrogative occurs at normal levels. Because the interrogative is derived from a deep structure, first the underlying declarative deep structure is built and then this is transformed to become the interrogative surface structure which the speaker produces. In this way, a declarative prime can prime an interrogative target at the deep structure declarative phase of processing. However, as the surface structure of a declarative target is the same as its deep structure, an interrogative does not prime a declarative to the same extent even though the interrogative does have an underlying declarative deep structure.

An alternate way of interpreting the processing differences between declarative sentences and interrogative sentences involving an unbounded dependency, is to look at the actual structural differences in each case. In matrix clauses, the alternative ditransitive structures are marked by the presence or absence of the preposition *to* and a difference in word order. The PO structure uses the preposition *to* such as *The nun gave the jug to the monk.* The DO structure contains no preposition but uses an alternate word order where the recipient occurs before the direct object/theme: *The nun gave the monk the jug*. In contrast, the ditransitive alternation in the unbounded dependency structures differ only in the insertion of the preposition *to*, otherwise the word order and order of thematic roles are identical, for example, the unbounded dependency PO structure *Which jug is the nun giving to the monk?*, and unbounded dependency DO structure *Which jug is the nun giving the monk?*.

It is possible that the difference in the degree of priming that occurs when priming from matrix to unbounded dependencies and when priming from

unbounded dependencies to matrix clauses arises from differences between the two structures. There are two levels of structural difference between matrix and unbounded dependency structures. First, there is a global structural difference between a matrix structure and an unbounded dependency structure as the dependency occurs at the start of the sentence in a *wh*-phrase. Second, there is a difference between the ditransitive structure alternations for the two global structure types (e.g. matrix and unbounded dependency). Although the unbounded dependency clauses and matrix clauses share some of their structure which allowed priming to occur, priming from the same structure may be stronger than priming from a different structure because there is more overlapping structural information which can be used during production processing.

Priming from the matrix clause to the unbounded dependency may be stronger than priming from an unbounded dependency to a matrix clause because the alternate ditransitive structures are more marked in the matrix clauses because they have different word orders, whereas unbounded dependency ditransitive alternations are distinguished only by an optional preposition *to*. The difference in word order provides more structural information, which may also be more marked in the case of the DO 'recipient, theme' word order. The unbounded dependency PO ditransitive word order has a word order structure that is more similar to the matrix PO word order structure than the matrix DO word order structure, so this may not provide enough information for the processor to select a matrix DO structure, whereas the matrix DO structure is highly marked which aids the selection of a unbounded dependency DO structure.

If one presumes that matrix and unbounded dependency clauses share a similar thematic role representation, although in the *wh*-questions used here the unbounded dependencies also acquire an interrogative meaning, then final choice of syntactic structure arises from an interplay of syntactic preferences and available structures. The behaviour observed in these priming production experiments demonstrates competition between different types of syntactic structural information. On the one hand, the processor is accessing ditransitive structure

information activated by the prime sentence. On the other hand, the processor is also accessing global syntactic structural information in order to produce either a matrix or unbounded dependency structure. These two types of information may be compatible and facilitate production, or they may conflict and a competition between the different types of structure may arise or structural information that is less relevant to the desired sentence structure type may be disregarded.

Competition between the structures can be affected by the amount of activation a structure has received. A structure that has been produced previously like a ditransitive prime (e.g. PO prime) will be more highly activated and more likely to be a structure chosen for production. However, a structure may be marked because it is a rarer or more pragmatically constrained structure type. For example, the unbounded dependency structure may be more marked because of its specific function and relevance when producing an interrogative sentence, or the matrix DO ditransitive structure may be more marked because of its particular word order. Finally, a previously activated structure may share relatively few features with the possible structures available for a target sentence. In this case, the deciding factor for structure selection will come from the competition between the available possible structures with the previously activated structure providing only a little or no relevant structural information and thus influence. In the case of priming from an interrogative to a declarative sentence it is possible that the interrogative structure is particularly marked and thus receives a high level of activation. However, the processor may inhibit the interrogative structure because it is building a declarative and thus the ditransitive structure incorporated therein is also inhibited and the choice of PO or DO structure is made using other available information.

4.6. Conclusion

The previous chapter established that global sentence structure affected choice of a local syntactic structure by comparing matrix sentences and sentences containing a

relative clause. This chapter investigated whether syntactic mechanisms or structures are shared between sentences with different global syntactic structures but sharing a local structure. Syntactic priming of ditransitive structures occurred between declarative matrix clauses and interrogative clauses with a *wh-* unbounded dependency but the degree of priming was weaker from interrogatives to matrix clauses. I suggest a model of syntactic processing where structures are selected on the basic of competing structural information coming from the local structure and the global structure. During production possible global and local structures are activated and final selection can be affected by the compatibility of these two types of structures and how accessible a structure is by previous activation or other relevant syntactic information. However, these results are also consistent with a derivational model of syntactic structure that is compatible with mapping between stages of syntactic representation such as those assumed by Chomsky (1981). The final chapter discusses the implications of these processing influences and mechanisms on an overall model of language production and theories of grammar.

Chapter 5

Conclusion

5.0. Introduction

This chapter includes a summary of the findings presented in the previous chapters and a discussion of their implications for syntactic processing and theories of grammar.

5.1. Overview of Experiments

This thesis examined how speakers choose syntactic structures during production and which kinds of information or influence are available during processing. A series of six experiments investigated possible factors which influence choice of syntactic structure in the production of sentences with unbounded dependencies. In Chapter 2, a picture description task investigated whether a complex heavy noun phrase affected choice of structure in the production of matrix and interrogative sentences. In Chapter 3, two sentence recall experiments investigated whether overall sentence complexity and verb subcategorisation affect choice of grammatical voice structure in sentences containing subject and object relative clauses. In Chapter 4, three priming experiments investigated levels of priming between matrix and interrogative sentences to test whether syntactic structures or mechanisms were shared between the two types of sentences. In this chapter, I will summarise the findings of these experiments and discuss implications for models of language production processing and theoretical linguistic theories of grammar.

In Chapter 2, Experiment 1 used a picture description task to investigate

whether a complex heavy noun phrase affected choice of syntactic structure in matrix and interrogative sentences. The experiment failed to find any effect of complex heavy noun phrase shift in either matrix or interrogative sentences. As the heavy noun phrase shift effect is strongly attested in the literature (e.g. Hawkins, 1990; Stallings, MacDonald & O'Seaghda, 1998), I assume that the materials failed to elicit the heavy noun phrase shift effect. However, analysis of the Other responses showed that speakers tended to produce more Other responses when they produced the interrogative sentences. For example, *Which jug with the red spots was being thrown by the nun to the monk?*. Speakers made different choices for syntactic structure when the overall syntactic structure was more complex, i.e. when producing a sentence with an unbounded dependency.

In Chapter 3, two sentence recall experiments examined possible factors that affect choice of syntactic structure. Experiment 2 investigated whether overall sentence structure complexity affected choice of grammatical voice structure in sentences containing subject and object relative clauses versus sentences that did not contain unbounded dependencies. Although passive voice structures are generally dispreferred (Svartvik, 1966) and are more frequently misunderstood during comprehension (Ferreira, 2003), speakers tended to recall more actives as passive in relative clauses and more passives as active in matrix clauses. By producing subject relative passives such as *The boy that was kissed by the girl was embarrassed* speakers avoided producing dispreferred object relative structures (Wanner & Maratsos, 1978) such as *The boy that the girl kissed was embarrassed*. Choice of structure was influenced by overall sentence structure information: Speakers' choice of syntactic structure changed if they were producing a matrix clause or a sentence containing a relative clause.

Experiment 3 investigated whether verb subcategorisation preferences affected choice of grammatical voice structure in subject and object relative clauses. Experiment 2 showed speakers tended to produce passive voice structures in relative clauses but produced active voice structures in matrix clauses. Experiment 3 replicated Experiment 2 but used experiencer-theme verbs such as *like* , which prefer

active voice structures, instead of the previous agent-patient verbs (e.g. *kiss*) to observe whether verb subcategorisation preferences affect structure choice. In a norming study, speakers tended to produce agent-patient verbs and experiencer-theme verbs predominantly with active structures in matrix clause sentences. In Experiment 3, speakers recalled more passive structures as active for both matrix and relative clauses. The verb subcategorisation preference for active structures changed the previously demonstrated preference for passive structures in relative clauses to a preference for active structures in relative clauses. A statistical comparison between the two experiments confirmed this finding. These two experiments demonstrated that both overall sentence structure and verb subcategorisation preferences can affect choice of syntactic structure.

In Chapter 4, three priming experiments investigated levels of priming between matrix and interrogative clauses to test whether syntactic structures or mechanisms were shared between the two types of clauses. Experiment 4 investigated whether priming occurred from matrix clause and interrogative clause primes to a matrix clause target. Priming occurred from the matrix clause primes to the matrix clause target, but there was no effect of priming from the interrogative clauses. Experiment 4 found no evidence to suggest that priming occurred between matrix clauses and interrogative clauses. This suggests that either priming cannot occur between from interrogative clauses to matrix clauses or that the level of priming was too weak and the current experiment did not detect it. In order to confirm whether priming was possible between matrix clauses and interrogative clauses, the next experiment involved priming to interrogative clauses.

Experiment 5 investigated whether priming occurred from matrix clause and interrogative clause primes to an interrogative clause target. Priming occurred from both matrix clause and interrogative clause primes to interrogative targets. This contrasts with the findings of Experiment 4 where priming did not occur between interrogative primes and matrix targets as shown in a statistical comparison of experiments 4 and 5. This suggests that either priming only occurs in one direction and that matrix clauses prime interrogatives but interrogative clauses cannot prime

matrix clause, or that levels of priming in Experiment 4 from interrogatives to matrix targets were weak and the previous experiment failed to detect them. The next experiment used the lexical boost to priming (Pickering & Branigan, 1998) to enhance possible priming levels from interrogative primes to matrix targets.

Experiment 6 investigated whether priming occurred from matrix clause and interrogative clause primes to a matrix clause target when the verb was repeated between prime and target. Pickering & Branigan (1998) showed that repeating the verb between prime and target increased levels of priming; a phenomenon which they called lexical boost. Experiment 6 found evidence of priming from both matrix clause and interrogative primes to matrix clause targets, but the magnitude of priming was higher for matrix clause primes than for interrogative primes. This suggests that interrogative and matrix sentences do share some syntactic structures or mechanisms but that priming levels in Experiment 4 were too low for the experiment to detect. The overall sentence structure affects processing during selection of a syntactic structure.

In summary, these experiments demonstrate that choice of structure can be affected by overall sentence structure complexity and also by verb subcategorisation preferences. In the following section, I discuss possible implications of these findings for models of syntactic processing and linguistic theories of grammar, as well as ideas for further research.

5.2. Implications of findings and suggestions for future research

In this section, I discuss possible implications of the findings of my thesis for syntactic processing theory, models of production and compatibility with theoretical linguistic theories of grammar.

