Investigations of syntactic knowledge in question structures in children with Specific Language Impairment

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Without doubt and limitations we have set upon ourselves, we are able to achieve whatever we have placed in our hearts.

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Statement of Candidate

The research presented in this thesis is my original work and it has not been submitted for a higher degree in any other institution. In addition, I certify that all information sources and literature have been acknowledged for in this thesis. The research presented in this thesis has obtained ethics from Macquarie University (Ethics number 5201400107D) as well as from the Department of Education of Western Australia (Ethics number D14/0326286).

The chapters (Chapters 3, 4 and 5) are prepared as separate papers for potential publications in keeping with the requirements of thesis by publication. The chapters have been sent for publication. Subsequently, there may be some duplication of literature across the chapters. The experiments comprising the chapters were administered by the first author. The first author wrote the first draft of the three chapters, the supervisors played a significant role in refining those chapters.

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Thesis Summary

Children with specific language impairment (SLI) are a group of children who are known for their language difficulties despite a clean bill of health in all other aspects of development. It is now widely accepted that tense morphology is particularly affected in children with SLI, but the extent of the language deficit, especially in the area of syntactic knowledge, is not yet known. There is some literature in English and across languages showing that children with SLI have difficulties with the syntactic operations that are required to form and comprehend questions. However, it is not clear, at least from the production data, whether this finding is limited to a subgroup of children labelled Grammatical SLI (G-SLI) whose grammatical deficit is particularly severe, or whether this finding extends to a general population of children with SLI. To understand this important question, this thesis by publication explores three aspects of children's syntactic knowledge in question structures, comparing children with SLI with two control groups, an age-matched group and a group matched by MLU.

This thesis is structured as follows:

Chapter one provides background information and describes the theoretical framework upon which this thesis is based. The motivation for the studies reported in Chapters two through to Chapter five is discussed.

Chapter two investigates aspects of morphology, syntax and pragmatics in children with SLI's answers to wh-questions. The aim of this study is to investigate whether the impairment is seen in different language components. The study revealed that children with SLI demonstrated the reported difficulty with using tense, while demonstrating that they had no difficulty computing the appropriate syntactic structures.

Chapter three is a production study that investigated the syntactic rule of Subject-Aux Inversion (SAI) in main clauses and also in embedded clauses (where it is prohibited). This study found that the SAI rule is delayed for children with SLI, but once they have learned the

rule, children implement it well. The striking finding is that the children with SLI who implement the rule implement it too well, and extended it to embedded clauses. This group has difficulty inhibiting the rule.

Chapter four evaluates the adherence to the linguistic constraint on contraction in questions. The aim of this study is to investigate whether children with SLI have the same underlying grammar as typically developing children in this aspect of linguistic knowledge which is often claimed to be universal. The experimental findings showed that the children with SLI respected the constraint well, and were not different from the control groups.

Chapter five concludes the thesis by summarising the experimental findings from the studies in the three chapters.

The experimental results observed in three studies together provide evidence that children with SLI do not have difficulties in every area of language, and in fact, show strength in some areas of syntactic knowledge in their question structures.

Chapter 1

General Introduction

General Introduction

For most children, acquiring language is a relatively effortless process that comes naturally as part of a child's typical development. Within the first few years of life, children will have reached various language milestones that in turn enable them to master the grammar specific to their language by the age of five. There is, however, a group of children for whom this natural progression of language acquisition does not come so easily. This population group is known as children with specific language impairment, commonly referred as children with 'SLI'[1]. The most general and widely used definition describes specific language impairment (henceforth, 'SLI') as a developmental disorder that affects various aspects of a child's language development. The impairment is present in the absence of any other difficulties in the child's development. That is, children with SLI have typical cognitive development, hearing within normal limits, no impairment of reciprocal social interactions or restriction of activities, and no abnormalities of the speech apparatus (Leonard, 2014). Some researchers believe that, children with SLI also display broader deficits in areas such as phonological short-term memory, motor development and general processing (Leonard, 2014).

SLI affects approximately 7% of children (Tomblin et al., 1997) with the reported cases suggesting boys are more affected than girls; the ratio being two to three boys for every one girl (Kidd, Kidd, & Records, 1978; Ludlow & Cooper, 1983; Van Riper, 1971). The causes of SLI are unknown, however research suggests there is a strong genetic relationship to the language disorder (Bishop, 2014; Bishop, North, & Donlan, 1995; Hurst, Baraitser, Auger, Graham, & Norell, 1991; Marcus & Fisher, 2003; Rice, 2013; Rice, Haney, & Wexler, 1998; Vernes et al., 2008). A detailed twin study by Rice and her collaborators that spanned nearly 20 years was able to confidently conclude that particular genes are influential in the language

[1] The term 'developmental language disorder' is now a term that is used instead of 'specific language impairment' both in Australia and internationally (Bishop et al., 2017).

delay (Rice, 2013). The underlying deficit behind SLI has been the topic of a great deal of research to date. Two main thoughts have been prominent in this debate. One camp takes the stance that, as a result of the morphological challenges observed in the grammar of children with SLI, a deficit in linguistic knowledge is the explanation behind the disorder (Clahsen, 1989; Clahsen, Bartke & Gollner, 1997; Gopnik, 1990; Marshall & van der Lely, 2012; Rice et al., 1995; Rice & Wexler, 1996). The other type of account attributes the underlying deficit to processing limitations. These limitations may be in process speech and/or processing capacity (Bishop, 1997; Joanisse & Seidenberg, 1998; Kail, 1994; Leonard, 1989; Montgomery, 2000; Ellis Weismer, Evans, & Hesketh, 1999). The stance taken by and through this thesis is that the underlying deficit of SLI is due to a grammatical deficit. This thesis will support this claim with experimental evidence provided by the three studies discussed in the forthcoming chapters.

SLI appears in childhood and can often persist through adult life (Aram, Ekelman, & Nation, 1984; Johnson et al., 1999; Snowling, Adams, Bishop, & Stothard, 2001; Snowling, Bishop, & Stothard, 2000; Stothard, Snowling, Bishop, Chipchase, & Kaplan, 1998). The disorder is commonly first identified by a delayed start of first words relative to age expectations (Trauner, Wulfeck, Tallal, & Hesselink, 2000). Despite this late start, there is a body of evidence which argues that children with SLI have grammars that mirror a similar trajectory of linguistic development as their typically language developing peers who are two years younger (Rice, 2013; Rice & Wexler, 1996; Rice, Wexler & Cleave, 1995; Wexler, 1998).

SLI affects both production and comprehension and has the ability to manifest itself in various components of language, such as morphology, syntax, semantics, phonology, pragmatics, and vocabulary knowledge (eg. Bishop, 1997, 2006; Bishop & Rosenbloom, 1987; Claessen & Leitão, 2012; Clahsen, 1989; Clegg, Hollis, Mawhood & Rutter, 2005; Conti-

Ramsden & Durkin, 2007; Leonard, 1998; Marinis & van der Lely, 2007; Rice & Wexler, 1996; van der Lely, 2005; van der Lely & Christian, 2000). Due to the heterogeneity of SLI, the language profiles of children with SLI vary slightly from child to child (Dale et al., 1998; DeThorne, Petrill, Hayiou-Thomas, & Plomin, 2005; Tomblin & Buckwalter, 1998). However, as a positive consequence of much of the research to date, particular areas of linguistic weakness have been identified across this population of children. This investigation will focus on aspects of morphology and syntax, and will not address other aspects of language such as the lexicon or phonology.

Grammatical Morphology

Extensive cross-linguistic research has revealed that one area of linguistic weakness for English-speaking children with SLI is grammatical morphology (Cleave & Rice, 1997; Gopnik, & Crago, 1991; Grela & Leonard, 2000; Leonard, Miller & Gerber, 1999; Ullman & Gopnik, 1999). Rice, Wexler and their colleagues argue that English-speaking children with SLI are more likely to have difficulties with morphemes that carry finiteness features than morphemes without this feature (such as progressive aspect marker *–ing*) (Hadley & Rice, 1996; Rice et al., 1995; Rice & Wexler, 1996; Rice, Wexler & Hershberger, 1998). This research has documented that children with SLI lack knowledge of the rules governing morphological units that carry tense. Tense morphemes in English include: irregular and regular past tense *-ed*, as in '*She jumped'*; third person singular *-s*, as in '*She jumps*'; auxiliary and copula BE such as in *'is'* in the sentence *'She is jumping';* and auxiliary DO as in the sentence '*Do you like jumping?*'. Due to the characteristic morphological difficulties seen in this group of children, several proposals have focused on a grammatical deficit as the reason behind the language disorder.

Typical error patterns produced by children with SLI result in frequent omissions of tense morphemes in contexts where they are obligatory (Rice et al., 1995; Rice, et al., 1998;

Rice & Blossom, 2012; Rice, Hoffman & Wexler, 2009; Rice & Wexler, 1996). For example, children with SLI produce sentences like '*He eating*' for '*He is eating*' or '*What you want?*' for '*What do you want?*'. As a result of the high rates of omission reported across numerous research studies, tense morphemes are widely accepted as a clinical marker and a hallmark of English-speaking children with SLI (Rice et al., 1995; Rice et al., 1998; Rice, et al., 2009; Rice & Wexler, 1996).

Despite English-speaking children with SLI frequently omitting tense morphemes in contexts where they are obligatory, research suggests this group of children still understand the grammatical principles governing tense. Rather, it is the morpheme's obligatory nature that is behind the difficulty. This finding is supported by empirical research that indicates children with SLI very rarely produce errors other than tense marking errors. For example, children with SLI omit the third person singular tense marker and say, '*He love chocolate*' instead of '*He loves chocolate*'. Contrastingly when the tense marker is present, children with SLI rarely produce utterances that are incorrectly marked for agreement or number. Therefore, it is not expected that these children would say things like '*They loves chocolate*', where there is correct marking of tense, but not of agreement (Rice et al., 1995; Rice & Wexler, 1996).

For children with SLI, finiteness (tense) is one aspect of grammar where similar gains relative to their language matched peers (who are two years younger) are not met. Children with SLI are more than two years delayed in their use of finiteness markers and often do not catch up on this aspect of grammatical knowledge (Rice, et al., 1998; Rice, 2013).

Syntax

Acquisition of syntax has been the focus of extensive research within the literature on typically developing children. One area of particular interest has centred around question structures. This research has shown that young children are quite good at forming questions (Bellugi, 1971; Crain & Thornton, 1998; de Villiers & Roeper, 1995; Kuczaj & Brannick,

1979; Rizzi, 1990; Rowland, 2007; Stromswold, 1990; Tyack & Ingram, 1977). Research has also suggested that children's proficiency at questions extends to more complex question structures. For example, Thornton (1990) found that children as young as three years of age show early acquisition of both long distance wh-questions, such as, '*Who do you think is in the box?*' and questions with complex wh-phrases, such as, '*Which boy?*' (Thornton, 1995).

While not as extensively studied, investigations on children with SLI's question structures has also been of importance in recent investigations. This research has suggested that children with SLI have difficulties with both forming and comprehending questions (Deevy & Leonard, 2004; Ebbels & van der Lely, 2001; Friedmann & Novogrodsky, 2011; Hamann, Penner & Linder, 1998; Hansson & Nettelbladt, 2006; Leonard, 1995; Marinis & van der Lely, 2007; Schulz & Roeper, 2011; Stravakaki, 2006; van der Lely & Battell, 2003; van der Lely, Jones, & Marshall, 2011; Wong, Leonard, Fletcher & Stokes, 2004).

A large majority of this work on children with SLI comes from investigations on children aged between 10 to 18 years of age classified as having Grammatical SLI (G-SLI). This group of children come from the larger SLI group, however, are thought to have a magnified weakness in grammar and therefore are sub-grouped and given the label 'G-SLI'. Children with G-SLI make up the lower end of the continuum of children with grammatical weakness, often meeting criteria of 2SD below the norm on standardised language assessments. According to van der Lely, children with G-SLI have a purely domain-specific grammatical deficit which extends to a deficit in the syntactic representation (van der Lely, 1998, 2005; van der Lely et al., 2011; van der Lely & Pinker, 2014). van der Lely and her collaborators make the claim that children with G-SLI have a significant grammatical impairment in any structure in which there is a relationship between noun phrase positions. This implicates structures such as wh-questions, passives and sentences containing reflexives (van der Lely, 1998, 2005; van der Lely et al., 2011; van der Lely & Pinker, 2014).

Theories of SLI can be broadly divided into domain general accounts and domain specific accounts. Domain general accounts of SLI attribute the linguistic deficit to the cognitive and/or perceptual mechanisms that support language. One view is that children with SLI have reduced processing speed and limitations in their processing capacity, which could have consequences for both linguistic and non-linguistic tasks (Bishop, 1997; Joanisse & Seidenberg, 1998; Kail, 1994; Leonard, 1989; Montgomery, 2000; Ellis Weismer, Evans, & Hesketh, 1999). By contrast, domain specific accounts attribute SLI to either a deficit or delay in properties of the language faculty itself (Clahsen, 1989; Clahsen, Bartke & Gollner, 1997; Gopnik, 1990; Marshall & van der Lely, 2012; Rice et al., 1995; Rice & Wexler, 1996). In the next section, this thesis will provide an overview of some of the research that has been done investigating question structures in children with SLI.

Literature on question structures in children with SLI

Children's question comprehension was explored in a study by Deevy and Leonard (2004). These investigators tested children with SLI aged 4;3 to 6;10 on the comprehension of subject and object short and long wh-questions using a picture-pointing task. According to the processing view adopted by Deevy and Leonard, both children with SLI and typically developing children should perform better on subject questions than on object questions. This is thought to be because there is a greater distance between the wh-word and the gap when the question word has moved from the object position in the sentence. Additionally, object questions should be more difficult for children with SLI than typically developing children due to processing limitations. Results from the study found that the control group and SLI group performed similarly on short subject and short object questions. However, where children with SLI performed poorer, was on long object compared to long subject questions. Additionally, children with SLI performed more poorly than the control group of children on long object questions. These authors concluded from their investigation that the syntactic representation

for questions in children with SLI is not impaired, but rather, children with SLI experience difficulties with question structures due to a general limitation in processing ability.

Van der Lely and Battell (2003) elicited wh-questions from 15 children with G-SLI (age 14;10) as well as from two control groups, one matched on grammatical ability (age 6;7) and one matched on vocabulary knowledge (age 7;9). In their task wh-questions were elicited in a 'Who done it?' game where the child had to find out who did what, and where. In this game the experimenter provided a lead-in, such as, '*Miss Scarlett left something in the library. Ask me what'* which was designed to elicit a wh-question from the chid, such as, '*What did Miss Scarlett leave in the library*?' The experimental results revealed that children with G-SLI failed to carry out the two movement requirements in the wh-question, thus resulting in poorly formed syntactic wh-questions. According to the authors, the G-SLI children's typical errors involved lack of tense/question feature movement, as evidenced, for example, by a missing auxiliary (a), lack of wh-operator movement, as shown by a filled gap (b), and by combinations of the two types of errors (c). Van der Lely and Battell's experimental results concluded that 80% of children within their G-SLI subject group were found to show both kind of errors, as compared to only 4% in the control group.

(a) What Mrs. Brown place in the library?

(b) What did Mrs. Peacock like jewellery?

(c) Who Mrs Peacock saw somebody?

Marinis and van der Lely (2007) investigated the comprehension of indirect object wh-questions in a group of children aged 10;2 to 17;2 with G-SLI and two control groups, one group matched on age, and a younger group matched on vocabulary. The experiment used a cross-modal picture priming task. Experimental questions such as '*Balloo gives a long carrot to the rabbit. Who did Balloo give the long carrot to at the farm?*' were given to the child. As the child listened to the question, a picture appeared. The picture appeared at the interpreted

position (after '*to'*); immediately after the verb ('*give'*); or at an unrelated position in the sentence (after '*long'*). The child's task was to press a button which corresponded to the animate picture (rabbit) or the inanimate picture (ladder). Children with G-SLI were slower than the younger children when the picture of the target appeared in the interpreted position. The priming effect was seen for children with G-SLI after the verb, while the control children showed priming at the gap. The results from the study led the investigators to make the claim that children with G-SLI fail to establish a syntactic filler-gap dependency and rather, interpret wh-questions through lexical/thematic information instead of through grammatical information. The authors concluded that children with G-SLI have a deficit in the computational system which affects syntactic dependencies involving movement.

In another comprehension study done by van der Lely and colleagues (van der Lely et al., 2011) grammaticality judgements of children with G-SLI children aged 10;5 to 17;1 were investigated. These authors found that children with G-SLI correctly accepted grammatical questions (e.g., '*Who did Mowgli hug?*') and correctly rejected questions with semantic violations (e.g., '*Which telephone did the sandwich rush?*'). Different to the children matched on mean length of utterance (MLU), children with SLI incorrectly accepted poorly formed wh-questions such as ('*Which door the policeman locked?*') and ('*What did Popeye move something?*'). The take home point from their investigation was that children with G-SLI have a deficit in the computational system that affects syntactic dependencies at the clause level.

Cross-linguistic data on question structures

Cross-linguistic literature has also documented that children with SLI make movement errors in relative clauses and questions (Adani, van der Lely, Forgiarini, & Guasti, 2010; Hamann et al., 1998; Jakubowicz, Nash, Riguat & Gerard, 1998; Stavrakaki, 2006). For the purpose of this chapter, this thesis discusses two studies carried out in German speaking and Swedish speaking children with SLI. This literature is relevant because inverted constructions

in these two languages require similar phrase structures in English. That is, they require a CP projection. German and Swedish are both verb-second (V2) languages, which means even in declarative sentences there is movement of the verb, according to generative linguistic theories. This particular aspect is different from English, which does not have movement of main verbs (except *have* and *be*).

A study by Hansson and Nettelbladt (2006) investigated wh-questions in spontaneous language samples of Swedish-speaking children with SLI, aged 4;3 to 5;7. The authors concluded in their investigation that Swedish speaking children with SLI have difficulties with inverted word order. This finding confirmed what Hansson and Nettelbladt (1995) had discovered in their earlier research. This investigation reported that, at least in a subgroup of Swedish children with SLI, questions with non-inverted word order were more prevalent than in the questions of children whose language was typically developing.

Moreover, another study done by Hamann and colleagues (Hamann et al., 1998) looked at the spontaneous language samples of German speaking children with SLI aged 3;10 to 9;1. Children with SLI produced the following errors in their question productions: utterances in which they failed to move the finite verb, as seen in question (a); questions with infinitive verb forms as in (b); and questions with a missing subject as in (c). These authors concluded that children with SLI have special difficulties with question formation. This study reinforced what was found in the investigation with Swedish speaking children (Hansson & Nettelbladt, 1995) and what van der Lely and colleges have reported, that being that questions produced by children with SLI often include non-inverted word order.

(a) Wo das brennt?

Where that burns?

Where does it burn?

(b) Wo das den wohl hingehen?

Where that then (wohl) fit/go (inf)?

Where might that fit?

(c) Wie geht (das)?

How works?

How does it work?

Object verses subject questions

The discrepancy between subject and object questions has been of keen interest to research investigations within the typically developing, SLI and cross-linguistic SLI literature. These studies have reported that subject wh-questions are produced more accurately than object wh-questions. This finding was reported in literature on English-speaking typically language developing children by de Villiers (1996); Manzini (1992, 1995); Rizzi (1990); Roeper and de Villiers (1994); and Tyack and Ingram (1977) and in English-speaking children with SLI by Ebbels and van der Lely (2001) and by van der Lely and Battell (2003). This has also been found cross-linguistically in children with SLI in Hebrew by Friedmann and Novogrodsky (2011); in German by Siegmüller (2005); and in Greek by Stavrakaki (2001, 2006). The finding that object questions are more problematic to children can be accounted for by the longer distance between the wh-word and the gap. In recent investigations, it has been reported that children's difficulty with these object gap questions is affected by the similarity in features between the moved object and the subject NP that intervenes between the wh-phrase and the gap (Friedmann, Belletti, & Rizzi, 2009; Friedmann, Rizzi, & Belletti, 2017). This thesis did not address the difficulty children with SLI's have with object (*who* and *which*) questions.

When considering the results of presented in our studies compared to van der Lely's work, the difference in the two population groups must be considered. As mentioned, one significant difference is the age range. Children in van der Lely's study are older than the children in this study. Additionally, children with G-SLI are thought to have a more severe

deficit in grammar than children not given this classification of G-SLI. This can be further supported by the fact that the children in van der Lely's studies perform 2 SD below the norm on standardized language measurements, whereas in our studies, a cut off of 1SD was used.

This research discussed in the previous section can be taken to suggest that children with SLI have difficulties with both the production of questions and comprehension of questions. It has been proposed that children have difficulty with both movement of the question word to SpecCP ('rules') and with subject-aux inversion involved in both forming and comprehending question structures. However, the literature on English-speaking children primarily comes from studies on an older group of children, classified as being part of a subgroup of children classified as Grammatical SLI (G-SLI) who been observed to have difficulty with the movement operations required in computing and forming questions (van der Lely, 1998). Therefore, the question of whether syntactic difficulties are seen in a more general population of children with SLI is a question that still needs further investigation. This is what motivated the investigations in this dissertation.

Research Questions

It has been confirmed by widespread and extensive research that the morphological component is affected in children with SLI. However, what is less understood is whether (or the extent to which) the syntactic component is also affected. Previous research has suggested that syntactic structures such as questions are an area of particular weakness. This finding comes chiefly from research on an older group of children classified as having G-SLI. However, the question about whether children who are not a part of this subgroup also have impaired syntactic knowledge which in turn affects question structures, is a question which has not been resolved. This underlying question forms the basis of the enquiry of this thesis. As a way to understand and test this important question, this thesis centres around three inter-related questions concerning

children with SLI's syntactic knowledge in respect to questions. The main questions are as follows:

Question 1: Which aspects of children's answers to wh-questions are accomplished without difficulty and which aspects differentiate children with SLI to typically developing children? Is the difficulty with the grammar confined to a particular aspect or grammar or does it extend across morphological, syntactic and pragmatic knowledge?

Question 2: Do children with SLI experience difficulty with the syntactic rule of subject-aux inversion when producing yes/no questions and wh-questions? If so, does this extend to embedded wh-questions?

Question 3: Are children with SLI sensitive to the gap left by a moved or deleted element, and if so, do they obey the linguistic constraint on contraction?

This investigation has its foundations in linguistic theory, specifically the Chomskyan generative framework (Chomsky, 1957, 1965, 1975, 1981, 1986). The experimental methodology that this thesis adopts is the elicited production procedure developed by Crain and Thornton (1998). Elicited production methodology is effective for investigating aspects of children's grammar which may not be as well represented and are less frequently heard in a spontaneous production data sample. This technique is advantageous in that it brings together situational context under experimental control, while ensuring that task itself is not inducing processing difficulties. This choice of technique is particularly important to this investigation because previous research on question structures within the SLI literature has generally used picture-pointing techniques in which children choose from an array of pictures (Deevy & Leonard, 2004; Ebbels & van der Lely, 2001; Novogrodsky & Friedmann, 2006). Such picture-pointing tasks can impose processing demands. This is because children must hold the test sentence in memory while they examine the array of pictures and then make a choice. This

methodology may disadvantage children with SLI, and as a result they may fail at the task. If the methodological task imposed fewer cognitive demands, they may have performed better.

The research presented in this thesis is focused on five-year-old monolingual English-speaking children with SLI. Each of the three studies includes children with SLI and two control groups. The children with SLI are aged five; the language equivalent group (LE) is matched on mean length of utterance (MLU) and these children are aged three years; the age matched (AE) group is matched on age, aged five. In study one there were 18 children with SLI, in study two we had 17 children with SLI, in study three we had 17 children with SLI. The sample size used across all three studies is comparable to sample sizes used in other work in this field (Claessen & Leitão, 2012; Cleave & Rice, 1997; Deevy & Leonard, 2004; Ebbels & van der Lely, 2001; Marshall & van der Lely, 2012). The usual matching inclusion criteria was completed for each of the experimental tasks and will be explained in each of the individual studies discussed in the forthcoming chapters.

The following studies have been influential in providing the building blocks for our own research on this work. As mentioned, previous research as mostly been focused on a subgroup of children, classified as having a severe grammatical impairment and termed children with G-SLI. In turn, our research was motivated to study the broader group of SLI children. Additionally, a lot of research looking at questions has focused on the discrepancy between object questions and subject questions. Our investigation provides a unique contribution in providing an evaluation of three bigger outstanding questions in the literature. Those queries being, comprehension of questions, grammatical rules and a constraint, which evaluates innate linguistic knowledge in children with SLI.

In the next section we will provide a brief summary of the relevant linguistic theory which is important for understanding the three research questions for which this thesis explores. We will first discuss the linguistic properties behind answers to wh-questions; we will then

discuss the rule of subject-aux inversion rule; finally, we will give a brief explanation of the linguistic constraint on contraction.

Answers to wh-questions

In order to answer a wh-question appropriately, the speaker engaging in the discourse uses their syntactic, morphological and pragmatic knowledge. Each of these three components of grammar have their own properties, while also interacting with one another.

Syntax

As noted, according to generative linguistic theory, in wh-question structures, wh-words (*who, what, when etc*.) are associated with a gap (Chomsky, 1977). The wh-word ('*what*' in this example) originates in the position of the gap and moves to sentence initial position. The movement of the wh-word can be seen in example 1. The strike-through font indicates that the copies are not pronounced.

(1) What is he singing?

What is he singing? ~~what~~

In order to provide an answer to a question, the person answering the question must compute a representation for the question. This requires building a structure for the question that associates the question word and its gap. This structural representation is then the basis for the structure of the answer (Merchant, 2004).

The form of possible answers is tightly constrained by the original question. This is shown in question (2).

(2) Question: What's the girl drinking?

(a) The girl's drinking juice

(b) *Drinking juice

(c) *Drink juice

(d) Juice

The full answer in (2a) '*The girl's drinking juice'* is grammatical. This answer does repeat some of the information in the question (*The girl*), however, the answer includes a noun phrase that answers the '*what*' question. A fragment answer to the question is also permitted. As can be seen in answer (2b), '*Drinking juice*' is not grammatical. This is because a fragment answer that begins with the progressive participle from the question is not permitted to answer to the question. It is also not grammatical to answer with a bare verb, as can be seen in the answer '*Drink juice*' in (2c). A fragment answer that is grammatical, and provides the most natural answer to the question is '*Juice*' as in (2d).

If the verb in the question is main verb DO, then a different range of grammatically appropriate answers is available. This is because DO carries less semantic contexts than other lexical verbs, and requires a more contentful verb in the answer. The progressive aspect (*-ing*) must also be maintained. This can be seen in the question '*What's the girl doing?*' in question (3).

(3) Question: What's the girl doing?

(a) The girl's drinking juice

(b) Drinking juice

(c) *Drink juice

(d) *Juice

Due to the nature of the lexical verb DO, the possible answers differ. As before, the full sentence '*The girl's drinking juice*' in (3a) is grammatical. In the fragment answer '*Drinking juice*' as seen in (3b), a fragment with a content verb is the progressive aspect is now possible. Just like in question (2), '*Drink juice*' with a verb phrase with a bare verb is not grammatical. An answer with a simple noun phrase, as in '*Juice*' in (3d), is ruled out, even though this was fine in question (2). The examples in question (2) and question (3) illustrate that the potential form of an answer to a question is highly dependent on the original question. An answer must

be of a syntactic category that reflects the syntax and lexical semantics of the question that was posed by the interlocutor. This investigation tests children's answers to both wh-questions with object extraction as well as wh-questions with subject extraction.

Morphology

Morphological knowledge is needed to provide the correct pieces to produce an answer to a question. These pieces must also provide the appropriate relevant information based on the question being asked.

In answering questions such as '*What's the boy eating?'* in question (4), the speaker needs to draw on morphosyntactic knowledge. Information about tense and aspect must also be carried from the original question to the answer. As question (4) shows, a felicitous answer generally maintains the same tense and aspect (here, progressive aspect) across the question and answer, as shown in (4a). Answers that use a different tense are understandable, however they are not optimal, as indicated by the question marks in the answers in (4b) and (4c).

(4) Question: What's the boy eating?

(a) The boy's eating an apple

(b) ?The boy ate an apple

(c) ?The boy will eat an apple

In order to provide an answer that maintains the same tense as the question, in question (4), the speaker must provide an auxiliary verb, a form of the verb BE. An additional requirement is that the speaker must use the *-ing* morphology that reflects progressive aspect. This study will examine if children have this morphological knowledge and know these requirements.

Pragmatics

In order to answer a question, pragmatic knowledge is also needed to provide an answer that fits the conversational contexts and follow the rules of discourse. In the discussion of the examples above, we focused on whether or not a given answer is grammatical. However, an

answer can be grammatical but not the best answer to a question in a given pragmatic contexts. This can be seen in the answers to the question '*What's the girl doing?*' in question (5).

(5) Question: What's the girl doing?

(a) The girl's feeding a fish

(b) She's feeding a fish

(c) Feeding a fish

The three answers in question (5) are all grammatical, however in everyday conversation, (5a) '*The girl's feeding a fish*' is slightly stilted due to the repetition of the full noun phrase, '*the girl*'. Since the '*the girl*' has already been mentioned, it becomes established information and therefore it is more natural to replace '*the girl*' with a pronoun '*she*' as seen in (5b). (5c) is the most natural response to the question because again, the person who is being asked about, '*the girl,*' is already established, and therefore the noun phrase does not need to be repeated in the answer. The new information is the only requested information. Therefore, '*feeding the fish*' in (5c) would be the most pragmatically appropriate answer to the question being asked. Our investigation is interested in knowing whether children with SLI give a pragmatically appropriate answer and favour the shorter, elliptical answer.

By exploring children's answers to questions, we can find out whether children with SLI have difficulties with particular aspects of answering wh-questions or whether the difficulties are observed across all aspects of question structures. If children do provide syntactically correct answers to wh-questions, this finding can be taken to suggest that this is one aspect of grammatical knowledge which is intact when it comes to question structures.

Subject-aux inversion rule in questions

Previous research has suggested that children with SLI have particular difficulty with rules. This research has come primarily from research on the morphological past tense rule (van der Lely & Ullman, 2001). Children often omit the past tense marker and say '*Yesterday we play*

soccer' for '*Yesterday we played soccer.*' Or they may over-generalise the past tense and say '*He runned the race*' for '*He ran the race*'. Children with SLI are different to typically developing children in their use of past tense morphology in two respects. Firstly, children with SLI do not use past tense morphology more for regular verbs than for irregular verbs. Secondly, children with SLI do not over-regularise past tense forms as often as their typically developing peers (van der Lely & Ullman, 2001). Nevertheless, children with SLI are thought to have difficulties with the past-tense rule for an extended period of time.

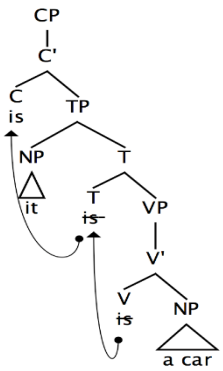
Much less is known about whether in addition to the past tense rule if children with SLI have difficulty with syntactic rules. As earlier discussed, there is some literature on the wh-movement rule and whether children form a dependency between the wh-phrase and the gap, however previous research has not focused on subject-aux inversion (SAI). It would be assumed that if children have difficulties with rules generally then a syntactic rule, such as (SAI) should also be problematic for this group of children. The syntactic rule of subject-aux inversion is also of interest because it is similar to the past tense rule in that, just as the past tense rule can be over-regularised and used for irregular verbs, so too can the subject-aux inversion rule be over-generalised. That is, while in a matrix question like '*What is Ryan drinking?'* the rule moves the auxiliary verb to the left of the subject noun phrase '*Ryan'*, this same rule can be over-generalised to embedded questions as in *'*Do you know what is Ryan drinking?'* If children overregularise the past tense rule less often, do they also over-generalise the SAI rule in embedded questions less often?

According to generative linguistic theory, English questions are derived from the canonical (base generated) word order of subject-verb-object (SVO) by movement operations. This investigation looks at three question structures that require movement: yes/no questions, wh-questions and embedded wh-questions.

Yes/no questions

Yes/no questions generally undergo subject-aux inversion, as seen in the question '*Is it a car?*' in Figure (1).[2] Here the main verb originates from a position within the verb phrase then moves from T to C. This movement is more commonly referred to as T to C movement because in the hierarchical structure, the copula is in T and moves to a higher position in the sentence representation, to C, leaving behind two copies of itself. The movement of the verb can be seen in the figure. The strike-through font indicates that the copies are not pronounced. If there is no auxiliary verb, modal or copula and just a lexical main verb in the sentence, then tense features (present or past) move, and a 'dummy' auxiliary verb DO gets inserted in T.

Figure 1



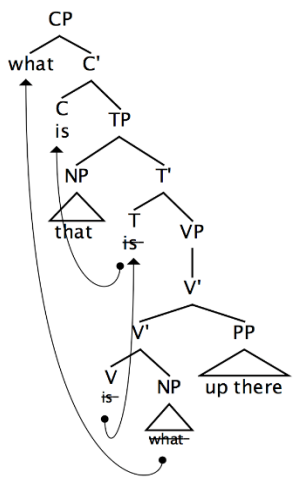
Wh-questions

Wh-questions also have T to C movement, but also movement of the question word. The first movement process that takes place in wh-questions is the wh-word movement, which moves the wh-word from the base position to the sentence initial position. The second type of movement is subject-auxiliary movement. Here the auxiliary verb, modal or copular verb is moved to a position preceding the subject. If there is a lexical verb (without an auxiliary, copula or modal) then tense features move. These features are then supported by a 'dummy' auxiliary verb DO (Chomsky, 1981, 1995; Haegerman, 1994).

[2] Yes/no questions do not undergo SAI in colloquial English. The declarative word order is kept by the speaker and rising intonation at the end of the sentence is used, such as '*You are leaving already?*'

The two movement operations can be seen in the question '*What is that up there?*' in figure (2). The first type of movement in this example involves the wh-word ('*what'*). The wh-word originates in its site of origin position and moves to the Spec of C position at the top of the hierarchical structure. The subject-aux inversion rule moves the copula '*is'* out of the verb phrase to T and then to the C position, as in the yes/no question.

Figure 2



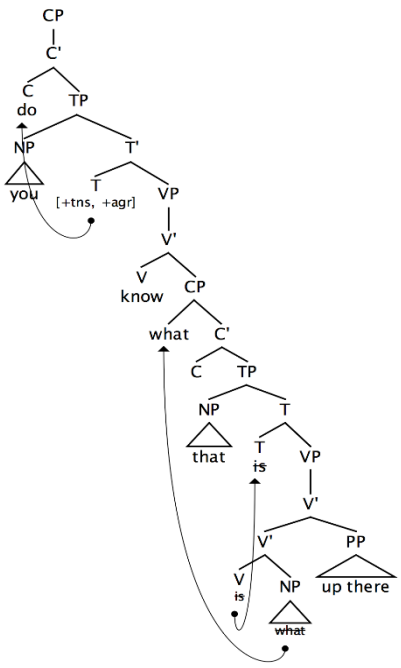
Embedded wh-questions

Embedded wh-questions add an additional complexity as they require the subject-aux inversion rule in the main clause, but not in the embedded clause, where it is prohibited. The prohibition against providing subject-aux inversion in the embedded clause does not fall out of a universal constraint, since it is grammatical in some dialects of English (Clarke, 2004; Fought, 2003; Green, 2002; Henry, 1995; McCloskey, 1992; Wolfram & Christian, 1976). This suggests children need to inhibit the rule in embedded clauses.

Embedded questions also undergo movement as can be seen in the question '*Do you know what that is up there?*' in figure (3). Subject-auxiliary inversion takes place in the main clause. The tense feature moves from T to C and gets supported by DO. The wh-word ('*what'*)

moves to the Spec of C position between clauses. Additionally, the main verb BE (‘*is’*) raises out of the verb phrase to T, but does not move to C.

Figure 3



If it is the case that children have difficulties with rules generally, then we should see that these children’s yes/no question and wh-question structures do not include the appropriate inversion. Additionally, children would not apply the SAI rule to the embedded clause structure, a structure which does not require inversion. It would also be hypothesized that once children get the SAI rule, they may over-generalise the rule in the embedded clause structure, learning when *not* to apply the rule would cause additional challenges. By exploring children with SLI’s questions involving subject-aux inversion, we can find out whether children with SLI difficulties with rules are confined to the rule of past tense or if these children have a more general difficulty with forming linguistic rules.

Constraint on contraction

Generative linguistic theory proposes that there are linguistic constraints that are a part of all human languages (Chomsky, 1965). Linguistic constraints are negative statements which

prohibit children from producing errors in form or errors in meaning. A constraint is different to a rule. Rules are positive statements specifying what forms and meanings are permitted. One constraint that has been the subject of much discussion in the literature is the 'structure-dependence` constraint (Chomsky, 1971). The structure dependence constraint prevents children from coming up with rules that are not based on hierarchical structure. This has been tested in child grammars and children are found not to produce errors that would violate this constraint (Crain & Nakayama, 1987). Since constraints are negative statements, and because negative evidence is not available in sufficient quantity, children cannot learn constraints from adult input (Bowerman, 1988). Thus, a constraint is believed to be inherent to children's grammar, as part of universal grammar (UG).

The constraint that is of interest to this investigation is the constraint of linguistic contraction. This constraint prohibits contraction of two words based on the linguistic environment in which the words are in. One well-known example is the contraction of '*want*' and '*to*' into '*wanna*'. Young children's adherence to '*wanna*' contraction has been used as a critical piece of evidence to show that young children have innate linguistic knowledge (Thornton, 1990). Contraction of the BE morpheme has also been investigated. In this thesis, our focus is on how this particular constraint on contraction applies to asking and answering questions containing the third person auxiliary or copula form of BE.

Contraction can be explained by a process where a full form such as '*is*' becomes reduced to a contracted form '*s*', and then gets cliticised to a host. This can be seen in the following example where '*is*' in the sentence '*She is a university student'* gets contracted to ''*s*' to become '*She's a university student*'. Contraction cannot take place in all linguistic contexts; there are restrictions in English about when words such as '*is*' can undergo contraction. These restrictions occur due to a syntactic constraint or when there is a strong

preference not to contract because of phonotactic or pragmatic reasons. Our main focus is on the syntactic constraint.

English orthography suggests that BE leans to the left. When we write '*John's coming*,' the '*'s'* appears to be contracted onto '*John'*. However, Bresnan (1978) proposed that, contrary to appearance, forms of BE contract to the right. This means that there should be some lexical material immediately to the right of BE to serve as a host. An example of an elliptical context can be seen in example (6). In this context, when we answer a wh-phrase with '*Yes he is [~~coming~~],*' the verb phrase is filled in from the previous discourse in our understanding, however it is silent. This silent verb phrase is not sufficient for the form of BE to lean on to (6b), as it needs an overt host. Therefore, only the full BE form, as shown in (6a), can be used. Notice that it is not the case that BE cannot be contracted because it comes at the end of the utterance. Consider example (7). In (7a and b) a question word has moved, but this does not interfere with the possibility of contraction because the question word moves from the position shown by the struck-out '*what'*. This position follows '*doing*', not BE. In (7c, d), however, the question word is moved from the position following BE. In this case, there is a gap (i.e., silent wh-word) immediately following BE, and therefore, contraction is not possible, as shown in (7d). Notice that the BE form that cannot be contracted is not sentence-final; there is a PP at the end.

(6) (a) Yes he is (~~coming~~)

(b) *Yes he's (~~coming~~)

(7) (a) Do you know what that is doing (what) up there?

(b) Do you know what that's doing (what) up there?

(c) Do you know what that is (what) up there?

(d) Do you know what that's (what) up there?

Children with SLI's adherence to this linguistic constraint can be used as evidence to support the claim that children with SLI have innate linguistic knowledge about this restriction. This finding would suggest that although children with SLI have difficulties with various aspects of language, this innate, universal syntactic constraint is intact in the grammar of children with SLI. This study also offers insight into the issue of whether children with SLI leave a gap in their question structures. If there is not a gap, then the constraint on contraction will not apply. Therefore, when children show that they have mastered the constraint, it is confirmation that they have generated a gap in that position.

Outline of Thesis

This thesis is structured as follows:

Chapter two of this thesis investigates aspects of morphology, syntax and pragmatics in children with SLI's answers to wh-questions. The aim of the study reported in Chapter two is to offer insight into the question of whether children with SLI have difficulties with the syntactic requirements of answering questions.

Chapter three of this thesis investigates the syntactic rule of subject-aux inversion (SAI) in main clause questions and embedded clause questions. The aim of this study reported in Chapter three is to explore whether children with SLI have difficulties with all linguistic rules or whether these difficulties are confined to the morphological past tense rule.

Chapter four of this thesis investigates adherence to the linguistic constraint on contraction across question structures. The aim of this study is to investigate whether the universal linguistic constraint on contraction is adhered to in children with SLI's question productions and answers to questions.

Chapter five brings together the experimental findings from the three studies discussed.

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Chapter 2

Probing morphological, syntactic and pragmatic knowledge through answers to wh-questions in children with SLI

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Abstract

Purpose: This study investigated aspects of morphology, syntax and pragmatics in children with Specific Language Impairment (SLI). These areas of language were investigated by evaluating children's answers to wh-questions.

Method: Elicited production methodology was used to evoke answers to three types of wh-questions. There were 54 participants: 18 children with SLI (mean age = 5;3); 18 language-matched children matched on mean length of utterance (mean age = 3;4) and 18 age-matched children (mean age = 5;3).

Result: The SLI group demonstrated comprehension of the wh-questions, as revealed by their answers using the appropriate syntactic category. Children with SLI also demonstrated knowledge of pragmatics by using a pronoun to refer to a discourse referent that was previously introduced as a full noun phrase. Unlike the control children, children with SLI did not show sensitivity to one measure of the Maxim of Quantity; they gave more full sentence answers to wh-questions in contexts when most speakers would give a shorter, fragment answer. The tense-related morphology was also frequently omitted from children's answers.

Conclusion: The experiment revealed that children with SLI did well on syntactic and pragmatic measures. The greatest challenge was in providing tense-related morphemes in their answers to questions.

Probing morphological, syntactic and pragmatic knowledge through answers to wh-questions in children with SLI

Introduction

Children with specific language impairment (SLI) are generally reported to develop language in a similar manner to their peers with typically developing language, but with a pace of development that is considerably slower (Rice, 2012, 2013; Rice, Wexler, & Hershberger, 1998). SLI is reported to affect aspects of children's grammar such as vocabulary knowledge, phonology, morphology, syntax and pragmatics (see Bishop, 2006; Clahsen, 1989; Conti-Ramsden & Durkin, 2007; Edwards & Lahey, 1996; Rice & Wexler, 1996; van der Lely, 1997). There is now general consensus that grammatical morphemes are particularly problematic for children with SLI (Cleave & Rice, 1997; Grela & Leonard, 2000; Ullman & Gopnik, 1999). According to Rice and colleagues, in children who are acquiring English, morphemes that express finiteness are most affected (Hadley & Rice, 1996; Rice & Wexler, 1996; Rice, Wexler, & Cleave, 1995). Rice and Wexler note that children whose language is developing typically also tend to omit tense-related morphemes in obligatory contexts, and propose that this stage of language development is extended in children with SLI (Rice & Wexler, 1996).

There has been little research studying the various components of language in a single group of children (but see COST Action A33, (2006–2010)), however. In this paper, we follow this line of investigation and study certain morphological, syntactic and pragmatic properties of language in a group of children with SLI, as realised in their answers to questions. Question structures have received considerable attention in the SLI literature cross-linguistically (Prevost, 2012; Schulz, 2013; Varnava & Grohmann, 2014). This literature reports that children find questions in which the question word is moved from object position of the sentence particularly difficult (Ebbels & van der Lely, 2001; van der Lely & Battell, 2003). However,

children's answers to questions have not yet been investigated. As we will illustrate, studying children's answers to questions is a productive research direction, as answers to questions bring together a great deal of complex yet subtle knowledge of language.

Our research is concerned with how different areas of linguistic knowledge contribute to children's knowledge and use of a particular structure. For this reason, we try to partial out the linguistic knowledge (morphology, syntax and pragmatics) that contributes to children's answers to wh-questions. In practice, of course, it is difficult to completely isolate a particular area of the grammar for testing, as it may have repercussions elsewhere in the grammar. However, to the extent that it is possible, we will separate these aspects of linguistic knowledge. Next, we introduce the background and details of morphology, syntax and pragmatics that are relevant for our study.

Background

Syntax

It has been argued by van der Lely that children with SLI have a deficit in the syntactic representation of wh-question structures (van der Lely 1998; van der Lely & Pinker 2014). This is because they involve dependencies, relationships between elements in the sentence; there is a dependency between the wh-question word and its copy and there is also a dependency between the moved auxiliary verb and its copy. Research studies have found that the dependency between a wh-phrase and its copy in object position are particularly difficult (van der Lely, 1998, 2005; van der Lely & Pinker, 2014; van der Lely, Jones & Marshall, 2011). Our focus is the relationship between the wh-word and its copy. This is shown in (1). Here, the wh-word *what* originates in object position, as shown by the copy in strikethrough font (cf. Chomsky, 1977, 1995).

(1) What is the boy eating?

What is the boy eating ~~what~~

It is possible that children's reported difficulties in comprehending questions, especially ones in which the wh-word is moved from object position, are, in part, due to methodological considerations. Comprehension studies have generally used picture-pointing tasks (Deevy & Leonard, 2004; Ebbels & van der Lely, 2001; Novogrodsky & Friedmann, 2006). Children see an array of two or four pictures, and their task is to answer an experimenter's wh-question by pointing to the correct picture. This requires children to hold the test sentence in memory while they examine the array and make a choice, which is subsequently implemented by pointing. In the present study, children simply answer the wh-question. Comprehension of the wh-question is tested by investigating the syntactic category of the answer to see whether or not children with SLI use a legitimate sentence or sentence fragment (noun phrase, verb phrase, etc.).

In order to provide an appropriate answer to a wh-question, a speaker must first compute a representation for the question that was posed by their interlocutor. This requires the speaker to build a mental representation for the question that associates the question word and its copy. The structural representation of the question then forms the basis for the structure of the answer (cf. Merchant, 2004). The form of possible answers is tightly constrained by the original question. This is shown in (2) (The asterisk is used to indicate ungrammaticality).

(2) Question: What's the boy eating?

(a) The boy's eating an apple

(b) *Eating an apple

(c) *Eat an apple

(d) An apple

The full sentence answer in (2a) is grammatical. This repeats some information from the initial question but also provides the noun phrase that answers the '*what*' question. Certain shorter fragment answers are also permitted. As (2b) shows, it is not possible to provide a

fragment answer that begins with the progressive participle from the question. Neither is it possible to answer with a bare verb, as in (2c), but just a noun phrase, as in (2d), is permissible, if not the most natural answer in a conversational context. Next, notice that the range of possible answers changes if the question incorporates the lexical verb DO. The verb DO carries less semantic context than other lexical verbs and requires a more contentful verb in the answer, while maintaining the progressive aspect (i.e. *-ing*). Consider the question in (3), which is one of the question types examined in our experiment.

(3) Question: What's the boy doing?

(a) The boy's eating an apple

(b) Eating an apple

(c) *Eat an apple

(d) *An apple

The question in (3) has exactly the same syntactic structure as (2), yet the range of possible answers differs, due to the nature of the lexical verb DO. As before, the full sentence (3a) is grammatical. (3b) illustrates that a fragment with a content verb in the progressive aspect is now possible (3c) shows that a verb phrase with a bare verb is still ungrammatical. An answer with a simple noun phrase, as in (3d), however, is ruled out, even though this was fine in (2). The examples in (2) and (3) illustrate that the potential form of an answer to a question is highly dependent on the original question. An answer must be of a syntactic category that reflects the syntax and lexical semantics of the question that was posed by the interlocutor. Our study probes children's answers to both wh-questions with object extraction such as (3) as well as ones with subject extraction. The key point is that production of grammatical answers is parasitic on comprehension of the original interlocutor's question and computation of its syntactic structure.

Morphosyntax

The difficulty with morphemes that express finiteness encountered by children with SLI (Rice & Wexler, 1996; Rice et al., 1995, 1998) should also emerge in children's answers to questions. Children with SLI tend to omit the past tense *-ed*, the third person singular *–s*, the main verb and auxiliary forms of the verbs BE and HAVE, and the auxiliary verb DO. Our study of children's answers to questions focuses on the verb BE as a measure of provision of a tense-related morpheme. Previous research by Rice et al. (1995) found that five-year-old children with SLI omitted BE in 50% of obligatory contexts, as compared with only 1–2% in the age-matched group and 30% in the three-year-old language-matched group. Other grammatical morphemes such as the plural '*s'* and progressive aspect *-ing* marker are not be as problematic because they do not implicate tense (cf. Oetting & Rice, 1993; Rice & Oetting, 1993). Our morphological probe will compare provision of BE with use of the progressive aspect *–ing* marker, which is hypothesised to be omitted less frequently than BE.