5.2.1. Processing of Local Structure and Overall Sentence Structure

Experiments in this thesis clearly showed that choice of syntactic structure at the local level can be affected by overall sentence structure, in terms of choice of voice (Experiments 2 and 3) or the choice between PO and DO structures (Experiments 4, 5 & 6). Why should overall sentence structure affect local structure choice and how might this happen? One suggestion might be that there is a set hierarchy of rules dictating preferences for syntactic structures in various contexts. However, in Chapter 3, a comparison of Experiments 2 and 3 found that choice of active or passive structure changed as a result of verb subcategorisation preferences as more actives were produced overall with the experiencer-theme verbs in Experiment 3 than with the agent-patient verbs in Experiment 2. This suggests that a set hierarchy of structures based strictly on structural constraints and location in a larger complex structure is unlikely or at the very least not that rigid. I suggest instead that processing for different clauses occurs in parallel to a certain extent. There may be some processing of another clause while a larger proportion of processing resources are allocated to a clause currently in progress. Evidence that structure choice changes whether a clause is a main clause or integrated into a larger complex syntactic structure suggests that it is affected somehow by the processing of other material, though it remains unclear whether it is affected by the extra processing load of processing another clause at the same time, or whether the local clause is affected by accessing overall sentence structure information or the processing cost of attempting to integrate with the larger structure. Further research could attempt to distinguish between these factors or confirm the effects of overall sentence structure on local structure choice using other forms of unbounded dependency such as clefts or topicalization. It could be interesting to look more at priming between complex and simple structures in English to confirm the different levels of priming that were demonstrated in this thesis, or to prime the integration between local structures and larger complex structures.

5.2.2. Processing of Verb Subcategorisation Preferences and Thematic Roles

In Chapter 3, Experiment 3 demonstrated that verb subcategorisation preferences can affect structure choice. Ferreira (1994) showed that speakers tended to produce passive structures with theme-experiencer verbs. Ferreira argued that this could be attributed to the verb subcategorisation preferences of this category of verbs which arise from their thematic role arguments. For a theme-experiencer verb such as *frighten*, the theme may be animate (e.g. *the clown*) or inanimate (e.g. *the painting*) but the experiencer must be animate. In the case where the theme is inanimate, there may be a preference to allocate the animate experiencer as the syntactic subject. If the speaker produces a passive voice structure, then the animate experiencer can become the syntactic subject. For example, *The girl was frightened by the painting*. Similarly, there is a strong case for experiencer-theme verbs to have a strong dispreference for passives. When experiencer-theme verbs are produced with the active structure, the subject will always be animate because the experiencer role can only be filled by an animate. When experiencer-theme verbs are produced with the passive structure, there is a much greater chance that the subject may be inanimate as the theme role may be filled by an inanimate or an animate (e.g. *The chair was hated by the woman*).

This suggests that there is possibly a preference for the syntactic structure which best fits the conceptual content or thematic structure or that processing is facilitated when the syntactic structure best fits the thematic arguments. For example, there may be two possible syntactic structures and the processor must choose one. One structure may be a good fit for the thematic role arguments and receive a greater level of activation from the conceptual message level, or this preference may be specified at the verb lemma itself. The processor will then choose the structure which best fits the thematic roles because of the higher activation. The processor is blind to the thematic role argument information but is influenced by it

through the increased activation of certain structures. The processor may encounter difficulty though when two structures are both activated to similar levels where one structure is highly activated because it fits well with thematic role arguments but the other is highly activated for other reasons but is not the best fit to the thematic role information.

This also suggests that structure preferences vary according to thematic roles and argument structure. So categories of verbs defined by thematic roles and argument structures should display the same syntactic structure preferences. As with experiencer-theme verbs and theme-experiencer verbs, it should be possible to predict structure preferences and then verify these through production experiments. Further experiments could investigate other categories of verbs and test for structural preferences. Experiment 3 could be replicated with other verb types which show a strong preference for active structures. It may also be possible to compare the preferences of the different verb types and create a hierarchy according to structure preferences. Another interesting issue would be whether verbs with strong subcategorisation preferences could be primed to produce a dispreferred structure. For example, what happens if one uses prime experiencer-theme verbs to produce passives? Would theme-experiencer verbs prime for passive structures to the same degree as the usual agent-patient verbs or would they prime more?

I believe that the findings of this thesis suggest a model of language where processing of local and overall sentence structure occur in parallel to some degree and which is incremental, choosing from relevant information as it becomes available. Returning to the main question of my thesis, I propose that both syntactic and conceptual information influence choice of syntactic structure, whether directly or indirectly, and that the processor builds structures in parallel and the final structure is chosen through competition. This is compatible with the processing model proposed by Levelt, Roelofs and Meyers (1999) where a conceptual level passes information down to a lemma level which includes lemma nodes and nodes containing syntactic information. At the lemma level, it is possible to access both syntactic nodes for properties such as first person and present tense but also to store

and access combinatorial nodes which represent syntactic structures such as the ditransitive alternations prepositional object (PO) and double object (DO) (Pickering & Branigan, 1998). During production both individual features and possible structures may be activated and a processor may select the most highly activated compatible nodes including combinatorial structure nodes until a final structure is built.

For example, in Chapter 3 there was a conflict between overall structure preferences and verb subcategorisation preference. Overall sentence structure information and processing considerations established a syntactic preference for a passive subject relative clause structure such as *The boy that was kissed by the girl was embarrassed* in preference to the active object relative clause structure such as *The boy that the girl kissed was embarrassed* and there was a tendency to produce passive subject relative clauses. However, when the relative clauses included an experiencer-theme verb (e.g. love) which has subcategorisation preferences for active voice there was a tendency to produce active object relative clauses. In this case, overall sentence structure processing factors were either increasing activation for the passive structure or inhibiting the active structure. Similarly, the verb subcategorisation preference was leading to activation of the active structure. The syntactic processing, while blind to the sources of these preferences, perceives the increased activation and chooses the most activated structure. As preferences may vary according to specific verb, animacy or syntactic processing contexts, so the choice of structure can be influenced by different factors in different situations but the processor itself will always select according to the highest activated and fastest processed structure. In this way, priming can influence syntactic processing by increasing activation for a structure. Conceptual factors can increase activation for certain lexical items or syntactic roles which increases activation for compatible structures. Finally, overall sentence structure information or processing considerations may lead to increased activation or inhibition of a structure.

The different levels of priming observed in Chapter 4 could arise because of competition between different structures and information in the different contexts.

It may be that priming from interrogative structures is weaker in comparison to priming from declaratives because the interrogative has competing information and activation influences which cause a lower overall level of activation in the structures relevant to the declarative structures. It is not clear whether overall syntactic structural information need specify an entire sentence structure, or whether it just contains information regarding how the local structure integrates into a larger structure.

5.2.3. Grammar

Finally, I would like to consider how this information contributes to the theories of grammar discussed at the beginning of the thesis: Tree-Adjoining Grammar (TAG) (Ferreira, 2002), the Incremental Parallel Formulator (IPF) (De Smedt, 1990) and Construction Grammar (Goldberg, 2006). All of these grammar theories and formalisms assume a principle of parallel processing which builds multiple structures in parallel and at different levels of processing. In addition to this, it is assumed that these structures are in competition. This view is supported by the findings of this thesis which show that the factors of overall sentence structure complexity and verb subcategorisation both influence choice of local structure and that these structural preferences can be in competition.

Furthermore, all three theories presume that the processor builds structures of varying sizes which can then be integrated into larger structures to form a larger sentence structure. The priming studies described in Chapter 4 present evidence that smaller structures can be shared between structures which appear to be very different on an overall sentence structure level. Priming occurred between Declarative structures such as *The nun is giving the jug to the monk* and Interrogative sentence structures such as *Which jug is the nun giving to the monk?* for the ditransitive prepositional object (PO) and double object (DO) structures. Although in the case of Construction Grammar, it may be argued that Declaratives and

Interrogatives are entirely separate structures because of the difference in meaning between a question and a statement and therefore should not prime one another. However, they still share the same thematic structure of transfer and while there may be differences between the overall sentences smaller constructions within those larger constructions may still prime. However, In Chapter 3, choice of local structure is influenced by overall sentence structure which suggests that either integration or information about overall sentence structure is processed when local structure is selected. The processor works in an incremental fashion using information as it becomes available and seeking to integrate smaller structures into larger ones as soon as possible.

Syntactic information is assumed to be stored in the lexicon by the three grammars and grammatical feature information such as tense, number and gender is assumed to be determined by the conceptual level. Syntactic structure information is stored at the verb through subcategorisation frames as well as degrees of preference. Findings in Chapter 3 regarding effect of verb subcategorisation preference on structure choice support this. It is assumed that information for larger structures can also be stored and, again, findings from Chapter 3 regarding overall sentence structure influence on choice of local structure may be seen to support this. Both the IPF and Construction Grammar view passive structures as simply another possible structure which does not require extra processing and the passives elicited in Experiments 1 and 2 could support this interpretation.

There is also possible evidence for thematic role argument representations. TAG proposes propositional representation, the IPF outlines a case frame specifying roles and the idea of meaning structures in a core element of Construction Grammar. In Experiment 3 experiencer-theme verbs demonstrate a strong preference for active voice structures. One explanation for this is that there is a preference to map the experiencer role onto the subject role, which could suggest that there may be a representation of thematic argument structures or a thematic role hierarchy which is linked to corresponding syntactic structures. Combining parallel processing and this kind of model would mean that during ongoing

incremental processing the processor could be checking for possible violations and relevant information such as thematic role preferences and overall sentence structure information.

However, there are still important distinctions between TAG, IPF and Construction Grammars. TAG presents basic structures as trees and assumes that verbs and subcategorisation preferences play a fundamental role. Experiment 3 provides evidence that verb subcategorisation does play a formative role in structure choice. Ferreira (2002) proposed a processing model where the role of the verb is central to creating a structure and specified that an initial noun phrase cannot be assigned unless the verb has been selected and has licensed that position. However, the finding that the selection of active or passive structure depends on whether it occurs in a matrix main clause or a relative clause presents problems for an entirely verb-driven account. If two structures are integrated where one clause structure modifies the noun of another, then it is possible that the first available information may be that of the initial noun as it is already being processed in the clause being modified. It is also possible though that enough of both structures are processed in parallel that the verb of the embedded clause is already being processed at some level during the processing of the first clause.

IPF provides a great deal of detail for integrating small structures into clauses, but fails to describe a model for how clauses integrate into overall sentence structure. While some structure information is located at the verb through verb subcategorisation and lexicalised phrases are particularly hard to account for as is overall sentence structure information. Findings that overall sentence structure complexity affects choice of structure suggest that this is an important part of processing that a theory of grammar needs to be able to account for. It is also unclear how the proposed system of rules and procedures would interact with overall sentence structure information.

Finally, while Construction Grammar provides the least technical and detailed account of processing, its principal idea fits well with the findings of this thesis, that is, the idea of pairing form with meaning. While the experiments in this

thesis have shown that overall sentence structure information is an important factor in selection of a syntactic structure, it has also highlighted the importance of the idea of competition in structure choice. It seems that one important factor in this is how well a syntactic structure fits the intended message as communicated through thematic roles. Experiments in Chapter 3 showed that although overall sentence structure information can influence choice of structure, highly specified thematic role preferences led to verb subcategorisation preferences affecting an alternate structure choice in the same syntactic conditions. Processing and syntactic information factors will always be an undeniable core factor when selecting a structure, but this is tempered by the other important aspect of sentence production, the message. Structure choice is a competition between form (syntax) and meaning (thematic roles), and Construction Grammar places this as its central principle. However, exactly how the meaning structures of construction grammar fit to actual processing representations is unclear and needs further work. It is unclear whether these refer to thematic role argument structures, verb subcategorisation preferences of perhaps a mixture of both.

5.3. Conclusion

In this thesis, I have addressed the question of how speakers choose syntactic structures. A series of spoken production experiments have shown that overall sentence structure and verb subcategorisation preferences affect structure choice. Competition between syntactic processing requirements and thematic role preferences produces underlie each structure choice. In this way, language production processing attempts to create the best syntactic fit to the intended messages and its elements. Further experiments demonstrated that structures are shared between simple and complex sentence structures such as matrix clauses and unbounded dependency structures, which supports a model of language production where large complex structures are built through integrating smaller

structures. I have also established that unbounded dependencies provide a suitable subject for studying processing of linguistic complexity.

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Appendices

Appendix A

Participants were given the following instruction sheets:

- Thanks for volunteering for this experiment! In the experiment you will be describing pictures using a full sentence. You will be asked to describe a picture using either a sentence or by forming a question.

- First you will see a screen indicating whether a question or a sentence is required.

  ' Which… ' means you should ask a question

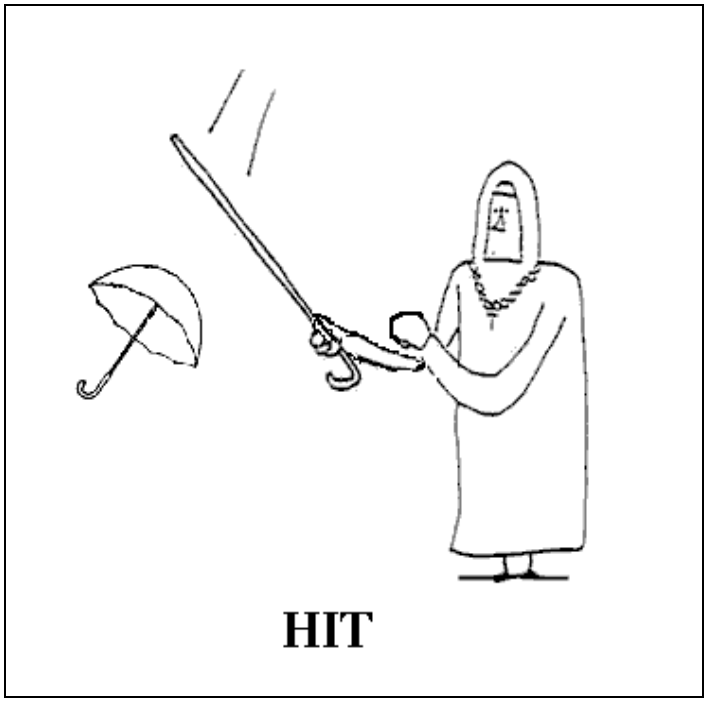
  ' The… ' means you should use a sentence

- The pictures show characters engaging in various activities. Most pictures feature objects and some feature coloured patterns as well. Don't forget to include the coloured patterns in your descriptions where appropriate!

- Start all questions with the word 'Which...?' and ask about the object. If there is no object in the picture just ask about the character instead.

Examples can be found on the next three pages.

Example 1



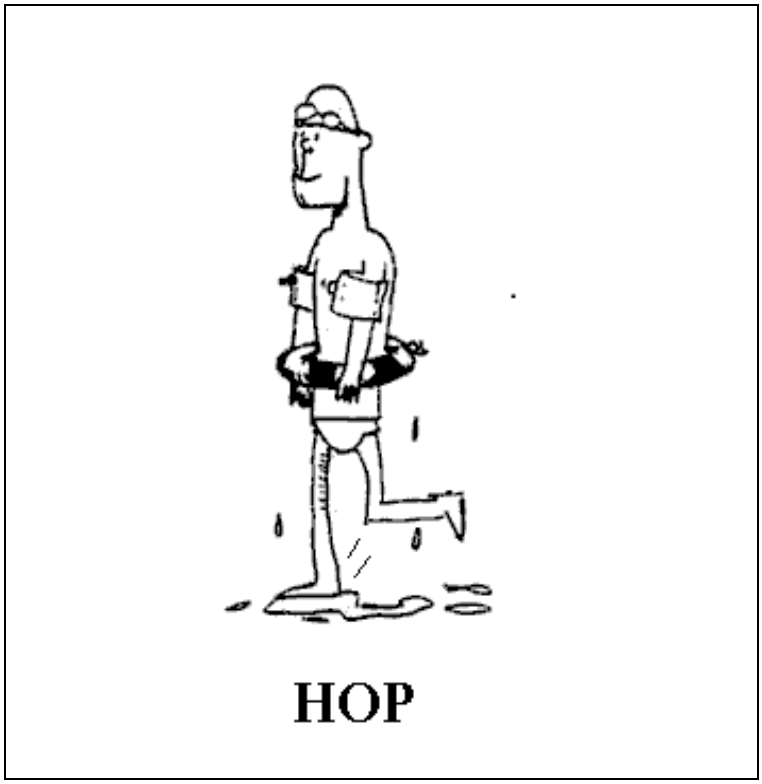
‘ The…’ Sentence

The nun is hitting the umbrella

‘ Which…’ Question

Which umbrella is the nun hitting?

Example 2



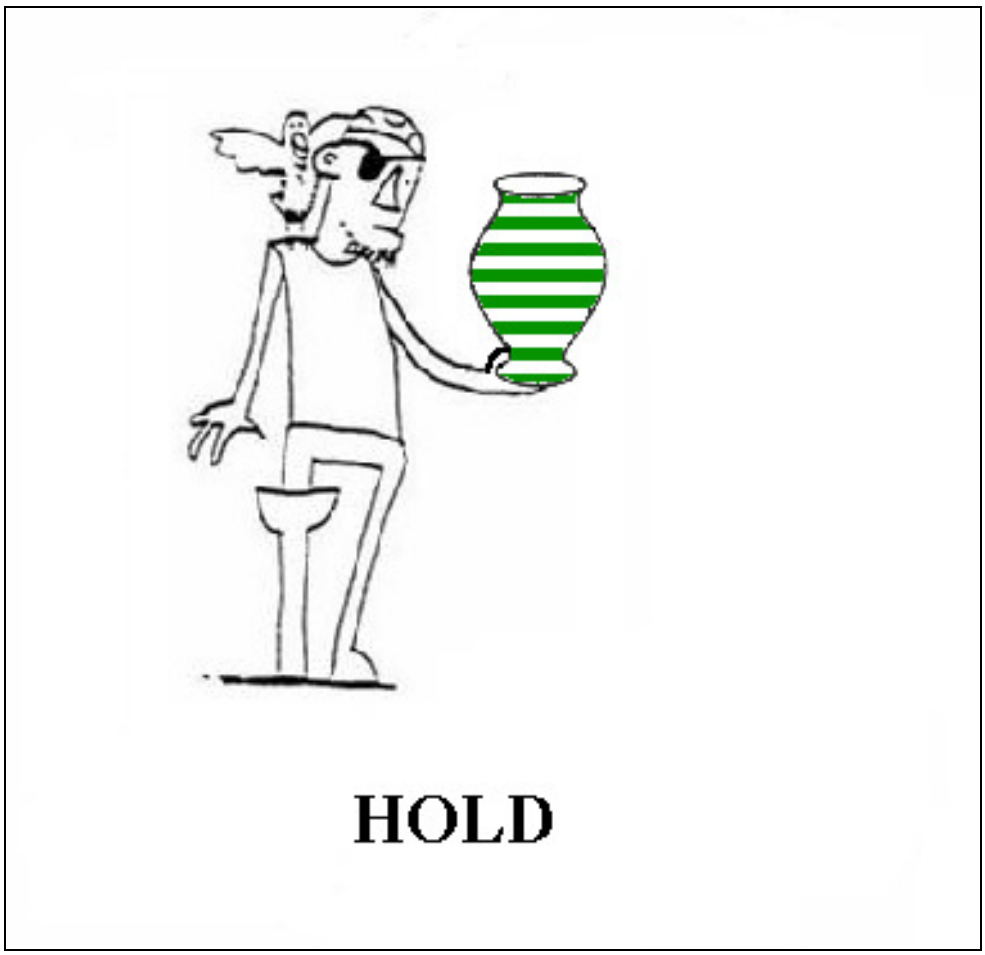
‘ The… ‘ Sentence:

The swimmer is hopping.

‘ Which… ‘ Question

Which swimmer is hopping?

Example 3



‘ The… ‘ Sentence

The pirate is holding the vase with green stripes.

‘ Which… ‘ Question

Which vase with green stripes is the pirate holding?

Appendix B

Experiment 1 Materials

Target Images and Verbs

1. nun	give	jug	cowboy
2. dancer	hand	jug	artist
3. monk	show	ball	boxer
4. pirate	throw	ball	knight
5. cowboy	sell	book	chef
6. artist	offer	book	teacher
7. boxer	lend	cup	waitress
8. knight	pass	cup	clown
9. chef	give	hat	sailor
10. teacher	hand	hat	doctor
11. waitress	show	umbrella	swimmer
12. clown	throw	umbrella	skier
13. sailor	sell	balloon	nun
14. doctor	offer	balloon	dancer
15. swimmer	lend	cake	monk
16. skier	pass	cake	pirate
17. nun	lend	bell	doctor
18. dancer	pass	bell	swimmer
19. monk	give	candle	skier
20. pirate	hand	candle	nun
21. cowboy	show	drum	dancer
22. artist	throw	drum	monk
23. boxer	sell	flag	pirate
24. knight	offer	flag	cowboy
25. chef	lend	kettle	artist
26. teacher	pass	kettle	boxer
27. waitress	give	kite	knight
28. clown	hand	kite	chef
29. sailor	show	sock	teacher
30. doctor	throw	sock	waitress
31. swimmer	sell	vase	clown
32. skier	offer	vase	sailor