Our study will also investigate how provision or omission of the verb BE (i.e. tense) is related to the choice of pronoun in the subject position of the sentence. According to Schütze and Wexler (1996) information about agreement is optionally omitted in children's sentence representations as well as information about tense. This information is encoded as abstract tense or agreement features in the sentence representation. Agreement information (1st person, 2nd person, etc.) must be present in the sentence for a pronoun to be used with nominative case (such as *I*, *he*, *she*, etc.) in subject position. If the agreement information is missing, then the default version of the pronoun surfaces instead; this is the accusative form in English (i.e. *him*, *her*, etc). Since a form like '*is'* is a unique form of BE for 3rd person in the present tense, a production using this form incorporates both tense and agreement features. Our focus is on whether '*is'* is present or omitted.

Since the form '*is'* incorporates both tense and agreement features, the prediction is that if children use this form of BE, they will always use the correct nominative form of the pronoun

in subject position, '*he'* or '*she*' (assuming these lexical items are part of their vocabulary) (Schütze & Wexler, 1996) as shown in (4a). If, on the other hand, children leave out '*is'*, then it can be assumed that their syntactic representation is missing either the feature for tense or agreement. The pronoun in (4b) is nominative so we can assume the tense feature is missing; in (4c), the pronoun is accusative, so we can assume the agreement feature is missing from the sentence representation. Examples like (4d) are predicted not to occur, because a nominative pronoun is predicted if '*is'* is present.

(4) Question: What's the girl doing?

(a) Her singing a song (just tense feature present)

(b) She is singing a song (both tense and agreement features present)

(c) She singing a song (just agreement feature present)

(d) *Her is singing a song

Pragmatics

Pragmatics refers to the ability to use language for social purposes and encompasses a broad spectrum of properties. Children with SLI have been reported to face challenges in turn-taking and in conversational responsiveness (Craig & Evans, 1989; Hadley & Rice, 1996; Rice, Sell, & Hadley, 1991) but less is known about whether children have difficulty adjusting their language to the discourse context. The present study investigates two areas of pragmatics: one aspect of the Gricean Maxim of Quantity and a related aspect of information structure. The Maxim of Quantity states that a speaker's contribution to the conversation should be as informative as required, but no more informative (Grice, 1975). Children's mastery of the Gricean Maxims of Quality, Quantity, Relation and Politeness was studied by Surian (1996) in a group of children with autism spectrum disorder as well as in children with SLI. The six-year-old children with typically developing language did not show a group difference from

children with SLI (mean age 11;1) but both performed at chance when evaluating violations of Maxims of Quantity.

The current study also investigates the Maxim of Quantity, but our experiment does not flout the maxim to the same extent as the Surian study. Our study focuses on the 'quantity' or size of children's responses to wh-questions. Our interest is in whether children answer wh-questions with full sentence answers, or whether they provide just the fragment giving the requested information. That is, in (5), do they give full sentence answers like (5a) or (5b), or the fragment answer in (5c)?

(5) Question: What's the boy doing?

(a) The boy's eating an apple

(b) He's eating an apple

(c) Eating an apple

A further question related to the Maxim of Quantity is whether or not children repeat 'given' information that has already been introduced in the discourse context. Once an entity has been introduced using a noun phrase (NP), it can generally be referred to thereafter with a pronoun. Although all of the answers in (5) are grammatical, since '*the boy'* has already been established in the conversational context, it is 'given' information and, therefore, the use of a pronoun is more natural, as illustrated in (5b). (5c) also assumes that the topic of conversation is '*the boy'* and this answer is perhaps the most natural one, providing only the new information requested by the question. Our study will investigate whether children with SLI are sensitive to these aspects of pragmatics.

Research questions

The research questions were designed to investigate whether the difficulty with the grammar that children with SLI experience extends across a range of areas, that is, morphological, syntactic and pragmatic knowledge. In particular, we were interested in which aspects of

answers to wh-questions would be accomplished without difficulty, and which aspects differentiated the children with SLI from the control groups. The research questions follow:

Research question 1: What is the range of answers children give to wh-questions?

Research question 2: Do children with SLI answer wh-questions using an appropriate syntactic category?

Research question 3: What is the status of children's use of finiteness morphology as compared with the use of aspect morphology (i.e. use of -ing)? Is finiteness connected with choice of pronoun in subject position?

Research question 4: Do children with SLI adhere to pragmatic norms in their answers to questions? Do they provide answers that are grammatical but over-informative? Are their answers sensitive to whether a noun phrase has already been introduced into the discourse?

Method

Participants

A total of 54 children participated in the experiment[3]. The participants were 18 children with SLI with a mean age of 5;3 (range 5;2–5;11), 18 language equivalent (LE) children with a mean age of 3;4 (range 3;2–3;11) and 18 age equivalent (AE) children with a mean age of 5;3 (range 5;0–5;10). All the children included in the study were drawn from English-speaking homes. The SLI participant group was made up of 12 boys and 6 girls, the LE group 7 boys and 11 girls and the AE group 8 boys and 10 girls. Table I displays the descriptive information for participants.

Children with SLI were recruited from early intervention centres for students with language impairment in Perth, Western Australia. The language development schools provide specialised language and academic intervention for children with SLI. For inclusion into the

[3] The study was approved by the Human Ethics Committee at Macquarie University as well as by the Department of Education of Western Australia.

school programme, the children had to have a diagnosis of language impairment by a speech-language pathologist and a recommendation for enrolment in the school programme. Prior to enrolment, children's language skills were assessed using the Clinical Evaluation of Language Function (CELF-4) (Semel, Wiig, & Secord, 2003). In addition, referral information also included evidence that children's non-verbal cognitive skills were within the normal range, as attested by a psychologist or paediatrician, using the Leiter international performance scale (Roid, Miller, Pomplun, & Koch, 2013) as well one of the following assessments: Griffiths mental development scales (Griffiths, 1970) or Bayley scales of infant development (Bayley, 2003). Children in the LE and AE groups were recruited through the university's paid participation pool as well from pre-school centres on the university campus. Children in the LE and AE groups were recruited through a paid participation pool of children as well as from pre-school centres on the university's campus.

In order to be included in the study, children in the SLI group scored 84 standard score or below on the Clinical Evaluation of Language Fundamentals-Pre-school-2 (CELF-P2) language screener assessment (Semel, Wiig, & Secord, 2006) and scored 85 standard score or above on the Kaufman Brief Intelligence Test (KBIT-2) IQ assessment (Kaufman & Kaufman, 2004). To be included in the control groups, children scored 85 standard score or above on the CELF-P2 language assessment and scored 85 standard score or above on the KBIT-2 IQ assessment. To ensure the control groups were matched evenly, the children in the AE group were within six weeks of age to at least one child in the SLI group. The children in the LE group had mean length of utterance (MLU) values that were within ± =1 *SD* of the mean expected for age based on Rice et al. (2010) norms. In order to ensure equivalent groups based on language abilities, each subject in the MLU group (LE) was within 0.04 morphemes of at least one child in the SLI group.

Table I. Mean and *SD* of group data by group.

Group	N	Age (years; months)	SD %	MLU in morphemes	SD %	CELF-P2	SD %	KBIT	SD %
SLI	18	5;38	0.3	3.43	0.5	76.39	7.9	99.33	13.1
LE	18	3;45	0.3	3.72	0.4	118.11	9.4	N/A	N/A
AE	18	5;33	0.3	4.76	0.6	111.94	11.8	103.33	10.9

Note: KBIT-2=Kaufman Brief Intelligence Test, Second Edition; CELF-P2=Clinical Evaluation of Language Fundamentals-Preschool-2; MLU=mean length of utterance; SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

The spontaneous language sample required for calculation of the MLU sample was collected by a speech-language pathologist in a naturalistic play environment. The sample was gathered using the same set of toys as stimuli for all three groups of children. The toys included a variety of animals, people, popular television characters, food items, as well as a van for the animals and people to drive in. All items were chosen to encourage interest and engagement in play and conversation. Each elicitation session lasted approximately 25 minutes, with 200 complete and intelligible utterances collected for each child. All language samples were coded and entered into SALT software for analysis (Miller, Gillon, & Westerveld, 2012).

Experimental stimuli

The child's task was to verbally produce an answer to each of the questions posed during the course of a game. Three types of wh-questions formed the stimuli:

Question Type 1: What's [the boy/girl doing]? (VP-question with BE)

Question Type 2a: Who's [wearing a beanie]? (NP-question with BE)

Question Type 2b: Who can [jump on the boxes]? (NP-question with modal)

A total of 29 wh-questions were posed to each child during the game. These questions included 10 Type 1 VP-questions; 15 Type 2a NP-questions; and 4 Type 2b NP-questions. A list of the questions used has been provided in Appendix A. The reason that there were a different number of questions for each of the three different question types was based on the original study design. As the studied evolved we discovered new and interesting findings which slightly changed the direction of our research study.

The stimuli were presented to all of the children in the same order. The verbs which were chosen as part of the experiment were familiar, high-frequency verbs, mostly based on the MacArthur-Bates Communicative Development Inventory (CDI). Of the 24 verbs chosen, 12 were regular verbs and 12 were irregular verbs (although this was not important for the study). The verbs which were used were *take, eat, sing, hold, buy, fish, cuddle, wear, play, dance, paint, make, shoot, help, read, sing, bake, hug, kick, watch, jump, run, walk and drive*. There were no patterns of difference observed in the data in children's productions that could be attributed to particular verbs.

Procedure

Children's answers to questions were elicited in appropriate discourse contexts (see Crain & Thornton, 1998). By eliciting answers during the course of a structured activity, a robust sample of data was gathered from every child. Children were presented with a variety of scenarios on an iPad, in which an animated character posed one of the wh-questions. A lapel microphone was attached to the child to record the child's productions which were captured on an Olympus voice recorder for later transcription.

The child was introduced to an animated character named Zac who explained that he had broken his glasses and needed the help of the child to tell him what his friends were doing throughout the story. For each scene, one of Zac's two friends was engaged in some activity while the other character was present but not participating. The two characters took turns at being engaged in the activity in different scenes. The characters were clearly identifiable, one being a green female animated character and the other a grey male character. Before starting the activity, to ensure the child was familiar with the experimental task four questions with *Can* were presented i.e. '*Who can run the fastest?*'. Once the child understood the task and was familiar with answering the questions, the game started.

The activity took approximately 15 minutes to complete. No feedback was provided during the activity. If the child did not answer the question, pointed or did not attend to the question, the experimenter provided the question again, either verbally or by replaying the iPad scenario. The experimental task, spontaneous language sample and standardised assessment tasks were administered in two to three sessions, each session lasting approximately 25 minutes.

Reliability

To ensure reliability, all experimental utterances were transcribed by the same speech-language pathologist who administered the activity to the child. The transcriptions were then double scored by a second speech-language pathologist. Reliability was calculated across morphemes. The agreement was 99%, with a range of agreement between the transcribers of 93–100%. Any differences were resolved by further discussion.

Results

Children's answers to questions

For both the NP- and VP-questions, all three groups of children produced a variety of answers. The form of children's answers to each type of wh-question is provided in Tables II, III, IV and V. Table II displays the total raw number of answers for each of the three questions. Across the three questions, each of the three groups of children had a total of 522 opportunities to produce an answer to the wh-question presented in the experiment.

Table II. Total number of answers for each question type by group.

Question type	Opportunities	SLI	LE	AE
Who's VP?	270	268	266	268
Who can?	72	71	67	72
What's NP doing?	180	171	179	179
Total	522	510	512	519

Note: VP=Verb phrase; NP=Noun phrase; SLI=Specific Language Impairment; LE=language equivalent; AE= age equivalent.

Children's answers for the Type 2a '*Who's VP*?' questions are summarised in Table III for the three groups. The mean percentage and standard deviation for each type of answer

is given for each of the participant groups. 'Full Sentence' answers were ones with a subject noun phrase (full NP or pronoun) and a verb phrase, as well as sentences with an omitted auxiliary verb. The table reveals that children with SLI produced more full sentence answers compared to their peers. The children with SLI primarily gave full noun phrase responses to '*Who's VP?'* questions rather than pronoun answers, as do the AE children; these formed over 66% of both groups' answers. Responses with ellipsis of the verb phrase (VP ellipsis) like '*The boy is'* were used less often by the children with SLI than the control groups, especially when compared with the younger LE children who used VP ellipsis close to 50% of the time. 'Cleft elided responses' were ones like '*It's him'* where an answer like '*It's him who's dancing*' is intended.

Table III. Mean percentage and *SD* of answers by group for *'Who's VP?'* questions.

Who's VP?	**SLI %**	**SD %**	**LE %**	**SD %**	**AE %**	**SD %**
Full Sentence	7.4	13.3	0.4	1.6	1.1	2.6
Noun Phrase	65.5	36.8	32.2	39.8	67.4	40.6
Nominative Pronoun	7.8	22.3	4.1	6.5	5.2	15.1
Accusative Pronoun	1.9	5.0	14.3	23.9	6.3	22.2
VP Ellipsis	11.9	27.9	47.7	43.9	19.7	37.2
Cleft Elided	2.6	11.0	0.0	N/A	0.0	N/A
*Verb Phrase	0.4	1.6	0.0	N/A	0.4	1.57
Other	2.6	11.0	0.7	2.2	0.0	N/A

Note: * indicates ungrammatical
VP=Verb phrase; SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

Table IV displays the answers for the Type 2b '*Who can'* questions. The data show similar distributions to the '*Who's VP?'* questions. Again, the children with SLI produced more full sentence responses than their peers.

Table IV. Mean percentage and SD of answers by group for '*Who can'* questions.

Who can?	**SLI %**	**SD %**	**LE %**	**SD %**	**AE %**	**SD %**
Full Sentence	13.0	23.4	1.4	5.9	0.0	N/A
Noun Phrase	65.3	40.3	30.6	43.3	68.1	42.7
Nominative Pronoun	5.6	17.2	4.6	13.8	1.4	5.9
Accusative Pronoun	1.9	7.9	12.0	29.0	5.6	23.6
VP Ellipsis	11.6	29.0	51.4	48.1	25.0	39.3
Cleft Elided	2.8	11.8	0.0	N/A	0.0	N/A
*Verb Phrase	0.0	N/A	0.0	N/A	0.0	N/A

Other	0.0	N/A	0.0	N/A	0.0	N/A

Note: * Indicates ungrammatical
VP=Verb phrase; SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

Table V displays the answers for the Type 1 VP-questions of the form '*What's NP doing*?' All three groups of children produced more full sentences for VP-questions than for NP-questions. The children with SLI produced more full sentence answers than the children in the control groups. Verb phrase answers refer to ones such as '*Driving'* or '*Driving a car'*. There were less than 1% ungrammatical noun phrase responses by the SLI group, as indicated in the table, and none at all produced by the control groups of children.

Table V. Mean percentage and SD of answers by group for '*What's NP doing?'* questions.

What's NP doing?	**SLI %**	**SD %**	**LE %**	**SD %**	**AE %**	**SD %**
Full Sentence	43.4	35.9	29.4	33.9	17.2	20.2
Verb Phrase	49.3	34.5	68.3	34.7	81.1	21.1
*Noun Phrase	0.6	2.4	0.0	N/A	0.0	N/A
Other	6.7	9.7	2.2	5.5	1.7	3.8

Note: * Indicates ungrammatical;
SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

Syntactic category

The next question investigated whether children answered wh-questions with a legitimate syntactic category. Responses were classified as an error if the child's answer was an illicit fragment.

For the Type 2 wh-questions ('*Who's VP?'* and '*Who can VP?'*), an answer that is of the category NP (e.g. '*The boy'*) is grammatical, whereas an answer that is a VP (e.g. '*Driving a car'* is ungrammatical. The SLI group produced 339 answers to the Type 2 questions and of these, 338 were grammatical NP answers. One child with SLI produced an ungrammatical VP answer '*Playing drum*s' on one occasion. Of the 333 answers produced by the LE group, all 333 were grammatical NP answers. Of the 339 answers produced by the AE group, 338 were correct NP answers with one ungrammatical VP answer, '*Wearing a beanie'*. These data can be seen in Table III under the 'verb phrase' category. A Kruskal–Wallis (non-parametic) test was used to compare the group difference across the three groups of children for grammatical

and ungrammatical answers for the Type 2 questions. The results showed no group difference, $X^2(2)= 2.00$, $p< 0.368$.

For Type 1 wh-questions that target the VP *('What's NP doing?')*, full sentences and VP answers with a verb in progressive aspect are grammatical (e.g. '*Driving a car'*). It is not grammatical to answer with a bare VP (e.g. '*Drive the car'*) or an NP. The main finding was that all three groups of children were very accurate in answering questions. Of the 171 answers produced by the children with SLI, there was just one ungrammatical NP answer. The LE and AE groups both produced 179 answers to VP questions with no errors of syntactic category. A Kruskal–Wallis (non-parametric) test was used to compare the group difference across the three groups of children for the '*What's NP doing?'* question. The test showed no group difference across all three groups of children, $X^2(2)=1.02$, $p< 0.601$.

Finiteness morphology

Our study examined finiteness by comparing children's provision of BE morphemes with their use of the aspectual -*ing* grammatical morpheme in children's full sentence answers. Table VI shows the mean percentages for provision of each morpheme. Children with SLI did not provide the BE morpheme for either question type as frequently as the control groups, whereas the -*ing* morpheme was almost never omitted by any of the children. A Kruskal–Wallis (non-parametric) test was used to assess the rates of provision of BE across all full sentence answers across all three groups of children. This test showed a main effect of group $X^2(2)=9.98$, $p< 0.05$. A Mann–Whitney test was used as a way to compare differences between the three group means. There was a significant difference between the SLI group and the AE children, $Z=3.14$, $p< 0.005$. This test showed there was not a significant difference between the SLI group and the LE group, $Z=1.51$, $p=0.13$. We also compared BE provision with -*ing* omissions. Further statistical analyses showed that children with SLI produced significantly more BE omissions than -*ing* aspect marker omissions. A Wilcoxon signed rank (non-

parametric) test was used to compare the BE omissions and *–ing* aspect marker omissions within the SLI group. The Wilcoxon signed rank (non-parametric) test showed a significant difference between the two variables, Z=2.27, p< 0.005.

Table VI. Mean percentage and *SD* of provision of BE and *-ing* aspect marker in full sentences by group.

Provision	**SLI %**	**SD %**	**LE %**	**SD %**	**AE %**	**SD %**
Provision of BE morpheme	70.2	33.3	81.4	38.0	100.0	N/A
Provision of *–ing* aspect marker	97.4	7.0	100.0	N/A	100.0	N/A

Note: SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

We also tested Schütze and Wexler's (1996) predictions about children's use of pronouns in subject position. Recall the prediction is that when the verb BE is missing, the pronoun in subject position may be either nominative or accusative, but that when BE is present in the sentence, children will always use a nominative pronoun. Our findings provide strong support for Schütze and Wexler's prediction. When the BE form was present, a nominative pronoun (i.e. '*he is…'* or '*she is…'*) was used without exception. When the BE form was missing, our findings showed that across both question types there were 16 incidences of nominative pronouns with the BE morpheme omission. This made up 56% of the subject types. The remaining forms were accusative pronouns with omission of the BE morpheme.

Pragmatic knowledge

Our first analysis investigated the Maxim of Quantity by examining whether children provided full sentence answers to questions, or whether they were more likely to provide just the information requested by answering with a sentence fragment. The first analysis compared fragment answers with full answers across all three groups of children for the three question types. For Type 2 wh-questions targeting NP answers ('*Who's VP?'* and *'Who can VP?'*), a fragment answer included any kind of NP (full noun phrase or pronominal answer, irrespective of nominative or accusative Case) or an answer with VP ellipsis, such as '*He is'* (again, ignoring Case). Full sentence answers were ones like '*He is eating ice cream'*. For Type 1 wh-

questions targeting the VP, fragment answers included verb phrase answers, such as '*Walking'*. Full sentence answers were classified as such if they had an NP subject with an articulated VP, whether or not the auxiliary verb was provided.

The table reveals that all groups of children produced the most full sentence answers to the Type 1 VP questions '*What's NP doing*?'. The children with SLI produced more full sentence answer responses than the children in the control groups. A Kruskal–Wallis (non-parametric) test was used to assess the differences across the three groups of children. This test showed that there is a main effect of group $X^2(2)= 6.47$, $p < 0.05$. A Mann–Whitney test was used to compare differences between the three groups against each other. This test showed a significant difference between the SLI group and the AE children, Z=2.62, p=0.009. There was no significant difference between the SLI and the LE control children, Z =1.29, p=0.203. When comparing the fragment answers to the full sentence answers in the 'Type 2 Who' question types, a Kruskal–Wallis (non-parametric) test showed that there is a main effect of group $X^2(2)=6.11$, $p< 0.05$. A Mann–Whitney test showed there is no significant difference between the SLI group and the AE control children, Z=1.86, p=0.062. There was a significant difference between the SLI group and the LE children, Z=2.12, $p < 0.05$.

Table VII. Mean percentage and *SD* of full sentence answer and fragment answers by group.

Question Type	**Full answer/ Fragment answer**	**SLI %**	**SD %**	**LE %**	**SD %**	**AE %**	**SD %**
What's NP doing?	Full answer	48.2	36.4	31.1	35.0	17.8	21.6
	Fragment answer	49.8	34.5	68.8	35.0	78.2	28.9
Who's VP & Who can	Full answer	10.3	17.8	0.6	1.8	0.9	2.0
	Fragment answer	89.7	17.8	99.4	1.8	99.1	2.0

Note: NP=Noun phrase; VP=Verb phrase; SLI=Specific Language Impairment; LE=language equivalent; AE= age equivalent.

A second investigation evaluated children's knowledge that given information that has already been introduced in the conversational exchange does not need to be repeated in full. This was examined by investigating whether children answered Type 1 questions like '*What's*

the boy/the girl doing?' with a full NP or with a pronoun. Our analysis was restricted to the '*What's NP doing?'* questions because these introduce a full NP in the question. Table VIII shows the percentage of pronoun and NP answers. The children with SLI produced a pronoun in their answer 78% of the time as compared with their LE peers who produced pronoun in their answers 89%, and AE children who provided a pronoun in their answers 80% of the time.

Table VIII. Mean percentage and *SD* of full NP and pronoun answers by group.

Full NP vs Pronoun answers	**SLI %**	**SD %**	**LE %**	**SD %**	**AE %**	**SD %**
Noun phrase	22.5	33.5	11.5	28.8	20.0	40.0
Pronoun	77.5	33.5	88.5	28.8	80.0	40.0

Note: NP=Noun phrase; SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

Discussion

This study investigated three aspects of grammar involved in answering wh-questions in order to determine whether specific components were more challenging than others for children with SLI. The results from the current investigation replicated previous experimental findings reporting that children with SLI face particular challenges with morphosyntax. Our study of children's use of the verb BE confirmed that the children with SLI find production of morphemes associated with finiteness challenging as compared with morphemes that do not express tense. Children with SLI frequently omitted BE, but almost never the aspectual marker -*ing*. Thus, our experimental findings are consistent with previous research by Rice et al. (1998) that have observed this contrast.

Our investigation also examined Schütze and Wexler's (1996) proposal that the form of the pronoun in subject position relies on the information about tense and agreement that is represented in the sentence. Our findings supported Schütze and Wexler's predictions. We found that on those occasions when children with SLI used the default form of the pronoun (i.e. accusative) instead of the correct nominative form, the BE morpheme was always omitted in their production. However, it was not the case that BE omission always evoked an accusative

pronominal form. Productions with a nominative pronoun and omission of BE (‘*He wearing a beanie’*) recorded in our data are also consistent with the theory. This is because children could be inserting an agreement feature in their syntactic representation but not a tense feature, and both features are necessary for ‘*is’* to be used.

In contrast to children’s difficulty with morphosyntax, children did not have any difficulty representing the syntactic structure of questions and their answers. The study found that children did not produce fragment answers that were not of a syntactic category permitted for the relevant wh-question. As noted, although our study elicited answers to questions, the range of possible answer forms depends on the question form itself. Therefore, consistent, successful production of answers that fall within the range of legitimate answers suggests that children had no difficulty comprehending and computing the syntactic structure of the original wh-question. We have no evidence from these data to support the proposal in van der Lely and Battell (2003) that the impairment for wh-questions is within the computational system itself, affecting the syntactic dependencies between the wh-word and its copy at the clause level, as the authors have proposed.