Filler Images and Verbs

Transitive Fillers

nun	kick	ball
dancer	hit	ball
monk	hold	vase
pirate	lift	vase
cowboy	kiss	ball
artist	punch	ball
boxer	eat	book
knight	scold	book
chef	shoot	cup
teacher	drop	cup
waitress	push	cup
clown	catch	cup
sailor	pull	hat
doctor	polish	hat
swimmer	poke	hat
skier	injure	hat
nun	hit	umbrella
dancer	hold	umbrella
monk	lift	umbrella
pirate	kiss	umbrella
cowboy	punch	balloon
artist	eat	balloon
boxer	scold	balloon
knight	shoot	balloon
chef	drop	cake
teacher	push	cake
waitress	catch	cake
clown	pull	cake
sailor	polish	jug
doctor	poke	jug
swimmer	injure	jug
skier	kick	jug
nun	hold	bell

dancer	lift	bell
monk	kiss	bell
pirate	punch	bell
cowboy	eat	candle
artist	scold	candle
boxer	shoot	candle
knight	drop	candle
chef	push	drum
teacher	catch	drum
waitress	pull	drum
clown	polish	drum
sailor	poke	flag
doctor	injure	flag
swimmer	kick	flag
skier	hit	flag
nun	lift	kettle
dancer	kiss	kettle
monk	punch	kettle
pirate	eat	kettle
cowboy	scold	kite
artist	shoot	kite
boxer	drop	kite
knight	push	kite
chef	catch	sock
teacher	pull	sock
waitress	polish	sock
clown	poke	sock
sailor	injure	vase
doctor	kick	vase
swimmer	hit	book
skier	hold	book

Intransitive Fillers

nun	laugh
dancer	cry
monk	nod
pirate	sweat
cowboy	sneeze
artist	yawn
boxer	hop

knight	sleep
chef	laugh
teacher	cry
waitress	nod
clown	sweat
sailor	sneeze
doctor	yawn
swimmer	hop
skier	sleep
nun	sweat
dancer	sneeze
monk	yawn
pirate	hop
cowboy	sleep
artist	laugh
boxer	cry
knight	nod
chef	cry
teacher	nod
waitress	sweat
clown	sneeze
sailor	yawn
doctor	hop
swimmer	sleep
skier	laugh

Appendix C

Experiment 2 Materials

Experiment Sentences

1rc-pass	Before the lesson, the boy that was kissed by the girl was embarrassed
1rc-act	Before the lesson, the boy that the girl kissed was embarrassed.
1mc-pass	Before the lesson, the boy was kissed by the girl
1mc-act	Before the lesson, the girl kissed the boy.
2rc-pass	After the disaster, the architect that was punched by the builder was horrified.
2rc-act	After the disaster, the architect that the builder punched was horrified.
2mc-pass	After the disaster, the architect was punched by the builder.
2mc-act	After the disaster, the builder punched the architect.
3rc-pass	Before the race, the jockey that was bribed by the stablehand was nervous.
3rc-act	Before the race, the jockey that the stablehand bribed was nervous.
3mc-pass	Before the race, the jockey was bribed by the stablehand.
3mc-act	Before the race, the stablehand bribed the jockey.
4rc-pass	After the lesson, the teacher that was pinched by the pupil was furious.
4rc-act	After the lesson, the teacher that the pupil pinched was furious.
4mc-pass	After the lesson, the teacher was pinched by the pupil.
4mc-act	After the lesson, the pupil pinched the teacher.
5rc-pass	Despite the ruling, the lawyer that was kicked by the witness was overjoyed.
5rc-act	Despite the ruling, the lawyer that the witness kicked was overjoyed.
5mc-pass	Despite the ruling, the lawyer was kicked by the witness.
5mc-act	Despite the ruling, the witness kicked the lawyer.
6rc-pass	Prior to the election, the cabinet minister that was killed by the MP was confident.
6rc-act	Prior to the election, the cabinet minister that the MP killed was confident.

6mc-pass	Prior to the election, the cabinet minister was killed by the MP.
6mc-act	Prior to the election, the MP killed the cabinet minister.
7rc-pass	Before the curse, the princess that was rescued by the knight was beautiful.
7rc-act	Before the curse, the princess that the knight rescued was beautiful.
7mc-pass	Before the curse, the princess was rescued by the knight.
7mc-act	Before the curse, the knight rescued the princess.
8rc-pass	During the war, the soldier that was shot by the general was brave.
8rc-act	During the war, the soldier that the general shot was brave.
8mc-pass	During the war, the soldier was shot by the general.
8mc-act	During the war, the general shot the soldier.
9rc-pass	After the rescue, the pilot that was hit by the hijacker was relieved.
9rc-act	After the rescue, the pilot that the hijacker hit was relieved.
9mc-pass	After the rescue, the pilot was hit by the hijacker.
9mc-act	After the rescue, the hijacker hit the pilot.
10rc-pass	Despite the power cut, the chef that was helped by the waiter was undaunted.
10rc-act	Despite the power cut, the chef that the waiter helped was undaunted.
10mc-pass	Despite the power cut, the chef was helped by the waiter.
10mc-act	Despite the power cut, the waiter helped the chef.
11rc-pass	Regardless of the complaints, the journalist that was appointed by the editor was defiant.
11rc-act	Regardless of the complaints, the journalist that the editor appointed was defiant.
11mc-pass	Regardless of the complaints, the journalist was appointed by the editor.
11mc-act	Regardless of the complaints, the editor appointed the journalist.
12rc-pass	During the journey, the driver that was poked by the passenger was grumpy.
12rc-act	During the journey, the driver that the passenger poked was grumpy
12mc-pass	During the journey, the driver was poked by the passenger.
12mc-act	During the journey, the passenger poked the driver.
13rc-pass	During the rehearsal, the actor that was slapped by the director was sulking.
13rc-act	During the rehearsal, the actor that the director slapped was sulking.

13mc-pass	During the rehearsal, the actor was slapped by the director.
13mc-act	During the rehearsal, the director slapped the actor.
14rc-pass	During the football match, the striker that was tackled by the goalie was bleeding.
14rc-act	During the football match, the striker that the goalie tackled was bleeding.
14mc-pass	During the football match, the striker was tackled by the goalie.
14mc-act	During the football match, the goalie tackled the striker.
15rc-pass	Despite the traffic, the criminal that was chased by the policeman was speeding.
15rc-act	Despite the traffic, the criminal that the policeman chased was speeding.
15mc-pass	Despite the traffic, the criminal was chased by the policeman.
15mc-act	Despite the traffic, the policeman chased the criminal.
16rc-pass	Regardless of the cameras, the fan that was kissed by the rockstar was screaming.
16rc-act	Regardless of the cameras, the fan that the rockstar kissed was screaming.
16mc-pass	Regardless of the cameras, the fan was kissed by the rockstar.
16mc-act	Regardless of the cameras, the rockstar kissed the fan.
17rc-pass	Prior to the conference, the businessman that was questioned by the reporter was fidgeting.
17rc-act	Prior to the conference, the businessman that the reporter questioned was fidgeting.
17mc-pass	Prior to the conference, the businessman was questioned by the reporter.
17mc-act	Prior to the conference, the reporter questioned the businessman.
18rc-pass	Before the premiere, the actress that was chased by the photographer was posing.
18rc-act	Before the premiere, the actress that the photographer chased was posing.
18mc-pass	Before the premiere, the actress was chased by the photographer.
18mc-act	Before the premiere, the photographer chased the actress.
19rc-pass	During the exhibition, the model that was painted by the artist was smiling.
19rc-act	During the exhibition, the model that the artist painted was smiling.
19mc-pass	During the exhibition, the model was painted by the artist.
19mc-act	During the exhibition, the artist painted the model.

20rc-pass	Despite the crash, the driver that was hugged by the engineer was waving.
20rc-act	Despite the crash, the driver that the engineer hugged was waving.
20mc-pass	Despite the crash, the driver was hugged by the engineer.
20mc-act	Despite the crash, the engineer hugged the driver.
21rc-pass	Regardless of the controversy, the author that was interviewed by the publicist was laughing.
21rc-act	Regardless of the controversy, the author that the publicist interviewed was laughing.
21mc-pass	Regardless of the controversy, the author was interviewed by the publicist.
21mc-act	Regardless of the controversy, the publicist interviewed the author.
22rc-pass	Prior to the show, the juggler that was bitten by the clown was practising.
22rc-act	Prior to the show, the juggler that the clown bit was practising.
22mc-pass	Prior to the show, the juggler was bitten by the clown.
22mc-act	Prior to the show, the clown bit the juggler.
23rc-pass	After the class, the lecturer that was followed by the student was yawning.
23rc-act	After the class, the lecturer that the student followed was yawning.
23mc-pass	After the class, the lecturer was followed by the student.
23mc-act	After the class, the student followed the lecturer.
24rc-pass	Despite the diagnosis, the patient that was visited by the doctor was smoking.
24rc-act	Despite the diagnosis, the patient that the doctor visited was smoking.
24mc-pass	Despite the diagnosis, the patient was visited by the doctor.
24mc-act	Despite the diagnosis, the doctor visited the patient.
25rc-pass	Regardless of the jeering, the guitarist that was prodded by the drummer was singing.
25rc-act	Regardless of the jeering, the guitarist that the drummer prodded was singing.
25mc-pass	Regardless of the jeering, the guitarist was prodded by the drummer.
25mc-act	Regardless of the jeering, the drummer prodded the guitarist.
26rc-pass	Prior to the concert, the musician that was stabbed by the conductor was shouting.

26rc-act	Prior to the concert, the musician that the conductor stabbed was shouting.
26mc-pass	Prior to the concert, the musician was stabbed by the conductor.
26mc-act	Prior to the concert, the conductor stabbed the musician.
27rc-pass	Before the accident, the man that was injured by the barber was chatting.
27rc-act	Before the accident, the man that the barber injured was chatting.
27mc-pass	Before the accident, the man was injured by the barber.
27mc-act	Before the accident, the barber injured the man.
28rc-pass	During the spa visit, the woman that was massaged by the beautician was sleeping.
28rc-act	During the spa visit, the woman that the beautician massaged was sleeping.
28mc-pass	During the spa visit, the woman was massaged by the beautician.
28mc-act	During the spa visit, the beautician massaged the woman.
29rc-pass	After the encore, the singer that was tickled by the pianist was giggling.
29rc-act	After the encore, the singer that the pianist tickled was giggling.
29mc-pass	After the encore, the singer was tickled by the pianist.
29mc-act	After the encore, the pianist tickled the singer.
30rc-pass	Regardless of the interruption, the nun that was called by the monk was praying.
30rc-act	Regardless of the interruption, the nun that the monk called was praying.
30mc-pass	Regardless of the interruption, the nun was called by the monk.
30mc-act	Regardless of the interruption, the monk called the nun.
31rc-pass	Prior to the delivery, the postman that was greeted by the milkman was limping.
31rc-act	Prior to the delivery, the postman that the milkman greeted was limping.
31mc-pass	Prior to the delivery, the postman was greeted by the milkman.
31mc-act	Prior to the delivery, the milkman greeted the postman.
32rc-pass	Before the robbery, the shop assistant that was attacked by the customer was eating.
32rc-act	Before the robbery, the shop assistant that the customer attacked was eating.
32mc-pass	Before the robbery, the shop assistant was attacked by the customer.

32mc-act Before the robbery, the customer attacked the shop assistant.

Filler Sentences

F01 Before the catastrophe, there were no safety rules.
F02 During the occupation, there was no electricity.
F03 After the wedding, there were no arguments.
F04 Despite the delays, there was a big audience.
F05 Regardless of the cat, there were fat mice.
F06 Prior to the exam, there was hushed whispering.
F07 Before the interview, there were many tests.
F08 During the service, there were many snores.
F09 After the ceremony, there was huge applause.
F10 Despite the explosion, there were no injuries.
F11 Regardless of the rain, there were many festival goers.
F12 Prior to the announcement, there were many cameras.
F13 Before the graduation, there were prolonged strikes.
F14 During the emergency, there were uncontrollable crowds.
F15 After the date, there were many phone calls.
F16 Despite the holiday, there were many customers.

Appendix D

Norming Experiment Materials

Experiencer-Theme	Theme-Experiencer	Agent-Patient
abhor	alarm	appoint
admire	amuse	attack
adore	anger	bite
appreciate	annoy	bribe
cherish	appal	call
consider	baffle	chase
contemplate	bore	embrace
deplore	challenge	follow
despise	delight	greet
detest	demoralize	help
dislike	disappoint	hit
distrust	discourage	hug
doubt	distract	injure
endure	embarrass	interview
envy	encourage	kick
fear	enrage	kill
hate	entertain	kiss
idealise	frighten	massage
identify	frustrate	paint
like	impress	pinch
loathe	offend	poke
love	perplex	prod
misunderstand	persuade	punch
pity	provoke	pursue
ponder	scandalize	question
prefer	scare	rescue
resent	shame	shoot
respect	shock	slap
tolerate	soothe	stab
trust	terrify	tackle
value	upset	tickle
worship	worry	visit

Appendix E

Experiment 3 Materials

Experimental Items with Experiencer-Theme Verbs

1rc-pass	Before the lesson, the boy that was adored by the girl was embarrassed
1rc-act	Before the lesson, the boy that the girl adored was embarrassed.
1mc-pass	Before the lesson, the boy was adored by the girl
1mc-act	Before the lesson, the girl adored the boy.
2rc-pass	After the disaster, the architect that was trusted by the builder was horrified.
2rc-act	After the disaster, the architect that the builder trusted was horrified.
2mc-pass	After the disaster, the architect was trusted by the builder.
2mc-act	After the disaster, the builder trusted the architect.
3rc-pass	Before the race, the jockey that was depised by the stablehand was nervous.
3rc-act	Before the race, the jockey that the stablehand depised was nervous.
3mc-pass	Before the race, the jockey was depised by the stablehand.
3mc-act	Before the race, the stablehand depised the jockey.
4rc-pass	After the lesson, the teacher that was loathed by the pupil was furious.
4rc-act	After the lesson, the teacher that the pupil loathed was furious.
4mc-pass	After the lesson, the teacher was loathed by the pupil.
4mc-act	After the lesson, the pupil loathed the teacher.
5rc-pass	Despite the ruling, the lawyer that was hated by the witness was overjoyed.
5rc-act	Despite the ruling, the lawyer that the witness hated was overjoyed.
5mc-pass	Despite the ruling, the lawyer was hated by the witness.
5mc-act	Despite the ruling, the witness hated the lawyer.
6rc-pass	Prior to the election, the cabinet minister that was admired by the MP was confident.
6rc-act	Prior to the election, the cabinet minister that the MP admired was confident.
6mc-pass	Prior to the election, the cabinet minister was admired by the MP.
6mc-act	Prior to the election, the MP admired the cabinet minister.

7rc-pass	Before the curse, the princess that was cherished by the knight was beautiful.
7rc-act	Before the curse, the princess that the knight cherished was beautiful.
7mc-pass	Before the curse, the princess was cherished by the knight.
7mc-act	Before the curse, the knight cherished the princess.
8rc-pass	During the war, the soldier that was respected by the general was brave.
8rc-act	During the war, the soldier that the general respected was brave.
8mc-pass	During the war, the soldier was respected by the general.
8mc-act	During the war, the general respected the soldier.
9rc-pass	After the rescue, the pilot that was distrusted by the hijacker was relieved.
9rc-act	After the rescue, the pilot that the hijacker distrusted was relieved.
9mc-pass	After the rescue, the pilot was distrusted by the hijacker.
9mc-act	After the rescue, the hijacker distrusted the pilot.
10rc-pass	Despite the power cut, the chef that was resented by the waiter was undaunted.
10rc-act	Despite the power cut, the chef that the waiter resented was undaunted.
10mc-pass	Despite the power cut, the chef was resented by the waiter.
10mc-act	Despite the power cut, the waiter resented the chef.
11rc-pass	Regardless of the complaints, the journalist that was tolerated by the editor was defiant.
11rc-act	Regardless of the complaints, the journalist that the editor tolerated was defiant.
11mc-pass	Regardless of the complaints, the journalist was tolerated by the editor.
11mc-act	Regardless of the complaints, the editor tolerated the journalist.
12rc-pass	During the journey, the driver that was appreciated by the passenger was grumpy.
12rc-act	During the journey, the driver that the passenger appreciated was grumpy
12mc-pass	During the journey, the driver was appreciated by the passenger.
12mc-act	During the journey, the passenger appreciated the driver.
13rc-pass	During the rehearsal, the actor that was detested by the director was sulking.
13rc-act	During the rehearsal, the actor that the director detested was sulking.
13mc-pass	During the rehearsal, the actor was detested by the director.

13mc-act	During the rehearsal, the director detested the actor.
14rc-pass	During the football match, the striker that was envied by the goalie was bleeding.
14rc-act	During the football match, the striker that the goalie envied was bleeding.
14mc-pass	During the football match, the striker was envied by the goalie.
14mc-act	During the football match, the goalie envied the striker.
15rc-pass	Despite the traffic, the criminal that was identified by the policeman was speeding.
15rc-act	Despite the traffic, the criminal that the policeman identified was speeding.
15mc-pass	Despite the traffic, the criminal was identified by the policeman.
15mc-act	Despite the traffic, the policeman identified the criminal.
16rc-pass	Regardless of the cameras, the fan that was liked by the rockstar was screaming.
16rc-act	Regardless of the cameras, the fan that the rockstar liked was screaming.
16mc-pass	Regardless of the cameras, the fan was liked by the rockstar.
16mc-act	Regardless of the cameras, the rockstar liked the fan.
17rc-pass	Prior to the conference, the businessman that was misunderstood by the reporter was fidgeting.
17rc-act	Prior to the conference, the businessman that the reporter misunderstood was fidgeting.
17mc-pass	Prior to the conference, the businessman was misunderstood by the reporter.
17mc-act	Prior to the conference, the reporter misunderstood the businessman.
18rc-pass	Before the premiere, the actress that was worshipped by the photographer was posing.
18rc-act	Before the premiere, the actress that the photographer worshipped was posing.
18mc-pass	Before the premiere, the actress was worshipped by the photographer.
18mc-act	Before the premiere, the photographer worshipped the actress.
19rc-pass	During the exhibition, the model that was contemplated by the artist was smiling.
19rc-act	During the exhibition, the model that the artist contemplated was smiling.
19mc-pass	During the exhibition, the model was contemplated by the artist.
19mc-act	During the exhibition, the artist contemplated the model.

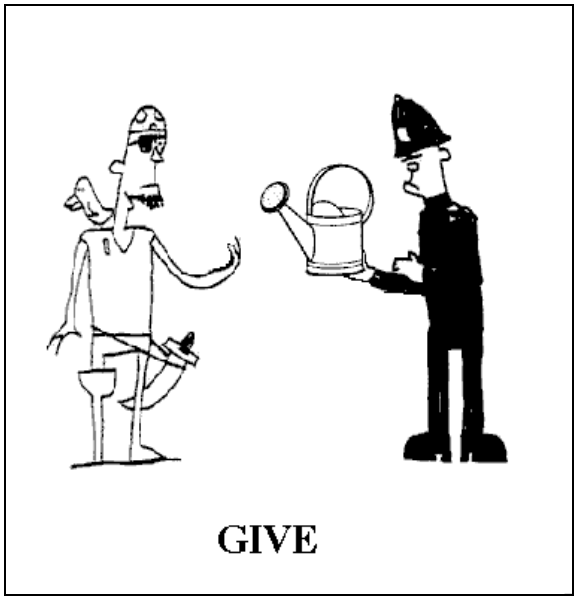
20rc-pass	Despite the crash, the driver that was valued by the engineer was waving.
20rc-act	Despite the crash, the driver that the engineer valued was waving.
20mc-pass	Despite the crash, the driver was valued by the engineer.
20mc-act	Despite the crash, the engineer valued the driver.
21rc-pass	Regardless of the controversy, the author that was idealised by the publicist was laughing.
21rc-act	Regardless of the controversy, the author that the publicist idealised was laughing.
21mc-pass	Regardless of the controversy, the author was idealised by the publicist.
21mc-act	Regardless of the controversy, the publicist idealised the author.
22rc-pass	Prior to the show, the juggler that was doubted by the clown was practising.
22rc-act	Prior to the show, the juggler that the clown doubted was practising.
22mc-pass	Prior to the show, the juggler was doubted by the clown.
22mc-act	Prior to the show, the clown doubted the juggler.
23rc-pass	After the class, the lecturer that was feared by the student was yawning.
23rc-act	After the class, the lecturer that the student feared was yawning.
23mc-pass	After the class, the lecturer was feared by the student.
23mc-act	After the class, the student feared the lecturer.
24rc-pass	Despite the diagnosis, the patient that was considered by the doctor was smoking.
24rc-act	Despite the diagnosis, the patient that the doctor considered was smoking.
24mc-pass	Despite the diagnosis, the patient was considered by the doctor.
24mc-act	Despite the diagnosis, the doctor considered the patient.
25rc-pass	Regardless of the jeering, the guitarist that was preferred by the drummer was singing.
25rc-act	Regardless of the jeering, the guitarist that the drummer preferred was singing.
25mc-pass	Regardless of the jeering, the guitarist was preferred by the drummer.
25mc-act	Regardless of the jeering, the drummer preferred the guitarist.
26rc-pass	Prior to the concert, the musician that was deplored by the conductor was shouting.
26rc-act	Prior to the concert, the musician that the conductor deplored was

	shouting.
26mc-pass	Prior to the concert, the musician was deplored by the conductor.
26mc-act	Prior to the concert, the conductor deplored the musician.
27rc-pass	Before the accident, the man that was disliked by the barber was chatting.
27rc-act	Before the accident, the man that the barber disliked was chatting.
27mc-pass	Before the accident, the man was disliked by the barber.
27mc-act	Before the accident, the barber disliked the man.
28rc-pass	During the spa visit, the woman that was endured by the beautician was sleeping.
28rc-act	During the spa visit, the woman that the beautician endured was sleeping.
28mc-pass	During the spa visit, the woman was endured by the beautician.
28mc-act	During the spa visit, the beautician endured the woman.
29rc-pass	After the encore, the singer that was loved by the pianist was giggling.
29rc-act	After the encore, the singer that the pianist loved was giggling.
29mc-pass	After the encore, the singer was loved by the pianist.
29mc-act	After the encore, the pianist loved the singer.
30rc-pass	Regardless of the interruption, the nun that was pondered by the monk was praying.
30rc-act	Regardless of the interruption, the nun that the monk pondered was praying.
30mc-pass	Regardless of the interruption, the nun was pondered by the monk.
30mc-act	Regardless of the interruption, the monk pondered the nun.
31rc-pass	Prior to the delivery, the postman that was abhorred by the milkman was limping.
31rc-act	Prior to the delivery, the postman that the milkman abhorred was limping.
31mc-pass	Prior to the delivery, the postman was abhorred by the milkman.
31mc-act	Prior to the delivery, the milkman abhorred the postman.
32rc-pass	Before the robbery, the shop assistant that was pitied by the customer was eating.
32rc-act	Before the robbery, the shop assistant that the customer pitied was eating.
32mc-pass	Before the robbery, the shop assistant was pitied by the customer.
32mc-act	Before the robbery, the customer pitied the shop assistant.