Turning to pragmatic knowledge, our focus was pragmatic knowledge related to the Gricean Maxim of Quantity. The first aspect investigated the ‘quantity’ (or size) of children’s answers to wh-questions, to see whether they produced full sentence answers, which were grammatical but provided redundant information, or, alternatively, whether they provided a fragment answer that provided only the requested information. The finding was that children with SLI produced more full answer responses than the control groups of children for both question types. One potential interpretation of the fact that children with SLI give more full sentence answers might be that teachers instruct the children with SLI to always answer their questions using a ‘whole sentence’. Recall the experimental findings that the ‘*Who’s VP?*’ questions for the AE children were significantly different to the SLI group, but for the ‘*What’s*

NP doing?' questions, the LE children were similar to the SLI group. These parallels with both control groups suggest that the school environment is likely not to be responsible for the high proportion of full sentence productions seen in the SLI data. If schooling were the key factor, we would expect the AE school-age children to be similar to the children with SLI, but not the three-year-old LE children. We might also ask why children with SLI have the ability to attend to instruction to provide a full sentence answer, but are unable to comply with instruction to provide tense-related morphology. While the school environment cannot be excluded, in our view, there are other factors that may also be implicated in the greater proportion of full sentence answers in the SLI group data.

Another possibility is that children are not sensitive to the Maxim of Quantity. This seems unlikely, however, because the 'size' of children's answers can be argued to stem from children's knowledge of language-specific properties of answers in English that must be learned. From the perspective of linguistic theory, full sentence answers are, in some sense, easier than fragment answers. This proposal is admittedly counterintuitive, as the commonsense expectation is that shorter utterances will be favoured over long ones in children with language difficulties. The commonsense expectation is no doubt true for some sentence structures, but question/answer pairs have a privileged status in syntactic theory. As we have already noted, the possible forms of an answer depend on the form of the question itself. According to the theoretical proposal by Merchant (2004), fragment answers to questions are more complex to derive than full sentence answers to questions (see also Merchant, Frazier, Clifton, & Weskott, 2013). To appreciate this, consider the wh-question '*What's the boy doing*?' that featured in our study. To answer this question, the hearer must represent the interlocutor's question, and use this as the basis for their answer, filling in the missing information, as illustrated in (6).

(6) Question: What's the boy doing?

Answer: The boy's driving a car

In order to give the fragment answer, '*Driving a car'*, two extra operations are required. First, the fragment that becomes the answer is focussed in the structure, and the remaining part of the sentence is deleted so that it is not pronounced. A full sentence answer is more economical because it does not require these extra focus and deletion operations. If we follow this line of reasoning, then the greater number of full sentence answers that are observed in the SLI group may be because they prefer the more economical answer, either due to more limited processing resources, or because they have not yet learned that elliptical fragment VP answers are permitted in English.

Fragment answers to questions with VP ellipsis (e.g. '*He is'*) are derived in the same way in linguistic theory. The experimental data from our study show that once more, children with SLI are using a smaller proportion of answers with VP ellipsis than the children in the control groups. As shown in Table III, for example, the children with SLI give only 12% VP ellipsis answers, while the LE children use 47% VP ellipsis and the AE children 20%. This finding supports the proposal that shorter fragment answers to wh-questions may be more challenging for children with SLI.

We have suggested two possibilities; either that children have not yet learned that VP ellipsis is permitted in English or that children with SLI have difficulty with ellipsis due to processing limitations[4]. The use or avoidance of ellipsis is a productive line for future research as there are few, if any, reports on this area in the literature for children with SLI. The explanation that children have not yet learned that English permits VP ellipsis is appealing, but, on this account, the high proportion of VP ellipsis answers in the LE group is not necessarily expected. In the future, it may be useful to test an older seven- to ten-year-old group

[4] It has been suggested by a reviewer that when children fail to carry out ellipsis, that this also supports the case that children with SLI have difficulty supporting long-distance dependency at the discourse level, a proposal made by van der Lely and colleagues (van der Lely & Batell, 2003; van der Lely, Jones & Marshall, 2011).

of children and also adults in order to fill out the developmental details. Turning to the alternative explanation, if processing capacity is responsible for the higher proportion of full sentence answers in children with SLI, then the proportion of full sentence answers should, in principle, increase if the processing load is further increased. One way to test this would be to have children answer 'long' wh-questions (Deevy & Leonard, 2004). For example, instead of answering the question '*What's the boy doing?'* children could answer questions such as '*What's the big tall boy doing?'* in which the noun is modified by a number of adjectives. Another avenue for research would be to study other kinds of elliptical structures such as verb phrase ellipsis and sluicing (ellipsis of a sentence-level category), or to study other types of questions such as questions with different types of wh-phrase, long-distance questions and so on.

A second aspect of pragmatic knowledge that is related to the Gricean Maxim of Quantity was also investigated in our study. This pragmatic knowledge is not related to the syntactic operations available in English, and here we find that children with SLI performed well. We inquired whether or not children with SLI know that once a person has been introduced into the discourse, they can be referred to in the next mention with a pronoun. So if the wh-question asked about 'the boy' children could answer with '*He*…'. The finding was that children with SLI showed that they knew when it was pragmatically appropriate to use a pronoun in their answer rather than a full NP, and there was little difference between the children with SLI and the children in the control groups. This aspect of pragmatics is clearly not problematic for children with SLI.

Clinical implications

The study has clinical implications. First, given that children with SLI frequently omitted the BE morpheme in their answers to wh-questions, the study supports proposals that finiteness should be a focus in speech-language pathology therapy sessions for English-speaking children

with SLI (Rice, Hoffman & Wexler, 2009; Rice & Wexler, 1996). Second, our experimental findings demonstrate that children with SLI do not have difficulties with computing the syntax per se of wh-questions, but there are related aspects of wh-questions that could become a focus for intervention services. For example, if we assume that children have to learn what kinds of ellipsis are permitted in answers to questions, then therapy could target the range of possible answers with ellipsis (e.g. VP-answers like '*Driving the car'* and answers with VP ellipsis such as '*He is'* etc.), so that children learn to give pragmatically appropriate answers to wh-questions.

Conclusion

The present study investigated aspects of children's morphological, syntactic and pragmatic knowledge as realised in their answers to wh-questions. A robust sample of over 1500 answers to three different types of wh-questions was elicited from five-year-old children with SLI as well as AE and LE groups of children.

The first analysis investigated whether children with SLI are able to compute the syntactic representations for wh-questions and their answers. The finding in this domain was that children with SLI had no difficulty providing the correct syntactic category in their answers to both wh-questions targeting NP answers (Type 2 wh-questions) or ones targeting VP answers (Type 1 wh-questions). While these were simple one-clause wh-questions, children appeared to have no difficulty computing the hierarchical structure required for wh-questions, and forming a dependency between the wh-word and the gap. This positive finding does not support van der Lely's proposal that such extended representations should be problematic (van der Lely & Pinker, 2014).

Our investigation of the pragmatic abilities of children with SLI investigated the Maxim of Quantity and related information about information structure. Our finding was that children with SLI tended to provide full sentence answers to wh-questions when a fragment answer was

sufficient. Our interpretation of the data was that the full sentence answers are more economical than short answers because they do not require knowledge of the syntactic operations that are required for fragment answers in English. We also investigated children's sensitivity to whether or not a referent has already been introduced in the discourse and found that children with SLI are as sensitive to this factor as the children in the control groups.

Children's ability to compute sentence representations contrasted with their knowledge of morphosyntax, in particular, finiteness. Children with SLI omitted the BE morpheme which expressed tense in their answers to wh-questions at higher rates than their peers, in contrast to the aspectual *-ing* marker which posed no difficulty. We also found that whether or not children represented information for tense and for agreement in their sentence representations affected the form of the pronoun used in subject position of the sentence.

Overall, our methodology of studying children's answers to wh-questions has been an informative tool for probing a variety of aspects of children's knowledge of language. Discourse sequences such as question-answer pairs, and also comprehension of sentences with various kinds of ellipsis offer rich opportunities for future research that has the potential to paint a more complete picture of grammatical knowledge in children with SLI.

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Declaration of interest

The authors report no declarations of interest. The authors alone are responsible for the content and writing of this paper.

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Chapter 3

Linguistic rules and over-generalisation: Subject-aux inversion in children with SLI

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Abstract

This investigation evaluates the syntactic rule of Subject-Aux Inversion (SAI) in children with Specific language impairment (SLI). Seventeen five-year-old children with SLI, 17 age-matched children and 17 three-year-old MLU-matched children participated in an elicited production study investigating main clause wh-questions and embedded wh-questions. Our hypothesis was that children with SLI would perform SAI less often than children in the control groups, and over-generalise the rule to the embedded clause, where it is prohibited, less often. Although children with SLI produced fewer analysable questions, there was no significant difference between the SLI group and the control groups in application of the SAI rule. Contrary to expectation, the SLI group over-generalised the SAI rule in embedded wh-questions at a much higher rate than the controls. The findings suggest that once children with SLI are adept at using the SAI rule in main clause questions, they have difficulty inhibiting it in embedded wh-questions.

Linguistic rules and over-generalisation: Subject-aux inversion in children with SLI

Introduction

Specific language impairment (SLI) is defined as a developmental disorder of language which cannot be attributed to neurological damage, hearing impairment, low nonverbal intelligence or other known factors (Leonard, 2014). Despite the research interest that SLI has received in the last decade, the underlying basis behind the impairment and the extent of the linguistic properties that are at risk remain controversial. Our focus in this paper is on the formation of linguistic 'rules' (also known as 'processes' or 'operations') in children with SLI. These rules encode generalisations about the local language, and children must learn them on the basis of positive evidence. There is consensus in the literature that linguistic rules, at least the rule forming past tense verbs, are challenging for children with SLI. In this paper, we turn to the rule often termed 'subject-aux inversion' that turns declarative sentences into questions, and ask if it poses similar difficulty for children with SLI.

The literature suggests that children with SLI fail to impose past tense marking as an obligatory operation. They implement the past tense rule less often, thus over-generalising the past tense rule to irregular stems (e.g. *catched, eated*) less often than typically-developing children also. The interest of the subject-aux inversion rule is that it parallels past tense formation in one critical respect. Just as the past tense rule can be over-regularised, and used for irregular verbs, so too can the subject-aux inversion rule be over-generalised. Subject-aux inversion applies only to questions in the matrix (main) clause of a question and not in the embedded clause. However, in principle, the rule has the potential to be over-generalised and applied to the embedded clause. That is, while a matrix question like '*What is John eating?'* has the auxiliary verb to the left of the subject noun phrase *John*, this same positioning of the auxiliary verb in embedded questions is ungrammatical, as seen in *'*Do you know what is John eating?'* Our goals in this paper are twofold. The first aim is to investigate whether children's

difficulty with past tense formation is mirrored in the acquiring the rule of subject-aux inversion. Second, we ask about over-generalisation. Our second question is whether or not children with SLI overextend the rule of subject-aux inversion, and if so, do they over-generalise less often than typically developing children, as anticipated if the two rules follow similar paths?

Past tense in child language

It is well known that typically-developing children initially start using the past tense rule for regular verbs between ages two and three, although there is a great deal of individual variation. Later, children (sometimes) over-generalise the past tense rule to irregular past tense verbs, to produce '*eated*, *bringed*, *goed*' and so on (Marcus et al., 1992). Children with typically-developing language provide the past tense morphology more for regular verbs than irregular verbs; they are said to have a 'regularity advantage' because they are adept at implementing the past tense rule. The pattern of development is different for children with SLI. Children with SLI are known to perform poorly on all tense morphology, including use of the past tense rule, hence the proposal that tense-marking is a clinical marker of English-speaking children with SLI (Rice & Wexler, 1996).

Children with SLI tend to mark the past tense inconsistently or omit the past tense morpheme and just use the stem form (Oetting & Horohov, 1997; Rice, Wexler, & Cleave, 1995; Rice, Wexler, Marquis & Hershberger 2000; Ullman & Gopnik, 1999). Unlike typically-developing children, children with SLI do not use past tense morphology more for regular verbs than for irregular verbs. For irregular verbs, children with SLI have been found not to over-regularise past tense forms as often as their peers with typical language development (Leonard, 1989; Marshall & van der Lely, 2012; Ullman & Gopnik, 1999; van der Lely & Ullman, 2001). For example, Oetting and Horohov (1997) investigated past tense formation in a group of eleven 6-year-old children with SLI, and 11 age-matched and MLU-matched control children,

using an experimental probe. They found that the over-regularisation rate for irregular past tense was 34% for the SLI group, 61% for the younger controls and 81% for the age-matched controls in their study. A more comprehensive, longitudinal study on children's use of regular and irregular past tense was conducted by Rice, Wexler, Marquis and Hershberger (2000). This study, also using an experimental probe, investigated 21 children with SLI, 23 age matched children and 20 children matched on MLU. Similar rates of over-regularisation were found for children with SLI. At round four of testing, when the children were a similar age to the children in the Oetting and Horohov (1997) study, the mean percent correct for irregular verbs for the SLI group was 31%, the MLU-matched group of three-year-olds were 40% correct, and the chronologically age matched five-year-old group of children were 69% correct.

The past tense rule

On the 'words and rules' (dual route) model of past tense, regular and irregular verbs are processed differently (see Pinker, 1999). Regular verbs are proposed to inflect for past tense by rule, so only the stem form of the verb needs to be stored in the lexicon. Irregular verbs, on the other hand, have their idiosyncratic past tense form stored as a whole in the lexicon (Marcus et al., 1992; Pinker & Ullman, 2002). Once an irregular verb is stored in the mental lexicon, a psychological mechanism named the 'blocking principle' acts to prevent the past tense being formed by rule. In cases of difficulty with lexical retrieval, the Blocking Principle can fail to apply, and as a result, the past tense rule may be applied to an irregular verb. In this case, the rule is over-generalised (Marcus et al., 1992).

As Rice et al. (2000) point out, the words and rules model obscures the fact that, no matter whether a verb is regular or irregular, it still carries tense. This fact is captured in theoretical models of syntax in which a verb satisfies any requirements for tense in the syntactic component but its form as a regular or irregular verb is a product of morphophonological spell-out rules at the level of Phonetic Form (PF) (Chomsky, 1981). This is the theoretical model

adopted in the 'Extended Optional Infinitive Account' (Rice et al., 2000; Rice & Wexler, 1996). Using growth-curve modelling, Rice et al. (2000) show that finiteness and morphophonological rule learning have different trajectories. In particular, if finiteness is measured, without regard to whether the surface form is correct or not, then the SLI group does not perform as well as the MLU-matched control group, or the age-matched group. On the other hand, if percentage correct for irregular past tense forms is the measure, then the SLI group performs at about the same level as the MLU-matched group, since their overall language level is the same (as measured by MLU). The conclusion is that it is important to distinguish finiteness and morphophonological knowledge in any discussions of past tense acquisition.

More recent theoretical models of syntax have changed the locus of (past) tense formation. According to a later 'lexicalist' proposal, all verbs, regular or irregular, are inserted into the syntactic derivation already full inflected (Chomsky, 1993). On this model, rule-based affixation of the past tense 'ed' would have to take place in the lexicon, not at the level of Phonetic Form (PF). Responding to various technical problems with this account, Lasnik (1999) proposed a 'hybrid model' according to which *have* and *be* have special status and are inserted into the syntactic derivation fully inflected, while all other main verbs are inserted bare (in their stem form) into the syntactic derivation of a sentence. This hybrid approach harks back to the earlier proposal, on which the form for the past tense is handled by morphophonological rules. The main point to take home from this discussion of changing theoretical viewpoints is that children need to acquire such a rule for past tense formation, whether it is proposed to be implemented in the lexicon/morphology or as a morphophonological rule at PF. And, children have to learn its domain of application; that it applies to regular main verbs but not to ones for which there is a known irregular past tense form[5].

[5] On the 'words and rules' model in Marcus et al. (1992), over-generalisation should not arise except in cases of lexical retrieval failure. This is because a psychological mechanism, the Blocking Principle, inhibits over-regularisation as a general process.

The literature on children's difficulty with implementing the past tense rule and the low rate of over-generalisation prompts our inquiry into rule learning more generally. We approach this issue by investigating children's acquisition of the subject-aux inversion rule, a syntactic rule. Our inquiry asks, first, if children have more difficulty with this rule than the typically-developing children in the control groups and, second, if this means that children with SLI over-regularise the rule less, as is the case with the past tense rule.

The rule of subject-aux inversion

Subject-aux inversion is the process by which a declarative sentence is turned into a question. This turns a declarative sentence into a question by moving the auxiliary verb, modal or copula, if one is present, to a position higher in the structure, so that it ends up being pronounced to the left of the subject noun phrase (cf Chomsky, 1977; Radford, 2004). For example, in a declarative sentence like '*John is eating an apple'*, the auxiliary verb *is* moves in the structure to form the yes/no question '*Is John eating an apple?'* Since languages do not universally signal questions in this way, children acquiring English have to internalise this language-specific rule, which we call the subject-aux inversion rule. In wh-questions subject-aux inversion operates alongside movement of the question word, which moves from its base position to the highest position in the structure. This further movement will be required in some of the structures we elicit from children but is not the main focus of our investigation.

Like past tense formation, the formulation of the process we are terming 'subject-aux inversion' has changed in theoretical syntax proposals over the years. The term 'subject-aux inversion' is, in fact a term dating back to theoretical syntax proposals from the 1960's but we will use this general term because it is widely used in the developmental literature. More accurately, subject-aux inversion is a movement from the position that houses Tense in the hierarchical syntactic structure to a higher position called the Complementiser position. We put the technical motivation for this movement aside, and present the theory using an older version

of syntactic theory (Chomsky, 1981). This will be more intuitive than current formulations which do not change our research question. The key point is that however subject-aux inversion is implemented in the theory, it is an English-specific rule that children have to learn. Furthermore, children have to learn that subject-aux inversion applies in main clauses, but does not extend to embedded clauses. Part of our investigation is to see whether children have learned this restriction on the subject-aux inversion rule, or whether they over-generalise the rule, and use it in embedded clauses as well.

Children's ability to implement the subject-aux inversion rule is investigated in three kinds of questions, yes/no questions, main clause wh-questions and embedded wh-questions. These three structures are introduced below. Since in our experiment, we limit our investigation to subject-aux inversion with the verb BE, we use this verb in the tree structures illustrated in our introduction to these question structures.

Yes/No questions

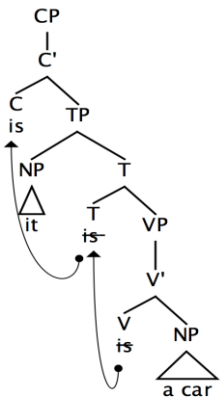
As implied by the name, yes/no questions elicit a 'yes' or a 'no' answer. In yes/no questions subject-aux inversion entails movement from T to a higher position in the sentence representation, C. The movement for the yes/no question '*Is it a car?*' is illustrated in figure 1. In this case, the main verb originates from a position within the verb phrase, and then moves from T to C, where it is pronounced in sentence initial position[6]. The figure shows a copy of the verb in the positions through which it moves as it travels to C[7]. The copies are shown in strike-through font to indicate that they are not pronounced. If there is no auxiliary verb, modal

[6] In English, *have* and *be* are exceptional verbs, demonstrating different linguistic behaviour from other main verbs. Unlike all other main verbs, they undergo movement from V to T in the structure. All other main verbs do not move from the V position.

[7] Some versions of linguistic theory assume movement leaves a 'trace' (e.g. Chomsky 1981). More recently, it is assumed that a 'copy' of the movement element is left behind (Chomsky, 1995). We will assume that a copy is left behind as this is quite intuitive and easy to represent.

or copula and just a lexical main verb in the sentence, it is assumed that tense features (present or past) move, and these are supported by the ‘dummy’ auxiliary verb DO.

Figure 1

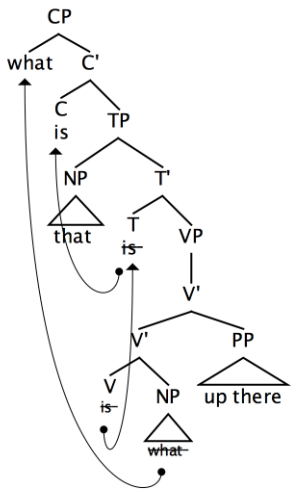


In colloquial English, it is also the case that a speaker can ask a yes/no question by maintaining the word order of the declarative sentence and simply using rising intonation at the end of the sentence. An example of this is, ‘*It’s Monday already?*’ In yes/no questions, then, register plays a part and it cannot be said that subject-aux inversion is obligatory.

Wh-questions

Wh-questions, questions beginning with wh-words such *as who, what, where, when, why* and *how,* also feature subject-aux inversion. Wh-questions request new information from the interlocutor, e.g., ‘*What ice cream flavour is your favourite?*’ Figure 2 illustrates the movements for the wh-question, ‘*What is that up there*?’. The wh-word ‘*what*’ has moved from its site of origin to the Spec of C position at the top of the hierarchical structure. The subject-aux inversion rule moves the copula *is* out of the verb phrase to T and then to the C position, as in the yes/no question.

Figure 2



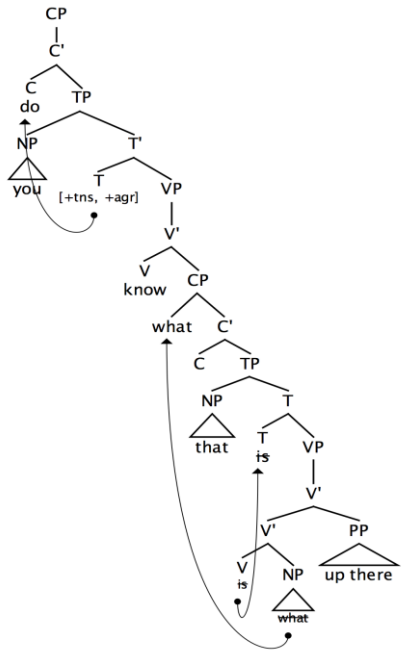
Embedded wh-questions

Embedded wh-questions such as '*Do you know where the closest bank is?*,' literally elicit a 'yes' or a 'no' answer, although most conversational contexts require the listener to provide additional information. For example, in response to '*Do you know where the closest bank is?*' a speaker would most likely provide the location of the bank. Embedded wh-questions are complex in the sense that they require the language learner to carry out the subject-aux inversion rule in the main clause, but not in the embedded clause, where it is prohibited. The prohibition against providing subject-aux inversion in the embedded clause does not fall out of a universal constraint, since it is grammatical in some dialects of English. For example, subject-aux inversion is reported to be grammatical in embedded questions in Hiberno English (McCloskey, 1992), in Belfast English (Henry, 1995), and also in dialects of American English (Clarke, 2004; Fought, 2003; Green, 2002; Wolfram & Christian, 1976). This suggests children need to inhibit the rule in embedded clauses.

The syntax of the embedded question such as '*Do you know what that is up there?'* is illustrated in figure 3. Subject-aux inversion takes place in the main clause. In this case, the tense features move from T to C and are supported by DO. In the embedded clause, the wh-

word moves to the Spec of C between clauses. In addition, the main verb BE raises out of the verb phrase to T, but does not move on to C. That is, the subject-aux inversion rule does not apply in the embedded clause.

Figure 3



Subject-Aux Inversion in child language

Within the literature on English-speaking children whose language is developing typically, there has been an abundance of research on subject-aux inversion (Bellugi, 1971; Crain & Thornton, 1998; de Villiers, 1991; de Villiers & Roeper, 1995; Kuczaj & Brannick, 1979; Manzini, 1992, 1995; Rizzi, 1990; Rowland, 2007; Santelmann, Berk, Austin, Somashekar & Lust, 2002; Stromswold, 1990; Tyack & Ingram, 1977). One of the main findings that has emerged from the research is that English-speaking children as young as three years of age are quite successful at producing well-formed main clause questions with subject-aux inversion. These studies have found that young children carry out subject-aux inversion at, or close to, ceiling rates (Pozzan & Valian, 2016; Sarma, 1991; Stromswold, 1990). An influential study investigating question structures is Stromswold's (1990) examination of question formation in

the spontaneous language samples of 12 children within the CHILDES database (MacWhinney, 1991). The children ranged in age between 1;2 to 2;6 during the first transcript session and from 2;3 to 6;0 during the final transcript session. She found that within the sample of children, the overall inversion rate for affirmative matrix clause questions was 93%. This is the rate of inversion for questions in which there was an auxiliary verb or modal provided.