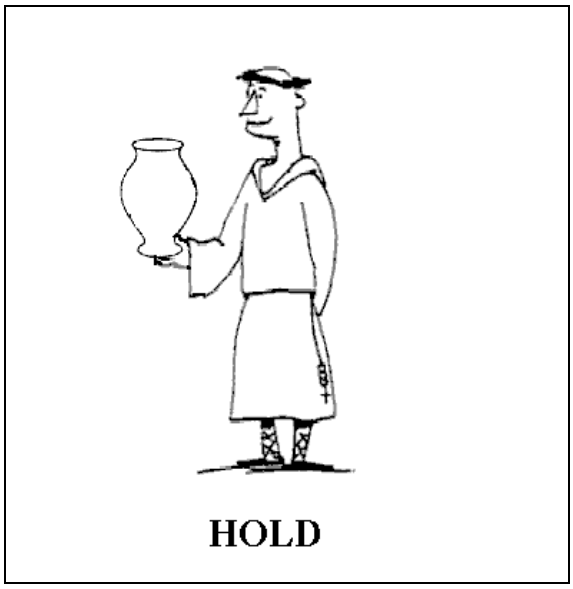
Appendix F

Experiment 4 -6 Sample Pictures

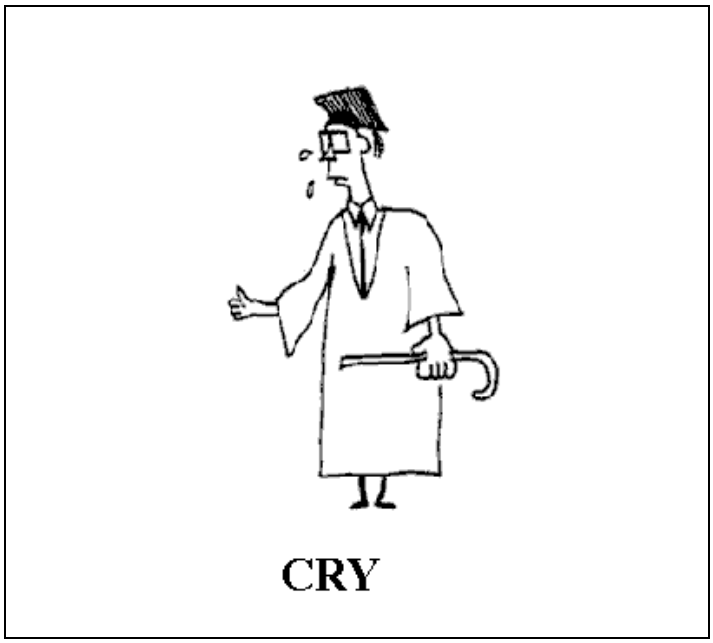
Target Picture



Transitive Filler Picture



Intransitive Filler Picture



Appendix G

Experiment 4 – 5 Materials

Experimental Items

Experiment Prime Sentences and Targets

item	prime sentence	target
1quepo	Which jug is the nun giving to the monk?	artist pass sailor hat
1quedo	Which jug is the nun giving the monk?	artist pass sailor hat
1decpo	The nun is giving the jug to the monk.	artist pass sailor hat
1decdo	The nun is giving the monk the jug.	artist pass sailor hat
2quepo	Which bell is the dancer handing to the pirate?	boxer show doctor kettle
2quedo	Which bell is the dancer handing the pirate?	boxer show doctor kettle
2decpo	The dancer is handing the bell to the pirate.	boxer show doctor kettle
2decdo	The dancer is handing the pirate the bell.	boxer show doctor kettle
3quepo	Which ball is the monk showing to the cowboy?	knight hand swimmer umbrella
3quedo	Which ball is the monk showing the cowboy?	knight hand swimmer umbrella
3decpo	The monk is showing the ball to the cowboy.	knight hand swimmer umbrella
3decdo	The monk is showing the cowboy the ball.	knight hand swimmer umbrella
4quepo	Which candle is the pirate throwing to the artist?	chef hand skier kite
4quedo	Which candle is the pirate throwing the artist?	chef hand skier kite
4decpo	The artist is throwing the candle to the artist.	chef hand skier kite
4decdo	The artist is throwing the artist the candle.	chef hand skier kite

5quepo	Which book is the cowboy selling to the boxer?	teacher throw burglar balloon
5quedo	Which book is the cowboy selling the boxer?	teacher throw burglar balloon
5decpo	The cowboy is selling the book to the boxer.	teacher throw burglar balloon
5decdo	The cowboy is selling the boxer the book	teacher throw burglar balloon
6quepo	Which drum is the artist offering to the knight?	waitress lend cricketer sock
6quedo	Which drum is the artist offering the knight?	waitress lend cricketer sock
6decpo	The artist is offering the drum to the knight.	waitress lend cricketer sock
6decdo	The artist is offering the knight the drum.	waitress lend cricketer sock
7quepo	Which cup is the boxer lending to the chef?	clown offer diver cake
7quedo	Which cup is the boxer lending the chef?	clown offer diver cake
7decpo	The boxer is lending the cup to the chef.	clown offer diver cake
7decdo	The boxer is lending the chef the cup.	clown offer diver cake
8quepo	Which flag is the knight passing to the teacher?	sailor offer fireman vase
8quedo	Which flag is the knight passing the teacher?	sailor offer fireman vase
8decpo	The knight is passing the flag to the teacher.	sailor offer fireman vase
8decdo	The knight is passing the teacher the flag.	sailor offer fireman vase
9quepo	Which hat is the chef giving to the waitress?	doctor hand policeman apple
9quedo	Which hat is the chef giving the waitress?	doctor hand policeman apple
9decpo	The chef is giving the hat to the waitress.	doctor hand policeman apple
9decdo	The chef is giving the waitress the hat.	doctor hand policeman apple
10quepo	Which kettle is the teacher handing to the clown?	swimmer give prisoner banana
10quedo	Which kettle is the teacher handing the	swimmer give prisoner

	clown?	banana
10decpo	The teacher is handing the kettle to the clown.	swimmer give prisoner banana
10decdo	The teacher is handing the clown the kettle.	swimmer give prisoner banana
11quepo	Which umbrella is the waitress showing to the sailor?	skier throw soldier bottle
11quedo	Which umbrella is the waitress showing the sailor?	skier throw soldier bottle
11decpo	The waitress is showing the umbrella to the sailor.	skier throw soldier bottle
11decdo	The waitress is showing the sailor the umbrella.	skier throw soldier bottle
12quepo	Which kite is the clown throwing to the doctor?	burglar show witch gun
12quedo	Which kite is the clown throwing the doctor?	burglar show witch gun
12decpo	The clown is throwing the kite to the doctor.	burglar show witch gun
12decdo	The clown is throwing the doctor the kite.	burglar show witch gun
13quepo	Which balloon is the sailor selling to the swimmer?	cricketer offer nun hammer
13quedo	Which balloon is the sailor selling the swimmer?	cricketer offer nun hammer
13decpo	The sailor is selling the balloon to the swimmer.	cricketer offer nun hammer
13decdo	The sailor is selling the swimmer the balloon.	cricketer offer nun hammer
14quepo	Which sock is the doctor offering to the skier?	diver lend dancer pipe
14quedo	Which sock is the doctor offering the skier?	diver lend dancer pipe
14decpo	The doctor is offering the sock to the skier.	diver lend dancer pipe
14decdo	The doctor is offering the skier the sock.	diver lend dancer pipe
15quepo	Which cake is the swimmer lending to the burglar?	fireman sell monk box
15quedo	Which cake is the swimmer lending the burglar?	fireman sell monk box

15decpo	The swimmer is lending the cake to the burglar.	fireman sell monk box
15decdo	The swimmer is lending the burglar the cake.	fireman sell monk box
16quepo	Which vase is the skier passing to the cricketer?	policeman give pirate watering can
16quedo	Which vase is the skier passing the cricketer?	policeman give pirate watering can
16decpo	The skier is passing the vase to the crickerter.	policeman give pirate watering can
16decdo	The skier is passing the cricketer the vase.	policeman give pirate watering can
17quepo	Which apple is the burglar giving to the diver?	prisoner pass cowboy jug
17quedo	Which apple is the burglar giving the diver?	prisoner pass cowboy jug
17decpo	The burglar is giving the apple to the diver.	prisoner pass cowboy jug
17decdo	The burglar is giving the diver the apple.	prisoner pass cowboy jug
18quepo	Which banana is the cricketer handing to the fireman?	soldier give artist bell
18quedo	Which banana is the cricketer handing the fireman?	soldier give artist bell
18decpo	The cricketer is handing the banana to the fireman.	soldier give artist bell
18decdo	The cricketer is handing the fireman the banana.	soldier give artist bell
19quepo	Which bottle is the diver showing to the policeman?	witch throw boxer ball
19quedo	Which bottle is the diver showing the policeman?	witch throw boxer ball
19decpo	The diver is showing the bottle to the policeman.	witch throw boxer ball
19decdo	The diver is showing the policeman the bottle.	witch throw boxer ball
20quepo	Which gun is the fireman throwing to the prisoner?	nun sell knight candle
20quedo	Which gun is the fireman throwing the prisoner?	nun sell knight candle
20decpo	The fireman is throwing the gun to the	nun sell knight candle

	prisoner.	
20decdo	The fireman is throwing the prisoner the gun.	nun sell knight candle
21quepo	Which hammer is the policeman selling to the soldier?	dancer show chef book
21quedo	Which hammer is the policeman selling the soldier?	dancer show chef book
21decpo	The policeman is selling the hammer to the soldier.	dancer show chef book
21decdo	The policeman is selling the solider the hammer.	dancer show chef book
22quepo	Which pipe is the prisoner offering to the witch?	monk sell teacher drum
22quedo	Which pipe is the prisoner offering the witch?	monk sell teacher drum
22decpo	The prisoner is offering the pipe to the witch.	monk sell teacher drum
22decdo	The prisoner is offering the witch the pipe.	monk sell teacher drum
23quepo	Which box is the soldier lending to the nun?	pirate pass waitress cup
23quedo	Which box is the soldier lending the nun?	pirate pass waitress cup
23decpo	The soldier is lending the box to the nun.	pirate pass waitress cup
23decdo	The soldier is lending the nun the box.	pirate pass waitress cup
24quepo	Which watering can is the witch passing to the dancer?	cowboy lend clown flag
24quedo	Which watering can is the witch passing the dancer?	cowboy lend clown flag
24decpo	The witch is passing the watering can to the dancer.	cowboy lend clown flag
24decdo	The witch is passing the dancer the watering can.	cowboy lend clown flag

Experimental Items Picture Descriptions: Match / Non-Match

item	match picture	non-match picture	change

1quepo	nun give monk jug	dancer give monk jug	agent
1quedo	nun give monk jug	dancer give monk jug	agent
1decpo	nun give monk jug	dancer give monk jug	agent
1decdo	nun give monk jug	dancer give monk jug	agent
2quepo	dancer hand pirate bell	nun hand pirate bell	agent
2quedo	dancer hand pirate bell	nun hand pirate bell	agent
2decpo	dancer hand pirate bell	nun hand pirate bell	agent
2decdo	dancer hand pirate bell	nun hand pirate bell	agent
3quepo	monk show cowboy ball	pirate show cowboy ball	agent
3quedo	monk show cowboy ball	pirate show cowboy ball	agent
3decpo	monk show cowboy ball	pirate show cowboy ball	agent
3decdo	monk show cowboy ball	pirate show cowboy ball	agent
4quepo	pirate throw artist candle	monk throw artist candle	agent
4quedo	pirate throw artist candle	monk throw artist candle	agent
4decpo	pirate throw artist candle	monk throw artist candle	agent
4decdo	pirate throw artist candle	monk throw artist candle	agent
5quepo	cowboy sell boxer book	artist sell boxer book	agent
5quedo	cowboy sell boxer book	artist sell boxer book	agent
5decpo	cowboy sell boxer book	artist sell boxer book	agent
5decdo	cowboy sell boxer book	artist sell boxer book	agent
6quepo	artist offer knight drum	cowboy offer knight drum	agent
6quedo	artist offer knight drum	cowboy offer knight drum	agent
6decpo	artist offer knight drum	cowboy offer knight drum	agent
6decdo	artist offer knight drum	cowboy offer knight drum	agent
7quepo	boxer lend chef cup	knight lend chef cup	agent
7quedo	boxer lend chef cup	knight lend chef cup	agent
7decpo	boxer lend chef cup	knight lend chef cup	agent
7decdo	boxer lend chef cup	knight lend chef cup	agent
8quepo	knight pass teacher flag	boxer pass teacher flag	agent
8quedo	knight pass teacher flag	boxer pass teacher flag	agent
8decpo	knight pass teacher flag	boxer pass teacher flag	agent
8decdo	knight pass teacher flag	boxer pass teacher flag	agent
9quepo	chef give waitress hat	chef give waitress kettle	patient
9quedo	chef give waitress hat	chef give waitress kettle	patient
9decpo	chef give waitress hat	chef give waitress kettle	patient
9decdo	chef give waitress hat	chef give waitress kettle	patient

10quepo	teacher hand clown kettle	teacher hand clown hat	patient
10quedo	teacher hand clown kettle	teacher hand clown hat	patient
10decpo	teacher hand clown kettle	teacher hand clown hat	patient
10decdo	teacher hand clown kettle	teacher hand clown hat	patient
11quepo	waitress show sailor umbrella	waitress show sailor kite	patient
11quedo	waitress show sailor umbrella	waitress show sailor kite	patient
11decpo	waitress show sailor umbrella	waitress show sailor kite	patient
11decdo	waitress show sailor umbrella	waitress show sailor kite	patient
12quepo	clown throw doctor kite	clown throw doctor umbrella	patient
12quedo	clown throw doctor kite	clown throw doctor umbrella	patient
12decpo	clown throw doctor kite	clown throw doctor umbrella	patient
12decdo	clown throw doctor kite	clown throw doctor umbrella	patient
13quepo	sailor sell swimmer balloon	sailor sell swimmer sock	patient
13quedo	sailor sell swimmer balloon	sailor sell swimmer sock	patient
13decpo	sailor sell swimmer balloon	sailor sell swimmer sock	patient
13decdo	sailor sell swimmer balloon	sailor sell swimmer sock	patient
14quepo	doctor offer skier sock	doctor offer skier balloon	patient
14quedo	doctor offer skier sock	doctor offer skier balloon	patient
14decpo	doctor offer skier sock	doctor offer skier balloon	patient
14decdo	doctor offer skier sock	doctor offer skier balloon	patient
15quepo	swimmer lend burglar cake	swimmer lend burglar vase	patient
15quedo	swimmer lend burglar cake	swimmer lend burglar vase	patient
15decpo	swimmer lend burglar cake	swimmer lend burglar vase	patient
15decdo	swimmer lend burglar cake	swimmer lend burglar vase	patient
16quepo	skier pass cricketer vase	skier pass cricketer cake	patient
16quedo	skier pass cricketer vase	skier pass cricketer cake	patient
16decpo	skier pass cricketer vase	skier pass cricketer cake	patient
16decdo	skier pass cricketer vase	skier pass cricketer cake	patient
17quepo	burglar give diver apple	burglar give fireman apple	beneficiary
17quedo	burglar give diver apple	burglar give fireman apple	beneficiary

17decpo	burglar give diver apple	burglar give fireman apple	beneficiary
17decdo	burglar give diver apple	burglar give fireman apple	beneficiary
18quepo	cricketer hand fireman banana	cricketer hand burglar banana	beneficiary
18quedo	cricketer hand fireman banana	cricketer hand burglar banana	beneficiary
18decpo	cricketer hand fireman banana	cricketer hand burglar banana	beneficiary
18decdo	cricketer hand fireman banana	cricketer hand burglar banana	beneficiary
19quepo	diver show policeman bottle	diver show cricketer bottle	beneficiary
19quedo	diver show policeman bottle	diver show cricketer bottle	beneficiary
19decpo	diver show policeman bottle	diver show cricketer bottle	beneficiary
19decdo	diver show policeman bottle	diver show cricketer bottle	beneficiary
20quepo	fireman throw prisoner gun	fireman throw diver gun	beneficiary
20quedo	fireman throw prisoner gun	fireman throw diver gun	beneficiary
20decpo	fireman throw prisoner gun	fireman throw diver gun	beneficiary
20decdo	fireman throw prisoner gun	fireman throw diver gun	beneficiary
21quepo	policeman sell soldier hammer	policeman sell witch hammer	beneficiary
21quedo	policeman sell soldier hammer	policeman sell witch hammer	beneficiary
21decpo	policeman sell soldier hammer	policeman sell witch hammer	beneficiary
21decdo	policeman sell soldier hammer	policeman sell witch hammer	beneficiary
22quepo	prisoner offer witch pipe	prisoner offer policeman pipe	beneficiary
22quedo	prisoner offer witch pipe	prisoner offer policeman pipe	beneficiary
22decpo	prisoner offer witch pipe	prisoner offer policeman pipe	beneficiary
22decdo	prisoner offer witch pipe	prisoner offer policeman pipe	beneficiary
23quepo	soldier lend nun box	soldier lend prisoner box	beneficiary

23quedo	soldier lend nun box	soldier lend prisoner box	beneficiary
23decpo	soldier lend nun box	soldier lend prisoner box	beneficiary
23decdo	soldier lend nun box	soldier lend prisoner box	beneficiary
24quepo	witch pass dancer watering can	witch pass soldier watering can	beneficiary
24quedo	witch pass dancer watering can	witch pass soldier watering can	beneficiary
24decpo	witch pass dancer watering can	witch pass soldier watering can	beneficiary
24decdo	witch pass dancer watering can	witch pass soldier watering can	beneficiary

Filler Items

Fillers: Transitive Sentences

Item	Fillers (transitive)
FT1	Which ball is the nun kicking?
FT2	The dancer is hitting the ball.
FT3	Which vase is the monk holding?
FT4	The pirate is lifting the vase.
FT5	Which bell is the cowboy kissing?
FT6	Which flag is the artist punching?
FT7	The boxer is eating the bell.
FT8	The knight is criticising the book.
FT9	Which candle is the chef shooting?
FT10	The teacher is dropping the cup.
FT11	The waitress is pushing the book.
FT12	The clown is catching the cup.
FT13	The sailor is pulling the candle.
FT14	The doctor is polishing the drum.
FT15	Which hat is the swimmer poking?
FT16	The skier is stabbing the hat.
FT17	The burglar is kicking the drum.
FT18	The cricketer is hitting the flag.
FT19	The diver is holding the kettle.
FT20	Which kettle is the fireman lifting?
FT21	The policeman is kissing the kite.
FT22	The prisoner is punching the kite.

FT23	The soldier is eating the apple.
FT24	The witch is criticising the apple.
FT25	The nun is hitting the umbrella.
FT26	The dancer is holding the umbrella.
FT27	The monk is lifting the sock.
FT28	The pirate is kissing the sock.
FT29	The cowboy is punching the balloon.
FT30	The artist is eating the banana.
FT31	Which balloon is the boxer criticising?
FT32	The knight is shooting the cake.
FT33	The chef is dropping the cake.
FT34	Which banana is the teacher pushing?
FT35	Which bottle is the waitress catching?
FT36	The clown is pulling the bottle.
FT37	The sailor is polishing the jug.
FT38	The doctor is poking the jug.
FT39	The swimmer is stabbing the gun.
FT40	The skier is kicking the gun.
FT41	The burglar is shooting the hammer.
FT42	Which pipe is the cricketer dropping?
FT43	The diver is pushing the hammer.
FT44	The fireman is catching the watering can.
FT45	Which box is the policeman pulling?
FT46	The prisoner is polishing the watering can.
FT47	The solider is poking the pipe.
FT48	The witch is stabbing the box.