Some studies have investigated whether inversion rates differ across argument and adjunct questions. It has been reported that children make more errors with adjunct questions (e.g., how, why, when, where) than they do with argument questions (e.g., what, who) (Erreich, 1984; Sarma, 1991; Stromswold, 1990). It has also been proposed that 'why' has a special status, failing to invert when inversion is at ceiling with other wh-words (Thornton, 2008).

Across studies there have been slightly mixed results with respect to inversion rates in embedded questions. Stromswold (1990) reported that in embedded questions, children inverted 10% of the time in embedded wh-contexts, whereas Sarma's elicited production study focusing on three to five-year-old children (1991) found that children do not over-generalise in embedded wh-questions. A more recent study by Pozzan and Valian (2016), also using elicited production methodology, found that children aged three to six inverted less than 1% of the time in embedded yes/no questions but as much as 27% of the time in embedded wh-questions. A possible explanation for the asymmetry between the inversion rates reported across the three studies may be accounted for by variations in coding, experimental techniques and definitions of errors. For example, in both Sarma (1991) and Pozzan and Valian's (2016) investigations, elicited production methodology was used, whereas Stromswold (1990) used children's spontaneous production data.

Question structures in the SLI population

In the literature on question structures in children with SLI, several researchers have noted that children with SLI have difficulty in both forming and comprehending question

structures. It has been proposed that children have difficulty with both movement of the question word to SpecCP ('rules') and with subject-aux inversion involved in both forming and comprehending question structures (Ebbels & van der Lely, 2001; Friedmann & Novogrodsky, 2011; Hansson & Nettelbladt, 1995, 2006; Schulz & Roeper, 2011; Stavrakaki, 2006; van der Lely & Battell, 2003).

Much of van der Lely's research has focused on a group of children classified as Grammatical SLI (G-SLI) who been observed to have difficulty with the movement operations required in computing and forming questions (van der Lely, 1998). The experimental results from van der Lely and Battell's (2003) production study revealed that children with G-SLI failed to carry out the two movement requirements in the wh-question, thus resulting in poorly formed syntactic wh-questions. According to the authors, the G-SLI children's typical errors involved lack of tense/question feature movement, as evidenced, for example, by a missing auxiliary (a), lack of wh-operator movement, as evidenced by a filled gap (b), and by combinations of the two types of errors (c). Van der Lely and Battell's experimental results concluded that 80% of children within their G-SLI subject group were found to show both kind of errors, as compared to only 4% in the control group.

(a) What Mrs. Brown place in the library?

(b) What did Mrs. Peacock like jewellery?

(c) Who Mrs Peacock saw somebody?

Experiment: Elicited production of SAI in questions

Our experiment elicited both yes/no questions and wh-questions from children. The wh-question game elicited both main questions and embedded wh-questions and examined children's implementation of the subject-aux inversion rule in all of these question types. Although subject-aux inversion has been claimed to be a general process by generative linguists, there are also claims that children learn each wh-word plus auxiliary combination

piecemeal (cf. Ambridge, Rowland, Theakston & Tomasello, 2006; Rowland & Pine, 2000). For this reason, we elected to control the auxiliary verb/verb in our experiment so that all questions required subject-aux inversion with the verb BE.

Our experimental hypotheses are as follows:

1. Given that children with SLI have been found to use the past tense rule with regular verbs less often than typically-developing children, we hypothesize that children with SLI will implement subject-aux inversion rule in main clauses less often than typically-developing children.

2. Given that children with SLI over-regularise less often with irregular past tense verbs than typically-developing children, we hypothesize that children with SLI will over-generalise the subject-aux inversion rule less often in embedded clauses than typically-developing children.

3. Children who attempt to extend subject-aux inversion to the embedded clause will all be children who have acquired the subject-aux inversion rule and implement it in main clauses.

Method

Participants

Fifty-one children participated in the experiment[8]. The participants included 17 children with SLI, mean age 5;6 (range 5;0-5;10), 17 children aged-matched (AE), mean age 5;4 (range 5;2-5;11) and 17 children language-matched (LE) mean age 3;6 (range 3;2-3;11). All of the children included in the study were drawn from English-speaking homes. Table I provides detailed descriptive information for each of the three groups of children.

Children with SLI were recruited from early intervention centres for students with language impairment, in Perth, Western Australia. The language development schools provide specialised language and academic intervention for children with SLI. For inclusion into the

[8] The study was approved by the Human Ethics Committee at Macquarie University as well as by the Department of Education of Western Australia.

school program the children had to have a diagnosis of language impairment by a speech-language pathologist and a recommendation for enrolment in the school program. Prior to enrolment, children's language skills were assessed using the Clinical Evaluation of Language Function (CELF-4) (Semel, Wiig, & Secord, 2003). Additionally, referral information also included evidence that children's non-verbal cognitive skills were within the normal range, as attested by a psychologist or paediatrician, using the Leiter international performance scale (Roid, Miller, Pomplun & Koch, 2013); as well one of the following assessments: Griffiths mental development scales (Griffiths, 1970) or Bayley scales of infant and toddler development (Bayley, 2003). An evaluation of children's adaptive behaviour was also completed using a carer and/or teacher questionnaire. This questionnaire measures independence, emotional regulation and behaviour. Children in the LE and AE groups were recruited through the universities paid participation pool as well from preschool centres on the university campus. To the authors' knowledge, at the time of referral, all children met the inclusion/exclusion criteria based on Leonard's (1998) requirements for diagnosis of SLI. This included a passing score of standardised hearing assessment, no recent episodes of otitis media with effusion, no neurological dysfunction, no oral structural or oral motor function anomalies, no symptoms of impaired reciprocal social interaction or restriction of activities.

To be included in the study, children in the SLI group had to have a standard score of 84 or below on the CELF-P2 language screener assessment (Semel, Wiig, & Secord, 2006) and a score of 85 standard score or above on the non-verbal Kbit-2 IQ assessment (Kaufman & Kaufman, 2004). To be included in one of the two control groups, children had to have a standard score of 85 or above on the CELF-P2 language screener assessment and a score of 85 standard score or above on the non-verbal KBIT-2 IQ assessment. To ensure that the control groups were matched evenly, the children included in the AE group were all within six weeks of age of at least one child in the SLI group. The children in the LE group had MLU values

that were within +/= 1 *SD* of the mean value expected for their age based on Rice et al. (2010) norms. In order to ensure equivalent groups based on language abilities, each subject in the LE group was within 0.04 morphemes of at least one child in the SLI group based on their spontaneous language sample.

Table I. Mean percentage and *SD* of group data by group.

Group	**N**	**Age**	**MLU in Morphemes**	**SD %**	**CELF-P2 Standard Score**	**SD %**	**KBIT-2 Standard Score**	**SD %**
SLI	17	5,6	3.48	0.44	77.06	7.61	99.47	13.45
LE	17	3,6	3.67	0.40	118.59	9.59	N/A	N/A
AE	17	5,4	4.74	0.62	112.06	12.17	103.29	11.26

Note: KBIT-2=Kaufman Brief Intelligence Test, Second Edition; CELF-P2=Clinical Evaluation of Language Fundamentals-Preschool-2; MLU=mean length of utterance; SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

The spontaneous language sample required for calculation of the MLU sample was collected by a speech pathologist in a naturalistic play environment. The same set of toys was used to elicit the language sample for all three groups of children. The toys included a variety of animals, people, popular television characters, food items, as well as a van for the animals and people to drive in. All items were chosen to encourage interest and engagement in play and conversation. Each session lasted approximately 18-25 minutes, with 200 complete and intelligible utterances collected for each child. All language samples were recorded then coded and entered into SALT software for analysis (Miller, Gillon, & Westerveld, 2012).

Procedure

Questions were elicited from the three groups of children using the procedures outlined in Crain and Thornton (1998). Elicited production methodology has proven to be particularly successful for investigating children's grammars, especially those aspects that may not be well represented in spontaneous production data. In the present experiment, each of the children participated in two activities in which they interacted with a dog puppet and the puppet's animal friends. The ongoing game with the puppet allowed for a more natural exchange between the puppet and

the child. Questions were elicited in pragmatically appropriate information seeking contexts. A detailed description of each of the two elicited production activities is provided in the following section. A list of the sentence used is provided in Appendix B.

Activity 1

In Activity one, yes/no questions were elicited from the child participants. The child's job was to ask 'Polly' the dog to identify items in a box of toys. The experimenter began by explaining to the child that Polly has a box of toys and will pull out one toy at a time. The child was then told that it was their job to ask Polly the name of each item. To familiarise the child with the game, the experimenter first elicited three practice 'can' questions, using a lead-in such as the following (where the material in square brackets can be substituted): '*I wonder if [it can swim], ask Polly if [it can swim]*'. Following the practice questions, the experimenter moved to elicitation of the target questions. The lead-in for the target questions was similar, but this time used the main verb BE, here the form '*is*'. The experimenter's lead-in was as follows: '*I wonder if [it's a car], ask Polly if [it's a car]*'. This lead-in was used to encourage the child to ask the dog puppet the target yes/no question, '*Is it a car?*' The dog puppet then responded to the child's question by giving a yes or no answer.

The child was given a total of 20 opportunities to produce a yes/no question, in the game which took approximately 10-15 minutes to complete. There was no specific time limit and there was no feedback provided during or after the activity. If the child did not ask the question, the experimenter gave the child one more chance by repeating the lead-in.

Activity 2

In the second game the child was presented with a number of different scenarios, each designed to elicit a wh-question. The lead-in was designed to elicit embedded wh-questions, but it was anticipated that it would elicit matrix wh-questions as well. The experimenter started the activity by eliciting simple questions, such as, the puppet's name, if he was a girl or a boy and

if he had any brothers or sisters. It was important that these first questions in the game were ones the children did not know the answer to. This alleviated the 'ask-tell problem' that can arise, when children tell the puppet the answer to the question rather than ask the puppet. After these warm-up questions, the experimenter moved to eliciting the target questions. A sample scenario was as follows:

Scenario: <Toy monkey is sitting high on a shelf>

Experimenter: Ask Polly if he knows what that is doing up there

Child: Do you know what that is doing up there?

Or

Child: What is that doing up there?

The dog might respond with '*That is a silly monkey sleeping on a shelf.*' If the child did not ask the question or used only a wh-word such as '*what, who, where*' etc. rather than a full question, the experimenter repeated the lead-in one more time. The game continued with the child asking Polly the puppet various questions about his animal friends and what they were doing around the room.

The second activity provided a total of 20 opportunities to ask questions. This experimental context elicited both main clause embedded wh-questions; 9 object questions and 11 adjunct questions. The activity took approximately 15-20 minutes to complete. There was no specific time limit and there was no feedback was provided.

The two experimental activities were presented to all three groups of children using the same elicitation technique and in the same experimental order. All 51 children in the study completed both activities. An Olympus recorder with a lapel microphone was used to record the children's productions for later transcription and analysis.

Coding of responses

To ensure reliability, the same speech language pathologist who administered the activity with the child transcribed all experimental utterances. The transcriptions were then double scored

by a second speech language pathologist. Reliability was calculated across morphemes, where one difference between the two transcribers on any given morpheme was considered one error. In activity one the agreement rating was 96%. In activity two the agreement rating was 95%. Any discrepancies between the two transcribers were resolved by further discussion.

Experimental Findings

Across the three groups of children, the two experimental contexts elicited a robust sample of 1872 question productions. Table II reveals the total raw number of questions produced for each of the three groups of children for each of the three question types.

Table II. Total number of questions produced for each question type by group.

Total number of questions per group	**SLI**	**LE**	**AE**
Yes/no question	324	331	328
Wh-question	108	186	98
Embedded wh-question	161	112	224
TOTAL	**593**	**629**	**650**

Note: SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

Recall that use of the subject-aux inversion rule is calculated across those utterances in which children provided a form of BE (that is, '*is*') that could be moved by rule. Given that we know children with SLI tend to omit tense morphology, it is important to first assess the provision of the copula in the children's questions. This allows for an evaluation of how much of a total sample is being used to calculate the percentage of subject-aux inversion across the three question types for each group of children. Table III displays the BE omissions for each of the groups of children across the three question types. It can be seen that children with SLI produced more BE omission than both the control groups of children across all three types of questions. The omissions of the copula were especially prevalent in the embedded wh-questions. In these questions, the children with SLI omitted BE in 31% of questions. However, it is important to note that despite upwards of 10% of omissions of the verb in questions of children with SLI, there is nevertheless a robust sample of data to analyse for each question structure. Our investigation also found that omissions increase with complexity of the

production. In declarative sentences within the MLU sample, children with SLI omitted BE 6%, compared with 9% in yes/no questions, 14% in wh-questions and 31% in embedded wh-questions.

Table III. Mean percentage with *SD* and raw numbers of BE omission errors by group.

Omissions	**Example**	**SLI**	**SD %**	**LE**	**SD %**	**AE**	**SD %**
BE omissions in yes/no questions	*It blue?*	9.4% (30/320)	23.7	1.0% (3/332)	3.2	0.3% (1/327)	1.2
BE omissions in wh-questions	*What that up there?*	13.5% (14/109)	27.0	6.3% (10/189)	14.3	0.0% (0/98)	N/A
BE omissions in embedded wh-questions	*Do you know what that up there?*	30.5% (46/164)	38.0	7.5% (9/122)	17.8	0.0% (0/223)	N/A

Note: SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

We can now turn to children's use of the subject-aux inversion rule. The range of questions and errors types for the yes/no questions produced by the children is given in table IV. First, we report the percentage of subject-aux inversion across the groups. The SLI group of children produced fewer questions with subject-aux inversion than the LE children or the AE children. The children with SLI produced target yes/no questions with subject-aux inversion, '*Is it a car?*' 58% of the time, whereas both the LE children and the AE children were close to ceiling. Second, as already noted, the children with SLI produced more questions with omissions of the verb BE than the children in the control groups. Table IV also records that the children with SLI produced two other kinds of errors; null subject errors such as '*Is a car?*' and errors in which the child picked up on the experimenter's lead-in, producing '*If it's a car?*'. These errors were not frequent, both appearing around 1% of the time.

Table IV. Mean percentage with *SD* and raw numbers of Yes/No questions by group.

Question type	**Example**	**SLI**	**SD %**	**LE**	**SD %**	**AE**	**SD %**
Subject-aux Inversion	*Is it a car?*	57.8% (187/324)	41.6	99.0% (328/331)	3.2	98.8% (324/328)	2.2
Non-inversion	*It is a car?*	30.8% (99/324)	38.8	0.0% (0/331)	N/A	0.3% (1/328)	1.2
BE omission	*It a car?*	9.0% (30/324)	23.1	1.0% (3/331)	3.1	0.3% (1/328)	1.2

Null subject	*Is a car?*	1.2% (4/324)	3.9	0.0% (0/331)	N/A	0.3% (1/328)	1.2
Lead-in question	*If it's a car?*	1.2% (4/324)	2.8	0.0% (0/331)	N/A	0.3% (1/328)	1.2

Note: SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

Next, we present in turn the main clause wh-questions and the embedded wh-questions produced by the children. The range of questions and error types for the simple wh-questions produced by each of the groups of children are given in table V. Table V shows that the children with SLI correctly used the subject-aux inversion rule in 76% of their questions, as compared with 88% in the LE children and 98% in the AE. Questions in which there was no subject-aux inversion despite provision of a verb made up 9% of the questions for the SLI group of children, a bit more than the 6% in the three-year-old LE children. As might be anticipated, BE omission errors at 14% were also more prevalent in the children with SLI's question productions, compared to 6% seen in the LE group and 0% in the AE group.

Table V. Mean percentage with *SD* and raw numbers of main clause wh-questions by group.

Question type	**Example**	**SLI**	**SD %**	**LE**	**SD %**	**AE**	**SD %**
Subject-aux Inversion	*What is that up there?*	75.7% (79/108)	29.5	87.7% (165/186)	21.8	98.1% (96/98)	5.2
Double BE	*What is that is up there?*	2.1% (4/108)	4.3	0/0% (0/186)	N/A	0.0% (0/98)	N/A
Non-inversion	*What that is up there?*	8.7% (11/108)	15.4	6.3% (12/186)	10.4	1.9% (2/98)	5.2
BE omission	*What that up there?*	13.5% (14/108)	27.0	6.0% (9/186)	13.2	0.0% (0/98)	N/A

Note: SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

The data for the embedded wh-questions are presented in table VI. The focus is on the embedded clause, and so the example questions all show '*Do you know…*' with or without the auxiliary DO. We return to provision of DO shortly. The production data revealed that children with SLI produced fewer adult-like embedded wh-questions than the children in the two control groups. This is observed by target embedded wh-questions making up only 28% of the data in the SLI group, compared with 77% target productions in the LE group and 87% in the AE

group. It follows that the SLI group produced considerably more non-adult embedded wh-questions than the AE and LE groups of children. The non-adult embedded wh-questions included questions with subject-aux inversion in the embedded clause, questions with omission of the copula BE, wh-word omissions and productions with doubling of BE. Questions in which children changed the questions from object gap to subject questions were also observed, although these questions are grammatical. We will discuss the pattern of errors in further detail in our discussion.

Table VI. Mean percentage with *SD* and raw numbers of embedded wh-questions by group.

Question type	**Example**	**SLI**	**SD %**	**LE**	**SD %**	**AE**	**SD %**
Embedded (No inversion)	*Do you know what that is in the box?*	27.6% (46/161)	29.7	77.0% (87/112)	23.2	86.6% (204/224)	23.8
Subject-aux Inversion (Over-generalisation)	*Do you know what is that in the box?*	9.3% (15/161)	11.4	9.2% (8/112)	18.0	4.9% (5/224)	12.8
Double BE	*Do you know what is that is in the box?*	8.0% (14/161)	12.1	3.3% (3/112)	7.4	1.4% (4/224)	4.2
BE omission	*Do you know what that in the box?*	14.6% (29/161)	27.8	6.9% (8/112)	18.0	0.0% (0/224)	N/A
Object-to subject	*Do you know what is in the box?*	14.6% (21/161)	26.1	3.0% (5/112)	4.7	6.5% (10/224)	11.7
WH-word omission	*Do you know that is in the box?*	10.4% (19/161)	18.9	0.0% (0/112)	N/A	0.7% (1/224)	2.7
WH-word & BE omission	*Do you know that in the box?*	16.0% (17/161)	29.3	0.6% (1/112)	1.9	0.0% (0/224)	N/A

Note: SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

Table VII shows that children with SLI omitted the auxiliary DO in their question productions close to 50% of the time, whereas the LE and AE children always included it. This finding is consistent with other studies (Rice et al., 1995; Rice, Wexler, Hershberger, 1998; Rice & Blossom, 2012; Rice, Hoffman & Wexler, 2009). From the high rate of both BE and

DO omissions observed, it is evident that children with SLI have significant challenges with using morphemes that express tense in question structures.

Table VII. Mean percentage with *SD* and raw numbers of DO omission errors by group.

Omissions in embedded wh-questions	**Example**	**SLI**	**SD %**	**LE**	**SD %**	**AE**	**SD %**
DO omission in embedded wh-questions	*You know what that is up there?*	45.5% (79/167)	48.7	0.0%	N/A	0.0%	N/A
DO in embedded wh-questions	*Do you know what that is up there?*	54.5% (88/167)	48.7	100.0%	N/A	100.0%	N/A

Note: SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

This brings us to our research focus, children's implementation of the subject-aux inversion rule. Our hypothesis was that children with SLI would use the subject-aux inversion rule less often than children in the control groups. As noted, only those questions in which BE was provided in the question contribute to this analysis. Null subject questions as well as questions which began with the experimenter's lead-in '*if*' were not included. Questions which included two instances of the copula were categorised as implementing the subject-aux inversion rule, assuming the analysis that the lower instance of the copula was an overt copy of the moved one.

The data for subject-aux inversion across question types are summarised in Table VIII. The children with SLI produced more questions without subject-aux inversion than both the LE children and the AE children. The SLI group of children implemented subject-aux inversion in wh-questions more often than in yes/no questions. A Kruskal-Wallis (non-parametric) test was used to assess the differences across the three groups of children for the yes/no questions. This test showed that there is a main effect of group $X^2(2)=24.299$, $p<.000$. A Mann-Whitney (non-parametric) test was used to compare differences between the three groups against each other. This test showed a significant difference between the SLI group and the AE children, $Z=-3.612$, $p<.000$. There was also a significant difference between the SLI and the LE control

children, Z=-3.786, p<.000. A Kruskal-Wallis (non-parametric) test was used to assess the differences across the three groups of children for the main clause wh-questions. This test showed that there was not a significant group effect $X^2(2)=2.856$, $p<.240$.

A comparison was done between the argument and adjunct questions with inversion in the matrix clause question. Across the three groups a similar amount of argument and adjunct questions with inversion were produced. In the LE group, 58% of the questions with inversion were adjunct questions, 33% were argument questions. In the SLI group, 49%, of the questions with inversion were adjunct questions, 42% were argument questions. In the AE group, 52% of the questions with inversion were adjunct questions, 47% were argument questions.

Table VIII. Mean percentage with *SD* and raw numbers of inversion rates in yes/no questions and wh-questions by group.

Inversion	**Example**	**SLI**	**SD %**	**LE**	**SD %**	**AE**	**SD %**
Yes/no question with SAI	*Is it a car?*	66.3% (187/286)	40.4	100% (328/328)	N/A	99.7% (324/325)	1.2
Wh-questions with SAI	*What is that up there?*	89.5% (83/94)	17.4	91.3% (166/179	15.1	98.1% (96/98)	5.2

Note: SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent; SAI=Subject-aux inversion.

Our second hypothesis was that children with SLI would over-generalise the subject-aux inversion rule and use it in embedded wh-questions where it not permitted less often than the children in the control groups. Table IX reviews the percentage of embedded wh-questions with and without subject-aux inversion in the embedded clause. Our hypothesis was not borne out. The results reveal that the SLI group of children used the subject-aux inversion rule in the embedded questions at a significantly higher rate than the children in the LE and AE control groups. A Kruskal-Wallis (non-parametric) test was used to assess the differences across the three groups of children. This test showed that there is a main effect of group $X^2(2)=11.15$, p=.004. A Mann-Whitney test was used to compare differences between the three groups against each other. This test showed a significant difference between the SLI group and the AE

children, *Z*=-3.195, *p*=.001. There was also a significant difference between the SLI and the LE control children, *Z*=-2.094, *p*=.036.

Table IX. Mean percentage with *SD* and raw numbers of embedded wh-questions and over-generalisation by group.

Inversion	**Example**	**SLI**	**SD %**	**LE**	**SD %**	**AE**	**SD %**
Embedded (non-inversion)	*Do you know what that is doing up there?*	53.3% (46/75)	36.5	85.5% (87/98)	18.6	90.6% (204/213)	24.3
Over-generalisation	*Do you know what is that doing up there?*	46.7% (29/75)	36.5	14.5% (11/98)	18.6	9.4% (9/213)	24.3

Note: SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

Third, we hypothesised that if there were children who extended the subject-aux inversion rule to the embedded clause, these children would have implemented the rule in their main clause questions. The data in table X show the proportion of subject-aux inversion across the matrix yes/no and wh-questions and embedded wh-questions for those children who over-generalised the subject-aux inversion rule. There were nine children in the SLI group who used subject-aux inversion in the embedded question structure, and who made up the 47% over-generalisation errors. Table X shows that these children who invert in the embedded question structure also reliably use subject-aux inversion in their yes/no questions or in their wh-questions or in both question types.

Table X. Individual SLI group subject data for over-generalisation of the embedded wh-question.

Child	Inversion in yes/no questions	Inversion in wh-questions	Over-generalisation in embedded wh-questions
Adam	95.0% (19/20)	100.0% (3/3)	81.8% (9/11)
Amanda	94.4% (17/18)	100.0% (3/3)	53.8% (7/13)
David	100.0% (18/18)	100.0% (10/10)	40.0% (2/5)
Ella	100.0% (20/20)	100.0% (3/3)	23.1% (3/13)
Jason	94.7% (18/19)	100.0% (4/4)	23.1% (3/13)
Jemma	62.5% (10/16)	N/A	100.0% (1/1)
Owen	100.0% (19/19)	72.7% (8/11)	66.7% (2/3)
Ryan	100.0% (2/2)	N/A	100.0% (1/1)
Sam	56.3% (9/16)	N/A	25.0% (1/4)

Note: Children's names have been changed for confidentiality

Discussion

This study investigated whether the difficulties children with SLI are reported to encounter with past tense rule formation extend to the subject-aux inversion rule. We chose subject-aux inversion in particular since it presents the opportunity to over-generalise, just as the past tense presents the opportunity to over-regularise the morphological spell-out rule by applying it to irregular verbs.

Our first hypothesis was that if the morphological spell-out rules are challenging for children with SLI, and subject-aux inversion is similarly challenging, then children with SLI will implement the rule less often than the children in the AE and LE control groups. It must be remembered that children with SLI omitted the copula more frequently than children in the control groups so this calculation is necessarily across only those questions in which a copula and a subject NP were present in the structure. We were also interested in children with SLI's BE omissions in declarative contexts compared to their BE omissions in question structures.

Our investigation found that omissions increase with complexity of the production. Based on this result, it is proposed that in additional to a grammatical factor, there may also be a contribution from processing. We found a significant difference in the rates of subject-aux inversion between the group of children with SLI and the AE and LE groups for yes/no questions, but not for main clause wh-questions. Children with SLI used the subject-aux inversion rule in their wh-questions as much as 90% of the time, compared with 91% for the LE group and 98% for the AE group. These questions with inversion were produced by 13 children in the SLI group, 17 children in the LE group and 15 children in the AE group. Although they are not quite at the level of the control groups of children, when they use a form of BE, they are nevertheless performing using the subject-aux inversion rule in their wh-questions at a remarkable rate.

The children with SLI did not perform at the same level as their peers in their yes/no questions, however. At first glance this is surprising, since yes/no questions do not require the additional movement of a wh-phrase, and previous research has suggested that children have more difficulty with wh-questions than yes/no questions (Bellugi, 1971; Klima & Bellugi, 1966; Kuczaj & Brannick, 1979; Rowland, 2007). However, it is also the case that subject-aux inversion is not obligatory in yes/no questions in colloquial situations. It may be that children with SLI opt for the declarative word order and rising intonation given that this is, in some sense, more economical than the option with subject-aux inversion. This explanation rests on the proposal that children with SLI have more limited processing resources (Bishop, Adams, & Norbury, 2006; Kail, 1994; Leonard, 1989; Montgomery, 2000; Ellis Weismer, Evans, & Hesketh, 1999). As noted in figure 1, yes/no questions with inversion require a sentence representation with a CP phrase in addition to the sentence-level TP phrase so that the copula can move from T to C. It is possible that, given the choice, children with SLI choose the more economical option of just building an TP sentence representation, in which case they opt for a

question such as '*It's Monday already?*' without subject-aux inversion. This is grammatical, although not the most pragmatically appropriate structure in the experimental context. In contrast to the children with SLI, we can assume that the children in the control groups are able to produce the pragmatically appropriate structure. The proposal that children are just building a TP in their yes/no questions would also account for why children carry out subject-aux inversion at a higher rate in wh-questions than in yes/no questions. In wh-questions, a CP structure must be built regardless, so that the wh-word can move into Spec of C. As a result, a higher rate of subject-aux inversion in wh-questions than in yes/no questions would be expected, and this was observed.

Our second hypothesis was that just as children with SLI are less likely than typically-developing children to over-regularise and apply the past tense rule to irregular verbs, the children with SLI would also be less likely to over-generalise the subject-aux inversion rule to embedded wh-questions than the children in our LE and AE control groups. This seems especially likely given the complexity of embedded wh-questions; they require subject-aux inversion and do-support in the matrix clause and wh-movement but without subject-aux inversion in the embedded clause. That is, the target questions were ones like '(*Do) you know what that is doing up there?*' and not *'*(Do) you know what is that doing up there?*' In evaluating these data, we first make clear that not every child with SLI was able to produce embedded wh-questions, but 13 of the 17 children successfully produced this complex structure. These 13 children included children who omitted DO in the matrix clause, but nevertheless managed to produce an embedded question[9]. Nine of those 13 children over-generalised the subject-aux inversion rule to their embedded wh-questions, producing a mean 47% of the embedded wh-questions with inversion. This compared with seven children who

[9] Eight of these 13 children omitted DO in some incidences. Three out of the 13 children did not include auxiliary DO in any of their embedded clause questions.

made up the 15% over-generalisation for the LE group and five children who made up the 9.4% for the AE group. This data can be seen in table IX. There was a significant difference between the proportion of subject-aux inversion in the group of children with SLI and the LE and AE groups. This finding does not support our experimental hypothesis, which was based on findings from investigations of the past tense rule in children with SLI. We anticipated less over-generalisation for the SLI group. It was also of interest to compare the rate of over-generalisation errors found within the control groups in our study to the rate of over-generalisation reported in Pozzan and Valian's (2016) production study. These authors reported a 27% rate of inversion in embedded wh-questions. This is a slightly higher rate of inversion than what we observed in our two control groups, however the results are in line with Pozzan and Valian's findings. This bring us to the next point of interest in our study, examining the individual subject data in more detail.

We pointed out earlier that although subject-aux inversion is not grammatical in embedded clauses in Standard English, there is no universal constraint prohibiting it, given that it is even acceptable in certain varieties of English. This suggests that learners of Standard English have to learn the exception to the rule, and encode it in their grammar. Presumably, this is a two-step process. Children first learn the subject-aux inversion rule, then learn to inhibit its use in embedded clauses. If so, we can predict that children who are over-generalising the subject-aux inversion rule into the embedded clause are all the same children who are successfully using subject-aux inversion in the matrix clause. Turning to the individual subject data in table X, of the nine children who over-regularised subject-aux inversion in the embedded wh-questions, there were six children who used subject-aux inversion in both yes/no and wh-questions. The other three children produced subject-aux inversion in wh-questions, where it is obligatory. These data suggest that once the children have acquired the inversion rule, they supply it across the board. These nine children with SLI have not yet learned when

to hold the rule in check, and the data suggest that this process of 'unlearning' the rule is more difficult for children with SLI.

From another perspective, the finding that children with SLI over-generalise the subject-aux inversion rule into the embedded clause is indication that children are excelling with the linguistic rule of subject-aux inversion. Moreover, further examination of the individual subject data reveal that there were two children in the group of children with SLI who were adult-like; they implemented the subject-aux inversion rule in matrix clauses, but held it in check in embedded clauses. The data from the control children show a similar pattern. There are seven children in the LE matched group who over-generalise the rule in embedded questions, six of the children over-generalise just once or twice and one child over-generalised in four of her questions. From this pattern it is evident that this one child appears to not have reached the second step of holding the rule in check. As one might expect, it is a child in the younger LE group that has not yet learned the exception to the rule. In this respect, the data parallel the data for over-regularisation of past tense.

Clinical implications

It is important to note that findings from this research have important clinical implications. Firstly, in conjunction with previous research, one goal of the therapy should be on auxiliary/copula morpheme use. In addition, the present research found that morphemes get omitted at higher rates in question structures. Therefore, profession of the auxiliary should first be worked on at the basic sentence level and then provision of the BE form in questions. Secondary to that, when question structures are worked on in therapy sessions, the focus should be on first teaching the child the rule of auxiliary movement in matrix clause questions. Once children have grasped that rule in this structure, instruction can then be focused on teaching the exception to the rule, that being it does not get applied in the embedded question structure.

Conclusion

Using elicited production methodology, our experiment with children with SLI and control groups matched for age and language probed implementation of the subject-aux inversion rule in yes/no questions, matrix wh-questions and embedded wh-questions. The goal was to investigate whether children with SLI encounter difficulty with learning linguistic rules (cf. Marshall & van der Lely, 2012; van der Lely, 2005; van der Lely & Ullman, 2001). The main experimental finding was that the children in our SLI group were very proficient at implementing the subject-aux inversion rule, in those cases when they did not drop the finite auxiliary verb or copula. The SLI group implemented the subject-aux inversion rule close to 90% in matrix wh-questions. In embedded wh-questions, where subject-aux inversion must be held in check, the children with SLI were significantly different from the children in the control groups. In embedded wh-questions, those children who had learned the subject-aux inversion rule tended to over-apply it, extending it to embedded clauses. The overall findings suggest that children with SLI experience some delay in learning the subject-aux inversion rule and, once they have learned it, they are slower to learn the exception – that subject-aux inversion does not apply in embedded clauses. The success of children with SLI in performing subject-aux inversion in our experiments does not support the claim that children with SLI have a general deficit in ability to form rules (Marshall & van der Lely, 2012; van der Lely, 2005; van der Lely & Ullman, 2001). Future investigations could elicit both the past tense rule and the subject-aux inversion rule in with the same group of children for a more controlled examination of whether linguistic rules in general are impaired in children with SLI.

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Chapter 4

The linguistic constraint on contraction in children with SLI

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Abstract

Purpose: The goal of the present study was to investigate whether children with specific language impairment (SLI) obey the constraint on contraction with the verb BE in three contexts: ellipsis, yes/no questions and embedded questions.

Method: Using elicited production methodology, a total of 51 children were tested: 17 children with SLI (mean age=5;6); 17 language-matched children matched on mean length of utterance (mean age =3;6) and 17 children age-matched children (mean age=5;4).

Results: The experimental results revealed that children with SLI did not differ from the children in the control groups on this aspect of linguistic knowledge. Children contracted where it is possible and failed to contract where contraction is prohibited. Our experimental findings suggest that children with SLI have the same underlying grammar as children whose grammars are typically-developing for this aspect of linguistic knowledge.

The linguistic constraint on contraction in children with SLI

Introduction

Children with specific language impairment (SLI) are most often described as a group of children who have difficulty with various aspects of language, in the absence of cognitive impairment, hearing difficulty, or physical abnormality of the speech apparatus (Leonard, 2014). One area of particular weakness for children with SLI is with obligatory use of verbal tense marking morphology. This finding has been widely reported across various studies both in English and cross-linguistically (Cleave & Rice, 1997; Conti-Ramsden, Botting, & Faragher, 2001; Eadie, Fey, Douglas, & Parsons, 2002; Grela & Leonard, 2000; Hadley & Rice, 1996; Ingram, 1972; Johnston & Schery, 1976; Joseph, Serratrice, & Conti-Ramsden, 2002; Khan & James, 1983; Oetting & Horohov, 1997; Rice & Blossom, 2012; Rice, Wexler & Cleave, 1995; Rice, Wexler & Hershberger, 1998; Ullman & Gopnik, 1999). In English, morphemes that carry tense include: third person singular present tense '*s*', past tense '*ed*', auxiliary and copula BE and auxiliary DO. The typical error pattern observed in children with SLI is frequent omission of finite forms in obligatory contexts. Examples of these errors can be considered in the following sentences, where non-finite verb forms are produced, as in (1b) and (2b) instead of finite verb forms as seen in (1a) and (2a).

(1) (a) He kicked the ball (Provision of past tense –*ed*)

(b) *He kick the ball (Omission of past tense –*ed*)

(2) (a) John eats cake (Provision of third person singular –*s*)

(b) *John eat cake (Omission of third person singular –*s*)

In the case of the morpheme BE, the difficulties with finiteness show up as omission of the auxiliary verb form of BE as well as copula BE forms. These omissions errors can be seen in (3b) and (4b) and replace the adult forms with obligatory tense marking as shown in (3a) and (4a).

(3) (a) The boy is eating pizza (Provision of the auxiliary BE form)

(b) *The boy eating pizza (Omission of the auxiliary BE form)

(4) (a) The boy is a swimmer (Provision of the copula BE form)

(b) *The boy a swimmer (Omission of the copula BE form)

Based on the difficulties these children have with morphemes that carry tense, finiteness is widely recognised as a clinical marker of English-speaking children with SLI (Rice et al., 1995; Rice et al., 1998; Rice, Hoffman & Wexler, 2009; Rice & Wexler, 1996). Difficulty with tense marking has been shown to extend late into the teen and adult years (e.g. Marchman, Wulfeck, & Ellis Weismer, 1999; Norbury, Bishop & Briscoe, 2001; Rice et al., 1998; Rice, Tomblin, Hoffman, Richman & Marquis, 2004; van der Lely, 1997).

The morphosyntactic limitations of children with SLI are now well documented, but there are many other aspects of linguistic knowledge that have not yet been investigated. As yet, few aspects of linguistic knowledge that are claimed to be universal in the theory of Universal Grammar (UG) have been explored in any detail (cf. Chomsky 1975, 1981, 1986). According to the theory of UG, there are linguistic principles, or 'constraints', that apply across languages. Their purpose is to constrain children's grammatical hypotheses so that children do not entertain hypotheses that would be difficult to recover from should they not be appropriate for the target grammar. In other words, constraints limit children's potential errors. Such constraints are assumed to be 'hard constraints' and inviolable.

A well-known example of a linguistic constraint is the constraint of 'structure dependence' (Chomsky, 1971). This constraint restricts children from making grammatical hypotheses based on hierarchical structure rather than, say, linear order. See Crain and Nakayama (1987) for an experiment investigating the constraint of structure dependence in yes-no questions in typically-language developing three- to five-year-old children. Other constraints govern the reference of noun phrases such as pronouns and reflexives. Our main

concern is a linguistic constraint that governs contraction and liaison phenomena across languages. In English, a number of contraction phenomena are governed by this constraint. A famous example is contraction of '*want to'* into '*wanna*', but it also governs when '*have to*' can be contracted to '*hafta*', and so on. In this paper, our focus is on how this particular linguistic constraint applies to sentences containing forms of BE, in particular, the third person present auxiliary or copula form '*is*'. Using elicited production methodology this investigation tests whether children with SLI obey this constraint on contraction in two linguistic environments. We also test a third linguistic context which is not governed by this constraint but in which contraction is, nevertheless, strongly dispreferred for pragmatic reasons. In the next section, we will summarise the properties of the verb BE, and introduce the three different linguistic contexts that were the subject of our investigation: answers with ellipsis, inverted yes/no questions and embedded wh-questions.

Contraction

Contraction is a term used to indicate the process by which a word becomes phonologically reduced. For example, the form '*is*' loses its vowel and becomes phonologically reduced to '*'s'*, which then cliticises to a host. In written language, the form '*is*' in the sentence '*The boy is hungry*' cliticises to the preceding subject noun phrase, as in '*The boy's hungry'*. In some linguistic environments, contraction is prohibited; due to a putative universal constraint, which, for convenience, we will term the 'UG constraint'. In other environments, contraction is dispreferred, either due to phonotactic restrictions or pragmatic considerations (cf. Bresnan, 1978; Kuczaj, 1979; Labov, 1969; Radford, 1988). Our study investigates two linguistic contexts where the UG linguistic constraint prohibits contraction; answers with ellipsis and embedded wh-questions and one context (inverted yes/no questions) where we take pragmatics to rule out contraction.

In contrast to the phonetic and pragmatic environments where contraction is dispreferred but not totally ruled out, in certain syntactic environments there is an absolute prohibition on contraction. The following examples illustrate that in these linguistic environments, the full form of BE is required and contraction is ungrammatical. Note the asterisk, which indicates that the contracted form in both examples is ungrammatical.

- Elliptical contexts: Question: *Is John coming?*

  Answer: Yes he is

  *Answer: *Yes he's*

- Certain constructions when a wh-word is moved

  I know where he is

  **I know where he's*

There have been many proposals to explain why contraction is not permitted in such syntactic environments (Chomsky 1986; Pullum & Zwicky, 1997; Selkirk, 1984, Smith & Allott, 2016). For the purpose of the current investigation, we draw on a well-known proposal from Bresnan (1978), though nothing hinges on using this proposal versus any other. According to Bresnan, the point of departure is the direction in which the contracted form of BE cliticises. English orthography suggests that BE leans to the left. When we write '*John's coming*,' the '*'s'* appears to be contracted onto the preceding noun phrase '*John'*. However, Bresnan proposed that, contrary to appearances, forms of BE contract to the right. This means that there should be some lexical material immediately to the right of BE to serve as a host. If there is not, then contraction is not permitted. Whether Bresnan's rule is adopted, or the phenomenon is considered to be governed by a constraint on destressing at PF (Chomsky, 1986), the empirical facts are the same.

Consider the elliptical context in example (5) below. In this context, when we answer a question with '*Yes he is [*$_{VP}$~~*coming*~~*]*' the verb phrase '*coming*' is filled in from the previous

discourse in our understanding, but it is not pronounced. The form of BE cannot lean on this silent verb phrase (VP) as it needs an overt host. Therefore, only the full BE form, as shown in (5a) is permissible. Notice that it is not the case that BE is unable to be contracted because it comes at the end of the utterance. In response to '*Is he coming?*', it would be quite possible to answer '*Yes, he is later*'. Now consider example (6). In (6a, b) it is possible to use the full form of BE or the contracted form. There is an overt lexical item '*doing'*, following BE in each case, and so contraction is possible although not required. The question word '*what*' has moved, but it does not compromise the possibility of contraction of BE. In (6c, d), however, the question word is moved from the position immediately following BE. This means there is a silent copy of the wh-word immediately following BE, and because there is no overt host, contraction is not possible, as shown in (6d).

(5) (a) Yes he is (~~coming~~)

(b) *Yes he's (~~coming~~)

(6) (a) Do you know what that is doing (~~what~~) up there?

(b) Do you know what that's doing (~~what~~) up there?

(c) Do you know what that is (~~what~~) up there?

(d) *Do you know what that's (~~what~~) up there?

(7) (a) Is he (~~is~~) coming?

There are a variety of pragmatic considerations that interact with contraction. The Gricean Maxim of Manner (Grice, 1975) relates to how a message is conveyed; it should avoid obscurity of expression or ambiguity, and be brief and orderly. Broadly speaking, then, a message should be presented with clarity. This extends to contexts of emphasis, where a full form of BE is preferred over a contracted form. Consider the following situation where an onlooker notices someone hasn't eaten their food and asks '*Aren't you hungry?*' The person then responds with, '*I <u>am</u> hungry, I just don't like the food.*' In this situation '*am*' receives

stress and so the full form is preferred (Pullum & Zwicky, 1997; Selkirk, 1984, 1995). Likewise, in asking a question such as '*Is the boy hungry?*', there is a strong preference for the preposed verb '*is*' not to be contracted so that the speech act of question asking is clear. Yes/no questions (e.g., '*Is he coming?*') have also been reported in the literature as presenting a syntactic context in which contraction is prohibited (Cleave & Rice, 1997). However, these cases do not appear to conform to the prohibition on contraction as formulated by Bresnan (1978) or the destressing rule discussed in Chomsky (1986). In (7), there is a pronoun immediately to the right of the moved copula '*is*' so contraction should, in principle, be permissible, even if in practice, it is dispreferred. This case has not received any coverage in the theoretical literature, so we will simply assume, as proposed above, that contraction is disfavoured in order to conform to Gricean maxims (Grice, 1975).

Previous literature on contraction in children with SLI

The topic of linguistic constraints on contraction has received little attention within the SLI literature. To our knowledge, the only other study that has investigated contraction of BE in children with SLI was conducted by Cleave and Rice (1997). This study investigated the spontaneous language samples of 22 children with SLI aged 4;5 to 5;2 and 10 language matched controls.

The motivation for Cleave and Rice's study was to test between the Surface account and the Extended Optional Infinitive account of SLI. Both accounts acknowledge that children with SLI frequently omit BE from their productions. However, Cleave and Rice anticipated that because both contracted and non-contracted forms of BE both carry tense, contracted forms would not be omitted more than full forms of BE. The Surface account, on the other hand, would predict that because contracted forms are less salient, they would present more acute problems for children with SLI, and be more likely to be omitted. The authors investigated the predictions of the two theories by testing whether children with SLI omit BE more often in a

range of contractible or non-contractible contexts. BE forms were classified as contractible if the BE verb occurred in a context in which it could attach the form to the previous word, e.g. '*The boy's running away*'. The non-contractible contexts were syntactically uncontractible or phonetically uncontractible contexts. Cleave and Rice classified the following contexts as 'syntactically uncontractible': elliptical contexts, e.g. '*He is';* yes/no questions, '*Is it a girl?*'; and contexts where the wh-word has moved e.g. '*I don't know where he is'*. Additionally, phonetically uncontractible contexts were contexts where there were phonotactic restrictions on contraction, *e.g.* '*The dish is broken*'. It is important to note that Cleave and Rice include yes/no questions as 'syntactically uncontractible' whereas we propose to treat such cases as not subject to an absolute prohibition on contraction, but rather strongly dispreferring contraction.

Cleave and Rice's experimental results showed that both the SLI group and the control group produced fewer omissions in the contractible contexts than the contexts in which contraction was not allowed. There was no difference between the syntactically uncontractible and phonetically uncontractible forms. The experimental findings led Cleave and Rice to conclude that because forms that cannot be contracted are omitted more frequently than contractible forms, the phonetic salience of the surface forms cannot be the factor driving omissions. Rather, because all forms of BE carry tense; one form should not be more affected than the other. This finding goes against the Surface account and is consistent with what Cleave and Rice predicted in line with the Extended Optional Infinitive account.

It is worth asking, however, about the contexts in which Cleave and Rice (1997) assumed that contraction was not permitted. As we saw, these authors grouped together elliptical contexts, yes/no questions, and contexts where the wh-word has moved, as contexts in which BE is not contractible, and calculated the omission rate across all three contexts. They do not separate out the omission rate for each type of syntactic context, so we have no way of knowing if any particular context contributed more to the percentage of omissions. This is

important because previous research has suggested that children with SLI have a preference for the colloquial form of yes/no questions in which BE is omitted, that is, '*You coming?*' rather than '*Are you coming?*' (Leonard, 1995). Therefore, it may be that the colloquial form of yes/no questions without the preposed BE is children's preferred way of asking this type of question. This could have inflated the number of omissions in syntactic contexts in which BE cannot be contracted.

The experimental findings from Cleave and Rice's study provide an important foundation for our inquiry into the restrictions on contraction in various linguistic contexts. However, our research question differs from Cleave and Rice's study in one critical way. Our research question focuses on the productions in which children provided BE. We asked whether children tend to contract BE when they can in these contexts, but inhibit contraction in linguistic environments where it is prohibited due to the UG constraint or pragmatic preferences. This contrasts with Cleave and Rice (1997) which investigated whether contractibility of BE affects omission rates.

The present investigation used elicited production methodology to collect a robust sample of data to evaluate children's linguistic knowledge of contraction. As noted, two contexts in which contraction of BE would lead to a violation of the UG constraint were investigated: answers with ellipsis and embedded wh-questions. For comparison, we also inquired whether children would contract the preposed auxiliary verb or copula in yes/no questions, assuming that in this context a pragmatic preference for clarity favours a full form of BE. The experimental contexts all focused on the third person present form of BE, '*is*', to see whether children provided the full form or the contracted form '*'s*'.

The experimental hypothesis is as follows: If children with SLI have linguistic knowledge of the UG constraint on contraction, then they will not produce contracted BE forms in linguistic environments in which the constraint is in effect. On the other hand, in the case of

yes/no questions in which we have suggested there is a pragmatic preference against contraction, children could, in principle, contract some proportion of the time.

Experiments

Participants

Fifty-one children participated in this experiment[10]. The participants included 17 children with SLI with a mean age of 5;6 (range 5;2-5;11); 17 language-matched children with a mean age of 3;6 (range 3;1-3;10); and 17 aged-matched (AE) children with mean age 5;4 (range 5;1-5;10). All children included in the study were drawn from English-speaking homes, and were acquiring Standard Australian English. Table I provides the detailed information for each of the three groups of children.

Children with SLI were recruited from early intervention centres for students with language impairment, in Perth, Western Australia. The language development schools provide specialised language and academic intervention for children with SLI. For inclusion into the school program the children had to have a diagnosis of language impairment by a speech-language pathologist and a recommendation for enrolment in the school program. Prior to enrolment, children's language skills were assessed using the Clinical Evaluation of Language Function (CELF-4) (Semel, Wiig & Secord, 2003). In addition, referral information also included evidence that children's non-verbal cognitive skills were within the normal range, as attested by a psychologist or paediatrician, using the Leiter international performance scale (Roid, Miller, Pomplun & Koch, 2013) as well one of the following assessments: Griffiths mental development scale (Griffiths, 1970) or Bayley scales of infant development (Bayley, 2003). To the authors' knowledge, at the time of referral, all children met the inclusion/exclusion criteria based on Leonard's (1998) requirements for diagnosis of SLI. This

[10] The study was approved by the Human Ethics Committee at Macquarie University as well as by the Department of Education of Western Australia.

included passing score of standardised hearing assessment, no recent episodes of otitis media with effusion, no neurological dysfunction, no oral structural or oral motor function anomalies and no symptoms of impaired reciprocal social interaction or restriction of activities. Children in the LE and AE groups were recruited through the university's paid participation pool as well as from preschool centres on the university campus.