Fillers: Transitive - Items Picture Descriptions: Match / Non-Match

item	match picture	non-match picture	change
FT1	nun kick ball	swimmer kick ball	agent
FT2	dancer hit ball		
FT3	monk hold vase	nun hold vase	agent
FT4	pirate lift vase		
FT5	cowboy kiss bell	monk kiss bell	agent
FT6	artist punch flag	pirate punch flag	agent
FT7	boxer eat bell		
FT8	knight scold book		
FT9	chef shoot candle	boxer shoot candle	agent
FT10	teacher drop cup	teacher drop jug	patient
FT11	waitress push book	knight push book	agent

FT12	clown catch cup		
FT13	sailor pull candle		
FT14	doctor polish drum	clown polish drum	agent
FT15	swimmer poke hat	swimmer poke cup	patient
FT16	skier stab hat		
FT17	burglar kick drum		
FT18	cricketer hit flag		
FT19	diver hold kettle		
FT20	fireman lift kettle	dancer lift kettle	agent
FT21	policeman kiss kite	policeman kiss hat	patient
FT22	prisoner punch kite		
FT23	soldier eat apple	cowboy eat apple	agent
FT24	witch scold apple		
FT25	nun hit umbrella		
FT26	dancer hold umbrella	skier hold umbrella	agent
FT27	monk lift sock	monk lift kite	patient
FT28	pirate kiss sock		
FT29	cowboy punch balloon		
FT30	artist eat banana	artist eat sock	patient
FT31	boxer scold balloon	artist scold balloon	agent
FT32	knight shoot cake		
FT33	chef drop cake		
FT34	teacher push banana	chef push banana	agent
FT35	waitress catch bottle	waitress catch banana	patient
FT36	clown pull bottle		
FT37	sailor polish jug	sailor polish bottle	patient
FT38	doctor poke jug		
FT39	swimmer stab gun	swimmer stab hammer	patient
FT40	skier kick gun		
FT41	burglar shoot hammer	burglar shoot watering can	patient
FT42	cricketer drop pipe	cricketer drop box	patient
FT43	diver push hammer		
FT44	fireman catch watering can	fireman catch pipe	patient
FT45	policeman pull box	policeman pull gun	patient
FT46	prisoner polish watering can		
FT47	soldier poke pipe		
FT48	witch stab box		

Filler: Intransitive Sentences

Items	Fillers (intrans)

FI1	The nun is laughing.
FI2	The dancer is crying.
FI3	The monk is nodding.
FI4	Which pirate is sweating?
FI5	The cowboy is sneezing.
FI6	The artist is yawning.
FI7	The boxer is hopping.
FI8	The knight is sleeping.
FI9	The chef is laughing.
FI10	Which teacher is crying?
FI11	The waitress is nodding.
FI12	The clown is sweating.
FI13	Which sailor is sneezing?
FI14	The doctor is yawning.
FI15	Which swimmer is hopping?
FI16	The skier is sleeping.
FI17	Which burglar is laughing?
FI18	The cricketer is crying.
FI19	The diver is nodding.
FI20	The fireman is sweating.
FI21	The policeman is sneezing.
FI22	The prisoner is yawning.
FI23	The solider is hopping.
FI24	Which witch is sleeping?

Fillers: Intransitive - Items Picture Descriptions: Match / Non-Match

item	match	non-match	change
FI1	nun laugh		
FI2	dancer cry		
FI3	monk nod		
FI4	pirate sweat	burglar sweat	agent
FI5	cowboy sneeze		
FI6	artist yawn		
FI7	boxer hop		
FI8	knight sleep	policeman sleep	agent
FI9	chef laugh		
FI10	teacher cry	diver cry	agent
FI11	waitress nod		
FI12	clown sweat	fireman sweat	agent

FI13	sailor sneeze	cricketer sneeze	agent
FI14	doctor yawn		
FI15	swimmer hop	witch hop	agent
FI16	skier sleep	prisoner sleep	agent
FI17	burglar laugh	soldier laugh	agent
FI18	cricketer cry		
FI19	diver nod	teacher nod	agent
FI20	fireman sweat policeman		
FI21	sneeze	waitress sneeze	agent
FI22	prisoner yawn		
FI23	soldier hop	sailor hop	agent
FI24	witch sleep	doctor sleep	agent

Appendix H

Experiment 6 Materials

Prime sentences, fillers and match/non-match items were the same as experiments 4 and 5. Prime sentences are included here for reference.

Experimental Items

item	prime sentence	target
1quepo	Which flag is the knight passing to the teacher?	artist pass sailor hat
1quedo	Which flag is the knight passing the teacher?	artist pass sailor hat
1decpo	The knight is passing the flag to the teacher.	artist pass sailor hat
1decdo	The knight is passing the teacher the flag.	artist pass sailor hat
2quepo	Which vase is the skier passing to the cricketer?	prisoner pass cowboy jug
2quedo	Which vase is the skier passing the cricketer?	prisoner pass cowboy jug
2decpo	The skier is passing the vase to the crickerter.	prisoner pass cowboy jug
2decdo	The skier is passing the cricketer the vase.	prisoner pass cowboy jug
3quepo	Which watering can is the witch passing to the dancer?	pirate pass waitress cup
3quedo	Which watering can is the witch passing the dancer?	pirate pass waitress cup
3decpo	The witch is passing the watering can to the dancer.	pirate pass waitress cup
3decdo	The witch is passing the dancer the watering can.	pirate pass waitress cup
4quepo	Which ball is the monk showing to the cowboy?	boxer show doctor kettle

4quedo	Which ball is the monk showing the cowboy?	boxer show doctor kettle
4decpo	The monk is showing the ball to the cowboy.	boxer show doctor kettle
4decdo	The monk is showing the cowboy the ball.	boxer show doctor kettle
5quepo	Which umbrella is the waitress showing to the sailor?	burglar show witch gun
5quedo	Which umbrella is the waitress showing the sailor?	burglar show witch gun
5decpo	The waitress is showing the umbrella to the sailor.	burglar show witch gun
5decdo	The waitress is showing the sailor the umbrella.	burglar show witch gun
6quepo	Which bottle is the diver showing to the policeman?	dancer show chef book
6quedo	Which bottle is the diver showing the policeman?	dancer show chef book
6decpo	The diver is showing the bottle to the policeman.	dancer show chef book
6decdo	The diver is showing the policeman the bottle.	dancer show chef book
7quepo	Which bell is the dancer handing to the pirate?	knight hand swimmer umbrella
7quedo	Which bell is the dancer handing the pirate?	knight hand swimmer umbrella
7decpo	The dancer is handing the bell to the pirate.	knight hand swimmer umbrella
7decdo	The dancer is handing the pirate the bell.	knight hand swimmer umbrella
8quepo	Which kettle is the teacher handing to the clown?	chef hand skier kite
8quedo	Which kettle is the teacher handing the clown?	chef hand skier kite
8decpo	The teacher is handing the kettle to the clown.	chef hand skier kite
8decdo	The teacher is handing the clown the kettle.	chef hand skier kite
9quepo	Which banana is the cricketer handing to the fireman?	doctor hand policeman apple

9quedo	Which banana is the cricketer handing the fireman?	doctor hand policeman apple
9decpo	The cricketer is handing the banana to the fireman.	doctor hand policeman apple
9decdo	The cricketer is handing the fireman the banana.	doctor hand policeman apple
10quepo	Which candle is the pirate throwing to the artist?	teacher throw burglar balloon
10quedo	Which candle is the pirate throwing the artist?	teacher throw burglar balloon
10decpo	The artist is throwing the candle to the artist.	teacher throw burglar balloon
10decdo	The artist is throwing the artist the candle.	teacher throw burglar balloon
11quepo	Which kite is the clown throwing to the doctor?	skier throw soldier bottle
11quedo	Which kite is the clown throwing the doctor?	skier throw soldier bottle
11decpo	The clown is throwing the kite to the doctor.	skier throw soldier bottle
11decdo	The clown is throwing the doctor the kite.	skier throw soldier bottle
12quepo	Which gun is the fireman throwing to the prisoner?	witch throw boxer ball
12quedo	Which gun is the fireman throwing the prisoner?	witch throw boxer ball
12decpo	The fireman is throwing the gun to the prisoner.	witch throw boxer ball
12decdo	The fireman is throwing the prisoner the gun.	witch throw boxer ball
13quepo	Which cup is the boxer lending to the chef?	waitress lend cricketer sock
13quedo	Which cup is the boxer lending the chef?	waitress lend cricketer sock
13decpo	The boxer is lending the cup to the chef.	waitress lend cricketer sock
13decdo	The boxer is lending the chef the cup.	waitress lend cricketer sock
14quepo	Which cake is the swimmer lending to the burglar?	diver lend dancer pipe
14quedo	Which cake is the swimmer lending the burglar?	diver lend dancer pipe
14decpo	The swimmer is lending the cake to the	diver lend dancer pipe

	burglar.	
14decdo	The swimmer is lending the burglar the cake.	diver lend dancer pipe
15quepo	Which box is the soldier lending to the nun?	cowboy lend clown flag
15quedo	Which box is the soldier lending the nun?	cowboy lend clown flag
15decpo	The soldier is lending the box to the nun.	cowboy lend clown flag
15decdo	The soldier is lending the nun the box.	cowboy lend clown flag
16quepo	Which drum is the artist offering to the knight?	clown offer diver cake
16quedo	Which drum is the artist offering the knight?	clown offer diver cake
16decpo	The artist is offering the drum to the knight.	clown offer diver cake
16decdo	The artist is offering the knight the drum.	clown offer diver cake
17quepo	Which sock is the doctor offering to the skier?	sailor offer fireman vase
17quedo	Which sock is the doctor offering the skier?	sailor offer fireman vase
17decpo	The doctor is offering the sock to the skier.	sailor offer fireman vase
17decdo	The doctor is offering the skier the sock.	sailor offer fireman vase
18quepo	Which pipe is the prisoner offering to the witch?	cricketer offer nun hammer
18quedo	Which pipe is the prisoner offering the witch?	cricketer offer nun hammer
18decpo	The prisoner is offering the pipe to the witch.	cricketer offer nun hammer
18decdo	The prisoner is offering the witch the pipe.	cricketer offer nun hammer
19quepo	Which jug is the nun giving to the monk?	swimmer give prisoner banana
19quedo	Which jug is the nun giving the monk?	swimmer give prisoner banana
19decpo	The nun is giving the jug to the monk.	swimmer give prisoner banana
19decdo	The nun is giving the monk the jug.	swimmer give prisoner banana

20quepo	Which hat is the chef giving to the waitress?	policeman give pirate watering can
20quedo	Which hat is the chef giving the waitress?	policeman give pirate watering can
20decpo	The chef is giving the hat to the waitress.	policeman give pirate watering can
20decdo	The chef is giving the waitress the hat.	policeman give pirate watering can
21quepo	Which apple is the burglar giving to the diver?	soldier give artist bell
21quedo	Which apple is the burglar giving the diver?	soldier give artist bell
21decpo	The burglar is giving the apple to the diver.	soldier give artist bell
21decdo	The burglar is giving the diver the apple.	soldier give artist bell
22quepo	Which book is the cowboy selling to the boxer?	fireman sell monk box
22quedo	Which book is the cowboy selling the boxer?	fireman sell monk box
22decpo	The cowboy is selling the book to the boxer.	fireman sell monk box
22decdo	The cowboy is selling the boxer the book	fireman sell monk box
23quepo	Which balloon is the sailor selling to the swimmer?	nun sell knight candle
23quedo	Which balloon is the sailor selling the swimmer?	nun sell knight candle
23decpo	The sailor is selling the balloon to the swimmer.	nun sell knight candle
23decdo	The sailor is selling the swimmer the balloon.	nun sell knight candle
24quepo	Which hammer is the policeman selling to the soldier?	monk sell teacher drum
24quedo	Which hammer is the policeman selling the soldier?	monk sell teacher drum
24decpo	The policeman is selling the hammer to the soldier.	monk sell teacher drum
24decdo	The policeman is selling the solider the hammer.	monk sell teacher drum