In order to be included in the study, children in the SLI group scored 84 standard score or below on the Clinical Evaluation of Language Fundamentals-Pre-school-2 (CELF-P2) language screener assessment (Semel, Wiig & Secord, 2006) and scored 85 standard score or above on the Kaufman Brief Intelligence Test (KBIT-2) IQ assessment (Kaufman & Kaufman, 2004). To be included in one of the two control groups, children scored 85 standard score or above on the CELF-P2 language assessment and scored 85 standard score or above on the KBIT-2 IQ assessment. To ensure the control groups were matched evenly, the children in the AE group were within six weeks of age of at least one child in the SLI group. The children in the LE group had MLU values that were within ± =1 *SD* of the mean expected for age based on Rice et al. (2010) norms. In order to ensure equivalent groups based on language abilities, each subject in the LE group was within 0.04 morphemes of at least one child in the SLI group.

Table I. Mean and *SD* of group data by group.

Group	**N**	**Age (years; months)**	**MLU in Morphemes**	**SD %**	**CELF-P2 Standard Score**	**SD %**	**KBIT-2 Standard Score**	**SD %**
SLI	17	5.58 (3.42)	3.48	0.4	77	7.6	99	13.5
LE	17	3.55 (3.00)	3.67	0.4	119	9.6	N/A	N/A
AE	17	5.38 (3.39)	4.74	0.6	112	12.2	103	11.3

Note: KBIT-2=Kaufman Brief Intelligence Test, Second Edition; CELF-P2=Clinical Evaluation of Language Fundamentals-Preschool-2 (Australia and New Zealand edition); MLU=mean length of utterance; SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

The spontaneous language sample required for calculation of the MLU sample was collected by a speech pathologist in a naturalistic play environment. The same set of toys were

used to elicit the language sample for all three groups of children. The toy set included a variety of animals, people, popular television characters, food items, playground equipment, as well as a car and van for the animals and people to drive. All items were chosen to encourage interest and engagement in play and conversation. Each spontaneous sample lasted approximately 18-25 minutes, with 200 complete and intelligible utterances collected for each child. All language samples were coded and entered into SALT software for analysis (Miller, Gillon, & Westerveld, 2012).

Procedure: The elicited production task

Elicited production was used to evaluate children with SLI's knowledge of contraction in all three of our experimental conditions; elliptical contexts, inverted yes/no questions and embedded wh-questions (see Crain & Thornton, 1998). The next section of the paper presents each of the three experimental conditions along with the control conditions for each of the three experiments. A list of the questions used has been provided in Appendix C.

Experiment 1: Ellipsis

The goal of experiment one was to evaluate if children with SLI obeyed the UG constraint on contraction in discourse contexts in which there is ellipsis of the verb phrase. This was compared with children's rate of contraction in natural discourse, in environments where contraction is possible.

In this experiment, the child's task was to answer a question posed by an animated character presented in scenarios displayed on an iPad. In the original activity (authors work in press), the child was presented with three different types of wh-questions in the experiment[11]. However, for the purpose of this investigation, we restrict our attention to the one question type

[11] In the original experiment, three types of wh-questions formed the stimuli:
Question Type 1: What's [the boy/girl doing]? (VP-question)
Question Type 2a: Who's [wearing a beanie]? (NP-question with BE)
Question Type 2b: Who can [jump on the boxes]? (NP-question with modal)
This experiment looked at Question Type 2a.

that elicited an answer with ellipsis. It should be noted that the other two types of questions did not provide any input that could bias adherence to the constraint. An example of the question type is seen in example (8). The question posed to the child encouraged an answer with a noun phrase, such as '*The boy/He*' with a form of BE (e.g., '*He is*'). Of course, a full sentence answer with contraction, such as '*The boy's reading books at the library*' is also possible, but less likely in the context as it repeats information already presented in the discourse. The square brackets below indicate material that can be substituted. The lead-in question always included a contracted verb form. Should children have knowledge of the UG constraint, they would be compelled to go against the contraction they had just heard in the question and produce a question without contraction in their answer.

(8) *Zac: Who's [reading books at the library]?*

Child: The boy is/He is

This activity was presented in animated cartoons on an iPad. The child was introduced to an animated character named Zac who explained that he had broken his glasses and needed the help of the child to tell him what his friends were doing in the story. For each scene within the story, one of Zac's two friends was always engaged in an activity while the other character was present but not participating. The characters were clearly identifiable for the child, one being a female green animated character and the other a male grey character. After each of the scenarios was completed, Zac posed a wh-question such as (8) that asked about who was doing the activity in that particular scene in the story.

A total of 15 wh-questions were posed to each child during the activity. The activity took approximately 15 minutes to complete. No feedback was provided during the activity. If the child did not answer the question or only pointed rather than providing a verbal response, the experimenter provided the question again, either verbally or by replaying the question on the iPad.

Children's use of contraction in discourse contexts in which it is natural to elide the verb phrase was compared with children's rate of contraction in natural discourse. These spontaneous production data were taken from the speech sample collected for calculation of the MLU, as described above. This data sample was taken from a 200 utterance sample during play with the child and the experimenter[12].

Experiment 2: Inverted yes/no questions

The goal of experiment two was to evaluate if children with SLI obeyed the pragmatic restriction on contraction of the preposed auxiliary verb/copula in inverted yes/no questions. This was compared to children's rate of contraction in minimally different declarative sentences including the copula. In this activity, the child was required to ask yes/no questions such as '*Is it a car?*' or ''*s it a car?*' The rate of contraction in yes/no questions was compared with children's rate of contraction in a control condition in which declarative sentences such as '*It's a car*' or '*It is a car*' were elicited from the children.

The yes/no question elicitation game began with the experimenter explaining to the child that Polly the dog puppet has a favourite 'guessing game'. Polly pulled one toy at a time out of her box and then hid it from the experimenter and the child. Once Polly pulled out the toy the child was allowed to make a guess at what toy it was. On each trial, the experimenter provided a lead-in sentence to the child. To familiarise the child with the game and with asking questions, the game started with three '*Can*' practice questions about the toys. '*Can*' was used in the practice questions because it is less subject to contraction. The lead-in was as follows '*I wonder if it [can swim]. Ask Polly if [it can swim]*'. On completion of the practice items, the lead-in present the target items with BE: '*I wonder if it's [a car]. Ask Polly if it's [a car]'.* As in experiment one, contraction was used in the lead-in. If a child were sensitive to pragmatic restrictions on contraction, they would have to resist using the contraction they just heard, to

[12] This sample did not include utterances with BE which were syntactically or phonetically uncontractible.

produce a yes/no question without contraction. Following the lead in, the child then asked the question to Polly '*Is it a car?*' or '*'s it a car?*' Polly then responded to the child's question by giving a 'yes' or 'no' answer. The game continued until the child had guessed all items in the box.

During the course of the activity, a total of 20 yes/no opportunities were given to the child to produce the target question. The game took approximately 10-15 minutes to complete. There was no specific time limit given to the child. There was no feedback provided during or after the activity. If the child did not ask the question or used only a word such as '*Car?*' with rising intonation, the experimenter repeated the 'lead in' one more time.

The presentation of the stimuli was in the same order across all children participants. An Olympus recorder with a lapel microphone was used to record the children's utterances for later transcription and analysis.

Children's contraction rate in yes/no questions was compared with how frequently they contract BE in minimally different declarative sentences with the copula. Our assumption was that speakers are economical, and prefer to use the contracted form over the full form if they can (Crain & Thornton, 1998; McDaniel & McKee, 1998). The declarative sentences were elicited in a separate activity either within the same testing session or a separate session. In the declarative control condition, the child was told that Polly the dog puppet was learning the names of different toys. Given that the child is a 'toy expert', their job was to help Polly learn the names of the toys that Polly brought along in a toy box. The child was instructed to correct Polly if she guessed the wrong name of the toy that was pulled out of the box. To start the activity, the experimenter pulled out one toy item, and posed a question to Polly, '*What's this Polly?*' Polly then provided the probe sentence. In this probe, Polly made her guess at the toy, such as '*It's a dinosaur*'. If Polly made the incorrect guess, this was the child's opportunity to correct Polly by providing the correct name of the item, such as, '*(No), it's a fish*'. As in the

target yes/no questions, the lead-in probe sentence given by Polly (the experimenter) always included a contracted form of BE.

To familiarise each child with the game, there was a practice item at the beginning of the session, and every fourth item in the game was a filler item. On the filler trials, Polly made the correct guess and therefore could be rewarded for being correct. The purpose of the filler items was to ensure that the child did not recognise a pattern in the presentation of items, and to keep the child interested and motivated throughout the activity. The child produced a total of 15 target utterances during the course of the game. If the child did not correct the puppet, the probe sentence was repeated one more time. The game took approximately 5-10 minutes to complete.

Experiment 3: Embedded questions

The third experiment presented a second linguistic context relevant for application of the UG constraint on contraction. Recall that BE cannot contract if a wh-question word has moved from a position immediately to its right (e.g. '*What do you think that is/*that's ~~what~~?*') In this context, contraction is prohibited. In the experiment, we investigated the rate of contraction in embedded wh-questions were compared with minimally different control questions in which contraction is permitted. Type 1 questions tested the constraint on contraction. These target questions only permitted a full form of BE; a contracted form of BE would violate the constraint on contraction, '*Do you know what that is up there /*Do you know what that's up there?*'. The control questions permitted contraction, as well as the full form, as illustrated in '*Do you know what that's doing up there?*' or '*Do you know what that is doing up there?*' These control questions were termed type 2 questions.

This experiment had the child produce an embedded wh-question in a 'getting to know' game with Polly the dog puppet and her friends. The experimenter started the activity by encouraging the child to ask simple questions such as what the puppet's name was, if she had

any brothers or sisters, how old she was and so on[13]. Once the child was comfortable asking Polly questions the 'real' game started.

An example of the experimental protocol that was used is shown in (9) and (10). In this task, unlike the other two experimental tasks, the experimenters always used uncontracted forms in the lead-in. This was necessary as contracted forms would have been ungrammatical in (9).

(9) Type 1 target question protocol

Experimenter lead-in: I wonder [what that is up there]. Ask Polly if she knows [what that is up there]. <Experimenter points to something on the shelf>

Child: Do you know what that is up there?/~~Do you know what that's up there?~~

Puppet: That is a silly monkey!

(10) Type 2 control question protocol

Experimenter lead-in: I wonder [what that is doing up there]. Ask Polly if she knows [what that is doing up there] <Experimenter points to the monkey sleeping on the shelf.>

Child: Do you know what that is doing up there?/Do you know what that's doing up there?

Puppet: I think it is a monkey sleeping!

In experiment three, children had a total of 20 opportunities to ask a question. Of the 20 opportunities, 12 questions were 'type 1' questions and 8 of the questions were 'type 2' questions. Children produced both main clause wh-questions and embedded wh-questions in the experimental context, but only embedded wh-questions were included in our analysis. The other wh-questions were not relevant to the experimental hypothesis. The game took approximately 15-20 minutes to complete. There was no specific time limit given to the child and there was no feedback provided during or after the activity. If the child did not ask the

[13] It was important to have the child ask questions for which she didn't know the answer. This step ensures, for the most part, that children don't experience the 'ask-tell' problem in which they give the answer to questions rather than ask them.

question or used only a single wh-word such as '*what', 'who', 'where*' rather than a full question, the experimenter repeated the lead-in one more time.

Coding of responses across Experiments

To ensure reliability, all transcriptions were scored by the first author and then double scored by a trained speech-language pathologist with experience in transcription. Across the experimental conditions the agreement rating was 99.7%. Any disagreement between the two transcribers were resolved by further discussion.

Because perception of contraction could potentially be somewhat subjective, ten adults participated in a further reliability judgement. These ten adults had no knowledge of the research questions under evaluation. The adult reviewers were asked to listen to experimental data and make judgments regarding the utterances produced by children participants. The data presented to the reviewers were not presented in any surrounding linguistic context, making their task more difficult than the original transcription undertaken by the speech pathologists. Reviewers' judgments were then compared to those of the transcribers' judgments to ensure reliability.

The adults heard a combined total of 29% of the yes/no and ellipsis data sets. The children's utterances with and without contraction were randomly ordered and mixed between the yes/no questions, answers with ellipsis and the declarative dataset. The experimenters, on the other hand, listened to children's productions in the three separate experimental conditions, which was not as taxing as hearing a random selection of contracted and uncontracted utterances. None of the utterances were excluded from the sample based on the quality of the recording, none of the utterances were modified for quality of recording.

The dataset included the following from the SLI group:

- Each child's first four inverted yes/no questions e.g. '*Is it big?*'
- Each child's four elliptical utterances e.g. '*She is*'

The following two sets of data were interleaved as controls:

- Each child's first four full utterance productions with a contracted form of BE in the ellipsis activity e.g. '*He's cuddling the bear*'
- Each child's first four full utterances with a contracted BE verb in the declarative activity '*It's a flower*'

The adult reviewers were told that they would be listening to a series of children's sentences, one after another through noise cancelling headphones. The adults were given verbal instructions that each utterance included either a contracted form or full form of BE, such as '*He's eating icecream*' and '*He is eating icecream*'. The participant was instructed to verbally tell the experimenter which of the two forms they heard after each of the utterances. Adults gave their judgements verbally, to avoid any bias from written English orthography. The experimenter would then write down their response. All adult reviewers listened to the items independently and heard the same set of utterances presented in the same order. At any time throughout the activity the adult participant could stop the recording and listen to the utterance again. The task took approximately 15 minutes.

The reliability judgement rating made by each of the adult reviewers was compared to the transcribers' judgements. For example, if one adult participant thought the child said '*is*' but the experimenter made a judgement of '*'s*' this was calculated as one difference. For each adult, the total number of similar ratings was calculated out of the total number of utterances. A similarity rating for that adult was then combined with the similarity rating of the other adults in the group. A mean similarity rating between the ten adults compared to the experimenters was calculated. The agreement rating between the adult reviewers and the experimenters for the yes/no experiment was 87%. The agreement rating between the adult reviewers and the experimenters for the ellipsis productions were 91%.

Results

The authors hypothesised that children will contract rather than provide the full form of BE if the context allows for either form. On the other hand, in linguistic contexts where contraction is prohibited, the hypothesis was that children would fail to contract. We tested two contexts in which a purported UG constraint on contraction was in place, and a further context in which contraction was strongly dispreferred due to pragmatic restrictions.

Experiment 1: Ellipsis

In experiment one children answered a question, such as '*Who's wearing a beanie?*' Contraction of BE was used in the lead-in question. This game elicited a total of 207 statements with ellipsis of the verb phrase from the children. If a child's answer included either a nominative or accusative noun phrase, such as '*him, he, the boy, the girl,'* combined with BE without contraction '*is*' or with contraction *''s'* it contributed to this analysis. As can be seen from table II, the SLI group produced fewer elliptical answers than the other two groups of children. This is due to the fact that the SLI group tended to produce more full answer responses to questions, answering '*He is eating ice cream*' instead of '*He is*'. However, of the 30 elliptical answers produced by the children with SLI, every answer was produced without contraction. Children did not pick up on contraction in the lead-in question, and instead obeyed the UG constraint in the elliptical context. The children with SLI did not differ from the children in the control groups, who also adhered to the UG constraint 100% of the time.

Table II. Mean percentage and raw numbers of the total number of answers with ellipsis and spontaneous productions with contracted BE.

Question Context	**Ellipsis**		**Productions of BE within MLU sample**	
Group	**With Contraction**	**SD %**	**With Contraction**	**SD %**
Example	****The boy's***		***That's a bird***	
SLI	0.0% (0/30)	N/A	87.1% (349/405)	9.0
LE	0.0% (0/112)	N/A	84.2% (321/379)	13.1
AE	0.0% (0/53)	N/A	83.0% (388/466)	15.0

Note: SLI=specific language impairment; LE=language equivalent; AE=age equivalent.

Next, we look at the control data in table II, where the contracted BE form‘ *’s*’ in the spontaneous production data can be seen. Both copula and auxiliary BE forms were included in this dataset. It can be observed from table II that all three groups of children contracted BE over 80% of the time, clearly favouring contraction. These data were compared with children’s use of contraction in contexts of ellipsis shown in Table II. In order to test the significance of the difference, a Rank-based 2 X 3 mixed ANOVA (parametric) test was conducted with Condition (target condition and control condition) and Group (3 groups) (SLI=15, LE=17, AE=17). The main effect of group was not significant F=1.15, p=0.32, the main effect of condition was significant F=594.99, p<.001. The interaction between group and condition was not significant F=1.15, p=0.32.

Experiment 2: Yes/No questions

Experiment two elicited a total of 839 yes/no questions across the three groups of children. Only questions that were in the form of a yes/no question with a preposed copula, ‘*Is it [a/the boat]?*’ were included. Specifically, utterances that included BE in full form ‘*is*’, or contracted form ‘ *’s*’; as well as a noun phrase, such as, *’it, that’* and a noun or adjective, such as, ‘*dog, cat, fish, book, big, blue’* etc. were included. The SLI group produced fewer questions of this type than the other two groups of children because they were more likely to produce questions with BE omissions, e.g. ‘*It a book?*’, and were more likely to produce non-inverted yes/no questions with rising intonation, e.g. ‘*It’s a book?*’[14] However, as can be seen from table III, when children with SLI did produce an inverted yes/no question with all the required elements, they preferred to use the form without contraction 100% of the time. This showed that they have a strong pragmatic bias against contraction.

[14] Of the 17 children in the SLI group, 2 of the children did not produce any utterances with the inverted yes/no question structure. These children’s utterances were mostly comprised of yes/no questions without inversion, such as ‘*It’s a boat?*’

Table III. Mean percentage and raw numbers of the total number of yes/no questions and declarative productions with contracted BE.

Question Context	**Yes/No Q**		**Declarative**	
Group	**With Contraction**	**SD %**	**With Contraction**	**SD %**
Example	****'s it a book?***		***It's a boat***	
SLI	0.0% (0/187)	N/A	99.1% (193/195)	3.7
LE	0.0% (0/328)	N/A	99.1% (167/169)	3.4
AE	0.0% (0/324)	N/A	99.6% (204/205)	1.7

Note: SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

A total of 570 declarative sentences were elicited across the three groups of children, and were included in the analysis as the control structure. If the child's production included a pronoun, such as '*he, it, she, him*', a BE morpheme either in contracted form '*'s*' or not contracted form, '*is*' and a noun phrase, '*boat*' then it was included in the analysis[15]. Table III also displays the group data for the control context. All three groups of children have a clear preference for contraction when either form was appropriate in the control context. However, children never provided contraction in the context where there was the pragmatic bias for the full form; therefore, we do not report a statistical analysis for this comparison here.

Experiment 3: Embedded wh-questions

This experiment elicited two minimally different embedded questions which we termed type 1 target questions and type 2 control questions. The experimental scenario for experiment two elicited a total of 365 questions from the children for analysis. Only two clause questions with a clause embedded under '*Do you know'* clause, with or without the '*DO*', were included in the analysis. To meet inclusion criteria, the questions also needed to include a wh-word in the embedded clause, as well as BE, either in contracted or uncontracted form. Recall that in this

[15] Because of a phonotactic constraint on '*this*' and '*is*' appearing adjacent to each other, if the child used '*this*' we did not include it in our analyses. Interestingly, within our experiment one boy in the SLI group contracted in all other instances of BE, however used the full form when using '*this*' as the noun phrase in his sentence.

activity two types of embedded wh-questions were elicited from the children. However, the type 1 target questions such as '*Do you know what that is up there?*' allowed only a full BE form. Type 2 control questions allowed for either a full BE form or a contracted BE form; '*Do you know what that is doing up there?*' or '*Do you know what that's doing up there?*'. The experimental findings are shown in table IV. As can be seen in table IV, the findings for type 1 targets revealed that the children with SLI correctly inhibited contraction at rates close to 90%.

Table IV. Mean percentage with *SD* and raw numbers of the total number of embedded wh-questions with contraction BE in target context and control context.

Question context	**Type 1 context**		**Type 2 context**	
Group	**With contraction**	**SD %**	**With Contraction**	**SD %**
Example	****Do you know what that's up there?***		***Do you know what that's doing up there?***	
SLI	8.3% (2/38)	28.9	15.0% (5/30)	22.5
LE	10.6% (3/62)	28.6	28.2% (11/36)	32.3
AE	6.8% (5/95)	11.3	47.4% (48/104)	29.1

Note: SLI=Specific Language Impairment; LE=language equivalent; AE=age equivalent.

The type 2 control questions can be framed either with or without contraction. For the type 2 control condition, all three groups of children preferred to use the full form over the contracted BE form in their responses. The children with SLI preferred to use more full BE forms than their age-matched five-year-old peers, but had a profile similar to the three-year-old children.

The rate of contraction in type 1 embedded wh-questions was compared to the minimally different type 2 control questions in which contraction was permitted. A Rank-based 2 X 3 mixed ANOVA (parametric) test was conducted with Condition (target condition and control condition) and Group (3 groups) (SLI=7, LE=10, AE=16). The main effect of group was non-significant F=2.236, p=0.10, the main effect of condition was significant F=9.22, p<=0.002.

The interaction between group and condition was not significant F=1.26, p=0.28. The sample is small for this analysis. We discuss the implications of these findings in the next section of our paper.

Discussion

Previous research has shown that children with SLI have persistent difficulties in mastering grammatical morphology. Morphemes which carry the finiteness of the sentence have been found to be especially problematic for children with SLI (cf. Bedore & Leonard, 1998; Hadley & Holt, 2006; Hadley & Short, 2005; Marchman et al., 1999; Rice & Wexler, 1996). For this reason, finiteness has been proposed as a clinical marker for English-speaking children with SLI (Rice et al., 1995; Rice et al., 1998; Rice et al., 2009; Rice & Wexler, 1996). We turned to constraints, in order to enlarge our knowledge base about the kinds of grammatical structures or processes that are at risk in this population of children. We studied a constraint that has been proposed to be part of 'Universal Grammar', our innate linguistic knowledge and asked whether this aspect of linguistic knowledge is in place in children with SLI (cf. Chomsky, 1986). As noted, we also studied a linguistic environment that we have assumed to be governed by pragmatic knowledge. Although the source of the prohibition on contraction may differ, we did not find children more likely to contract in the pragmatic context, where we assumed that children could, in principle, contract.

In order to implement our study on contraction, we investigated children's productions of sentences involving contraction (or not) of the verb BE. Since this is a verb that carries finiteness, there was obviously some loss of data in the SLI group, as the verb was sometimes omitted in the productions of children with SLI, and such productions had to be excluded. Nevertheless, we were able to collect a robust enough sample of data to pursue our research question. The main finding was that children with SLI obey the UG constraint on contraction, and also fail to contract in the context governed by pragmatics. This suggests that the language

challenge faced by this group of children is quite specific, and does not extend to this purportedly innate constraint[16]. It is worth pointing out that it would be very difficult to learn the restrictions on contraction by attending to the sentences provided by parents and caretakers. It is likely that it would take considerable time to hone in on the details of when it is and is not possible to contract, and in the meantime, that children might make many errors. This is not what was observed in any of the child data. All of the children, including those children with SLI are very accurate, and make few errors.

We found that children have a strong tendency to contract when they can. In experiment one, we found that in natural discourse, all groups of children contracted BE over 80% of the time, while no child contracted when giving an answer with ellipsis of the verb phrase, such as '*He is'*. Likewise, when we elicited declarative sentences in an experimental situation, children in all the groups took the opportunity to contract as much as 99% of the time, while refraining from contraction in the yes/no questions 100% of the time. Notice that in both of these experiments, the experimenter's lead-in for the target structure used contraction of BE, and the children followed suit if they could. However, if contraction were to violate the constraint, children did not follow the contraction in the experimenter's lead-in. The third experiment was designed differently, because contraction in the lead-in would have introduced ungrammaticality. In experiment three, the experimenter used a full form of BE. It should be acknowledged from the outset that this structure was much more difficult than the structures elicited in experiments one and two. In the type 2 embedded questions, which were the controls where contraction was possible, the children did not contract to the same extent as in experiments one and two. The AE group contracted 47% of the time, while the SLI group and the LE group contracted less than 20% of the time. Nevertheless, in the type 1 targets, where

[16] Some readers may be reluctant to assume this knowledge is part of Universal Grammar. We have shown that children with SLI perform similarly to typically-language developing children. If this is the case, whatever mechanism is responsible for this knowledge appears to be the same in children with SLI and typically-language developing children.

contraction is ruled out, all children failed to contract around 90% of the time or more, and this yielded a significant difference between conditions.

We might ask, however, why it was that children did not contract to the same extent in the type 2 control questions as they did on the control conditions in experiments one and two. One explanation is that both very similar questions were elicited from the children within the same session, and these questions were quite tricky. Clearly, in this situation, the conservative strategy is to play it safe and not contract. To evaluate whether or not there was a carry-over effect, future research could use a between subject design or test the two types of questions in separate test sessions. Finally, we should acknowledge that the data sample used in the analysis is relatively small, although the results clearly indicate knowledge of the constraint. Future research investigations could include testing children's knowledge using different sentence structures and other linguistic contexts. There are clinical implications for these findings. In accordance with previous research, one goal of therapy sessions should be on instruction of grammatical morphemes. The obligatory nature of these forms needs more instruction for this group of children and this can be done at both in declarative sentences and question forms.

Conclusion

The present investigation evaluated adherence to the linguistic constraint on contraction in children with SLI. To the authors' knowledge this is the first experimental study investigating the UG linguistic constraint on contraction in children with SLI. This research offers a unique and important contribution to the nature of the internal grammar systems of children with SLI. Despite the challenge that English-speaking children with SLI experience with acquiring morphosyntax, their grammatical knowledge of the linguistic constraint on contraction does not differ from typically-developing children. Our experimental results showed that children with SLI have in place the linguistic knowledge that guides when contraction is permitted, and when it is prohibited in production. This suggests that this aspect of linguistic knowledge is not

learned from the environment, but follows from innate linguistic knowledge, as outlined in the theory of Universal Grammar (Chomsky 1965, 1981). Turning to theories of SLI, these experimental findings are compatible with Rice and Wexler's Extended Optional Infinitive account of SLI (Rice & Wexler, 1996), since this theory assumes a biological basis for language acquisition. In turn, the experimental findings challenge accounts such as Leonard's Surface account (Leonard 1995) which assumes that children must learn facts about contraction and other syntactic phenomena from the linguistic input.

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Chapter 5

General Discussion

General Discussion

There is something incredibly unique and remarkable about children's biological make-up that allows them to acquire and to use language the way that they do. The language abilities seen in children are evident even before a parent hears their child's first words uttered. The development of their language is ever changing and evolving rapidly throughout their first few years of life. There is a group of children who do not achieve the same successes in language. This group of children is generally referred to as children with specific language impairment (SLI). Although it is well documented in the literature that children with SLI have difficulties in a range of language areas, there is also reason to believe that some components of their grammar may be more affected than others. Extensive research has shown that grammatical morphology is one component of language where English-speaking children with SLI face difficulty. In particular, morphemes which carry tense have been found to be problematic for this group of children (Cleave & Rice, 1997; Grela & Leonard, 2000; Ullman & Gopnik, 1999). Previous literature has reported that children with SLI have difficulties with the syntactic component as well. As a consequence, structures such as questions are thought to be affected. These children are observed to have difficulty with the movement operations required in computing and forming questions (van der Lely, 1998). However, the evidence to support this finding has been mostly based on a subgroup of children who are classified as having Grammatical SLI (G-SLI). Therefore, less is known about whether those children who are not part of this subgroup have difficulties with the syntax involved in questions. It was this gap in the research which led us to explore the broad question: *Do children with SLI have difficulties with the syntax involved in question structures?*

This was the fundamental research question that guided the studies conducted for this thesis. As a way to explore this question, we set-up three experimental studies to investigate three phenomena that could contribute to our knowledge of children's syntactic knowledge of

question structures. Our investigations showed that although this group of children are challenged in various aspects of language, they do quite well with the syntax involved in question structures. They have no difficulty with the computation of structure needed to represent questions, although learned aspects of question structures, such as the rule for subject-aux inversion prove more challenging. The next section provides an overview of the main findings presented across the three chapters.

Overview of main findings

The first study (**Chapter 2**) investigated aspects of morphology, syntax and pragmatics in children with SLI's answers to wh-questions. The aim of the study was to investigate whether the impairment seen in children with SLI is observed across different language components. The experimental results showed that the SLI group of children demonstrates comprehension of wh-questions. This finding was revealed by studying the syntactic form of their answers and investigating whether or not they were of the appropriate syntactic category. Children with SLI also demonstrated knowledge of certain aspects of pragmatics. In contrast to the control children, children with SLI did not show sensitivity to one measure of Grice's Maxim of Quantity; in colloquial contexts when most speakers would give a short fragment answer to wh-questions, they gave more full sentence answers. As anticipated from previous research, the greatest challenge for children with SLI in this study was in providing tense-related morphemes in their answers to questions. Children's answers frequently omitted the tense-related morphology.

The second study (**Chapter 3**) investigated the syntactic rule of subject-aux inversion (SAI) in main clauses and embedded clauses. The aim of this study was to investigate whether children with SLI have difficulty in forming linguistic rules on the basis of the evidence in the input. The experimental results showed that although children with SLI produced fewer analysable questions (partly because there were many omissions of auxiliaries), these children

used the SAI rule at similar rates as their peers in main clause questions. In embedded clause questions, however, children with SLI over-generalised the rule at a much higher rate than the control children. This finding suggests that children with SLI are delayed in mastering the fine details of the SAI rule. Once adept at the SAI rule, they take longer to learn when *not* to use it.

The third study (**Chapter 4**) investigated children's adherence to the linguistic constraint on contraction across question structures. The aim of this study was to investigate whether children have the same underlying grammar as typically developing children in this aspect of linguistic knowledge. The experimental results revealed that children with SLI respected the constraint well. Children contracted where it is possible and avoided contraction where contraction is prohibited. In addition, this experiment also was able to show that children with SLI do, in fact, generate a gap in their question structures. This is evident because children prohibited contraction in certain linguistic environments, but only where there is a gap or trace in the question structure. This is an important result, as previous research has reported that children with G-SLI have a deficit in the computational system. Children with G-SLI have been shown to often fill the gap in their questions. This can be observed in the question '*What do you like something?*' where '*something*' is inserted where the gap should be (van der Lely & Batell, 2003; van der Lely, Jones & Marshall, 2011). However, the studies discussed in this dissertation did not show this result, and in fact showed that children with SLI do in fact have good command of the computational system[17].

These three studies on question structures offer significant and interesting broader implications about the grammatical knowledge of children with SLI. What we have learned from questions structures about aspects of morphology, syntax, and pragmatics will be discussed in the next section.

[17] It was suggested by a reviewer that the finding in study 1 where children with SLI tended not to use ellipsis can be taken to suggest a similar finding to van der lely's claim that children can't interpret or assign reference to a trace.

Morphology

There is general consensus that morphology is particularly challenging for English-speaking children with SLI (Cleave & Rice, 1997; Grela & Leonard, 2000; Ullman & Gopnik, 1999). The typical error pattern results in frequent omission of tense morphemes in contexts where they are obligatory. This finding was consistent across the three studies reported in this thesis as well. It was observed than children with SLI were more likely than their peers to drop the auxiliary verb/copula in their questions and their answers to questions. For example, in **Chapter two** the experimental results showed that children with SLI omitted the BE morpheme in their answers to wh-questions 27% of the time, whereas the language-matched children omitted 14% of the time, and the age-matched children omitted 0% of the time. These rates of omission coincide with data reported by other researchers.

Our study of children's use of the verb BE confirmed that children with SLI find morphemes associated with finiteness challenging as compared to morphemes that do not express tense. In **Chapter two**, we were able to show that children with SLI frequently omitted BE, but almost never the aspectual marker -*ing*. Thus, our experimental findings are consistent with previous research by Rice, Wexler, and Hershberger (1998), who reported this contrast.

Schütze and Wexler's (1996) prediction about the form of pronoun used in subject position was also put to the test in **Chapter two**. Under Schütze and Wexler's theory, nominative Case is assigned under agreement (and tense is unrelated). When a form of BE is present in the sentence (e.g., *is*, *was* etc.), children will always use a nominative pronoun because these idiosyncratic forms require incorporate both tense and agreement to be present in the structure. When a sentence is missing an auxiliary/copula form of BE, one or other of the tense or agreement features could be present; if agreement is present, the pronoun in subject position will be nominative but if only tense is present, the pronoun will be accusative. Our findings support Schütze and Wexler's prediction. When the BE form was present, a

nominative pronoun (i.e. '*he is…'* or '*she is…'*) was used. When the BE form was missing, children produced either a nominative pronoun or an accusative pronoun.

All three of the experiments discussed support what has been previously reported in the literature. It was found that children with SLI kids were much more likely than their peers to drop the auxiliary verb/copula, a morpheme which carries tense.

Pragmatics

Pragmatics covers a broad spectrum of properties related to the ability to use language for social purposes. This investigation touches on two aspects of pragmatic knowledge: one aspect of Gricean Maxim of Quantity and a related aspect of information structure (Grice, 1975).

Gricean Maxim of Quantity

In the first study, reported in **Chapter two,** we investigated the Maxim of Quantity in children's answers to wh-questions. We were interested in whether children answer wh-questions with full sentence answers, which were grammatical but provided redundant information; or whether they provide fragment answers giving the requested information. For example, in example (1), do they give full sentence answers like (1a) or (1b), or the fragment answer in (1c)?

(1) Question: What's the boy doing?

(a) The boy's drinking a soda

(b) He's drinking a soda

(c) Drinking a soda

The finding was that children with SLI produced more full answer responses, such as '*The boy's drinking a soda*' than the control groups of children for both question types in the study. Three possible explanations to account for this finding was discussed. One interpretation that was given for this result was that children with SLI are instructed from teachers to produce more full sentence answers. However, this explanation was ruled out for two factors. The first

reason being that in the '*Who's VP?*' question elicited to the children, the SLI group were significantly different to the AE children in their full sentence answers. However, in the '*What's NP doing?*' question, the LE children were similar to the SLI group. Therefore, it is unlikely that school is a factor since we observed these parallels with both control groups. If schooling were the reason behind these longer answers, we would expect the AE school-age children to be similar to the children with SLI, but not the three-year-old LE children. It was also put into question why children with SLI would be able to attend to instruction to provide a full sentence answer, but are unable to comply with instruction to provide tense-related morphology.

Another suggestion for this finding may be due to an insensitivity to the Maxim of Quantity. This explanation was ruled out based on linguistic theory. It was explained that the 'size' of the children's answers are thought to stem from children's knowledge of language-specific properties of answers in English. This knowledge must be learned by the child. From this perspective, full sentence answers are, in some sense, easier than fragment answers. A full sentence answer is thought to be more economical because it does not require extra focus and deletion operations. If this idea is adopted, then the greater number of full sentence answers that are observed in the SLI group may be because children are opting for a more economical answer. This may be due to more limited processing resources, or because they have not yet learned that elliptical fragment answers are permitted in English. This question remains open for further investigation.

Information structure

A second aspect of pragmatic knowledge that is related to Gricean Maxim of Quantity was also explored in **Chapter two**. Use of information structure is concerned with whether or not children repeat 'given' information that has already been introduced in the discourse context. The idea is that once an entity has been introduced using a noun phrase, such as '*the*

boy' in example (1a), it can generally be referred to thereafter with a pronoun '*he*'. This is because '*the boy'* has already been established in the conversational context. It is therefore the 'given' information and the use of a pronoun '*he*' is more natural, as illustrated in (1b). (1c) '*drinking a soda*' also assumes that the topic of conversation is '*the boy'* and this answer is the most natural one, providing only the new information requested by the question. Our study investigated whether children with SLI are sensitive to this aspect of pragmatics.

The finding was that children with SLI have knowledge that it is more pragmatically appropriate to use a pronoun in an answer, rather than a full noun phrase. The experimental results showed there was little difference between the children with SLI and the children in the control groups. This aspect of pragmatics is clearly not problematic for children with SLI.

Syntax

This dissertation offers considerable information about children with SLI's syntactic knowledge. The results across the three studies showed that children with SLI are quite good at the syntactic requirements of question structures. This finding diverges considerably from previous literature on the topic. Previous research has reported that English-speaking children with SLI, have difficulties with the syntactic requirements of question structures (Ebbels & van der Lely, 2001; Schulz & Roeper, 2011; van der Lely & Battell, 2003). Our findings from the three studies report different findings that will be explained in the next section.

Answers to questions

The study reported in **Chapter two** found that children did not produce fragment answers that were not of a syntactic category permitted for the relevant wh-question. Assuming Merchant's theory (Merchant, 2004; Merchant, Frazier, Clifton & Weskott, 2013) of question answer pairs, the comprehension results suggest that children do not have any difficulty representing the syntactic structure of questions and their answers. The results from our study do not support the findings reported in van der Lely and Battell's (2003) work with children

with Grammatical SLI (G-SLI). The authors report the impairment for wh-questions is within the computational system itself, affecting the syntactic dependencies between the wh-word and its copy at the clause level. The finding that children with SLI can understand question structures is in line with what Deevy and Leonard (2004) reported in their work. However, we argue that our task of verbally producing an answer does not induce the type of processing demands that the picture-pointing task they used may have.

Question productions

Children with SLI's ability to produce wh-questions was investigated in **Chapter three.** This study showed that children with SLI have the ability to produce grammatically appropriate question structures. This finding is important as production is assumed to be more difficult than comprehension. Although it is true that children with SLI are more likely to struggle to provide the required elements for their questions, all children in the SLI group showed that they were able to produce a grammatical wh-question at some point in their question elicitation. The result that children with SLI are able to produce grammatical wh-questions contrasts to the findings reported in previous work, particularly work done by van der Lely and colleagues (van der Lely, 1998, 2005; van der Lely et al., 2011; van der Lely & Pinker, 2014). These authors have made the claim that children with G-SLI fail to carry out the two movement requirements in wh-questions. According to the authors, children with G-SLI have difficulty with tense/question feature movement. Their utterances frequently include missing auxiliaries, or a lack of wh-operator movement, which results in a filled gap (van der Lely & Battell, 2003). This finding that children fill the gap was not found in our investigation. Furthermore, the data presented in **Chapter four** offered further evidence to show that children are, in fact, generating question structures that have a gap. This is known because if children did not have a gap (either from moving a question word, or deleting material) they then would not be obeying the constraint on contraction. However, our study found that they do obey the

constraint, without error. The data presented across the three studies suggests that the computational system does not seem to be impaired. According to the theory of Universal Grammar, this part comes for free, and that seems to be true for children with SLI as well.

Language-specific knowledge

This dissertation also tested knowledge that is language-specific to English. The rule of subject-aux inversion (SAI) is not universal to all languages, but rather a rule which English-speaking children must pick up from their language input. Even though it is a language specific rule, it builds on UG operations. In other words, it is an instance of head movement, movement from one head (T), to C. Therefore, this rule still operates within the confines of possible UG movements. In **Chapter three** it was reported that when children with SLI do include the auxiliary/copula in their wh-questions, they produce wh-questions with the correct subject-aux inversion. It is the case that these children do implement the rule, however we do not see evidence of this until a bit later. This is simply because children optionally use the auxiliary for an extended period of time. Our study was also able to show that once children learn the rule of SAI, they have more difficulty than their peers in inhibiting the rule. The SLI group over-generalised the SAI rule in embedded-clause in 27% of their question productions. This data from experiment two in **Chapter three** showed that children with SLI are a bit delayed in learning to use the rule and also learning when not to apply the rule.

Future directions

This investigation offers a piece of the puzzle concerning children with SLI's grammatical abilities. However, the picture surrounding the disorder of SLI is one which is not completely clear. There are a number of areas which have yet to be addressed, and the other areas which require further investigative attention to clarify the picture for both researchers and clinicians alike. This thesis offers important information about children's grammatical knowledge, especially in respect to syntactic knowledge. However, grammar, and in particular syntax is a

multifaceted and complex part of children's linguistic knowledge, and question structures are only one component of syntactic knowledge. Therefore, future avenues for research could include studying different syntactic structures in the same group of children. Structures such as relative clauses, i.e. '*Can I have the money that I lent you last week?'* and reversible passives, i.e. '*The boy is hugged by the girl'* would offer additional insight into the syntactic knowledge of children with SLI.

Conclusion

Children with SLI pass through stages of language acquisition in much the same way as children whose language is developing in a typical fashion. In contrast to their peers, children with SLI reach these milestones in a delayed timeframe. One aspect of children's grammar which does not reach adult-like capability, and remains an area of difficulty is tense morphology. This finding has been supported by rigorous research. It has also been suggested that children with SLI have difficulties with syntax; that in turn, has an effect on question structures. However, this research has mostly been drawn from an older subgroup of children classified as having G-SLI. This thesis set out to explore whether the finding of delayed syntactic knowledge involved in question structures is something seen across a general population of children with SLI. To do this, this thesis explored three aspects of children with SLI's syntactic knowledge in respect to question structures: answers to questions; the rule of subject-aux inversion in question productions; and adherence to the linguistic constraint on contraction in questions. These three questions together provided the theoretic basis behind the main argument given in this detailed investigation. That claim being, that children with SLI do not have difficulties in all areas of language, but show syntactic knowledge involved in their question structures.[18] This statement can be supported by evidence found across the three

[18] It must be noted that this investigation did not test children's comprehension of object (*who* and *which*) questions which have previously been found to be difficult for children with SLI. Therefore, the argument cannot be made that children with SLI have no difficulties with question structures since comprehension of object (*which* and *who*) questions were not studied in this investigation.

studies. Firstly, children with SLI demonstrate that they have no difficulty computing the appropriate syntactic structures in their answers to questions. Secondly, children with SLI show that they acquire the SAI in a delayed timeframe, however once they have learned the rule, children implement it well. Thirdly, children with SLI respect the linguistic constraint on contraction, and do not differ from the control groups in this aspect of linguistic knowledge. It was also seen in this study that children with SLI are generating a gap in their questions. This result provides evidence for command of the computational system.

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APPENDIX A

Who can jump on the boxes?
Who can run the fastest?
Who can walk on the rope?
Who can eat all the pizza?
Who’s taking food out of the fridge? He is/The boy is
Who’s eating ice cream on the grass? She is/The girl is
Who’s singing a song on the stage? He is/The boy is
Who’s holding a drink on the beach? She is/The girl is
Who’s buying food at the canteen? She is/The girl is
Who’s fishing for a fish on the boat? He is/The boy is
Who’s cuddling a teddy on the couch? She is/The girl is
Who's wearing a hat at the birthday? He is/The boy is
Who’s playing toys in the bedroom? He is/The boy is
Who’s dancing outside in the rain? He is/The boy is
Who’s painting a picture on the wall? He is/The boy is
Who’s making a snowman in the snow? She is/The girl is
Who’s shooting the ball in the hoop? He is/The boy is
Who’s helping the farmer on the farm? She is/The girl is
Who's reading books at the library? He is/The boy is

APPENDIX B

1. Yes/No questions

Can it swim?
Can it walk?
Can it talk?
Is it a horse?
Is it big?
Is it an animal?
Is it a puppy?
Is it a duck?
Is it a dog bone?
Is it a shoe?
Is it food?
Is it a hamburger?
Is it a rope?
Is it a ball?
Is it a cat Polly?
Is it blue?
Is it a dog collar?
Is it a magic wand?
Is it a book Polly?
Is it a texta?
Is it a coin?
Is it a shirt?
Is it glasses?

2. Matrix and Embedded-clause questions

Do you know what that is up there?/What is that up there?
Do you know how good Moe is at soccer?/How good is Moe at soccer?
Do you know where the crocodile is in the room?/Where is the crocodile in the room?
Do you know where the crocodile is on the shelf?/Where is the crocodile on the shelf?
Do you know where Sally is in the picture?/Where is Sally in the picture?
Do you know what that is in the box?/What is that in the box?
Do you know what that is in the box?/What is that in the box?
Do you know what that thing is up there?/What is that thing up there?
Do you know how high that is up there?/ How high is that up there?
Do you know who that is up there?/ Who is that up there?
Do you know what that is called?/ What is that called?
Do you know what that is called?/ What is that called?
Do you know where Sally is going on her trip?/Where is Sally going on her trip?
Do you know how Sally is doing today?/How is Sally doing today?
Do you know what Moe is doing up there?/What is Moe doing up there?
Do you know why Moe is wearing a bandaid?/Why is Moe wearing a bandaid?
Do you know how Moe is feeling today?/How is Moe feeling today?
Do you know where Moe is hiding his food?/Where is Moe hiding his food?
Do you know where the bag is hiding in here?/Where is the bag hiding in here?
Do you know what that is doing up there?/What is that doing up there?

APPENDIX C

Baseline Experiment Stimuli

Practice (Boy)
It's a flower
It's a cup
It's an elephant
Filler (It's a hairbrush)
It's scissors
It's a dog
It's a bike
Filler (It's a Smurf)
It's cheese
It's a shoe
It's a dinosaur
Filler (It's a ladder)
It's a fish
It's a book
It's a truck
Filler (It's a pirate)
It's an egg
It's a pencil
It's a giraffe

Activity 1 Stimuli: Yes/No questions

Can it swim?
Can it walk?
Can it talk?
Is it a horse?
Is it big?
Is it an animal?
Is it a puppy?
Is it a duck?
Is it a dog bone?
Is it a shoe?
Is it food?
Is it a hamburger?
Is it a rope?
Is it a ball?
Is it a cat?
Is it blue?
Is it a dog collar?
Is it a magic wand?
Is it a book?
Is it a texta?
Is it a coin?
Is it a shirt?
Is it glasses?

Activity 2 Stimuli: Ellipsis

Who can jump on the boxes?

Who can run the fastest?
Who can walk on the rope?
Who can eat all the pizza
Who’s taking food out of the fridge? He is/The boy is
Who’s eating ice cream on the grass? She is/The girl is
Who’s singing a song on the stage? He is/The boy is
Who’s holding a drink on the beach? She is/The girl is
Who’s buying food at the canteen? She is/The girl is
Who’s fishing for a fish on the boat? He is/The boy is
Who’s cuddling a teddy on the couch? She is/The girl is
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Who’s playing toys in the bedroom? He is/The boy is
Who’s dancing outside in the rain? He is/The boy is
Who’s painting a picture on the wall? He is/The boy is
Who’s making a snowman in the snow? She is/The girl is
Who’s shooting the ball in the hoop? He is/The boy is
Who’s helping the farmer on the farm? She is/The girl is
Who's reading books at the library? He is/The boy is
Activity 3 Stimuli: Embedded wh-questions

Target
Do you know what that is up there?
Do you know how good Moe is at soccer?
Do you know where the crocodile is in the room?
Do you know where the crocodile is on the shelf?
Do you know where Sally is in the picture?
Do you know what that is in the box?
Do you know what that is in the box?
Do you know what that thing is up there?
Do you know how high that is up there?
Do you know who that is up there?
Do you know what that is called?
Do you know what that is called?

Control
Do you know where Sally is going on her trip?
Do you know how Sally is doing today?
Do you know what Moe is doing up there?
Do you know why Moe is wearing a bandaid?
Do you know how Moe is feeling today?
Do you know where Moe is hiding his food?
Do you know where the bag is hiding in here?
Do you know what that is doing up there?

Ethics

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25 February 2014

Ms Kelly Rombough
Cognitive Science
Faculty of Human Sciences
Macquarie University NSW 2109

Reference: 5201400107D

Dear Ms Rombough,

FINAL APPROVAL

Title of project: Grammatical knowledge in children with Specific Language Impairment

Thank you for your recent correspondence. Your response has addressed the issues raised by the Faculty of Human Sciences Human Research Ethics Sub-Committee. Approval of the above application is granted, **effective 21st February 2014** and you may now commence your research.

This research meets the requirements of the National Statement on Ethical Conduct in Human Research (2007). The National Statement is available at the following web site:

http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/e72.pdf.

The following personnel are authorised to conduct this research:

Prof Stephen Crain
Associate Professor Rosalind Thornton
Dr Peng Zhou
Mr Cory Bill
Ms Elena Donofrio
Ms Kelly Ann Rombough

Please note the following standard requirements of approval:

1. The approval of this project is conditional upon your continuing compliance with the National Statement on Ethical Conduct in Human Research (2007).

2. Approval will be for a period of five (5) years subject to the provision of annual reports.

Progress Report 1 Due: 21st February 2015
Progress Report 2 Due: 21st February 2016
Progress Report 3 Due: 21st February 2017
Progress Report 4 Due: 21st February 2018
Final Report Due: 21st February 2019

NB. If you complete the work earlier than you had planned you must submit a Final Report as soon as the work is completed. If the project has been discontinued or not commenced for any reason, you are also required to submit a Final Report for the project.

Progress reports and Final Reports are available at the following website:

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/forms

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3. If the project has run for more than five (5) years you cannot renew approval for the project. You will need to complete and submit a Final Report and submit a new application for the project. (The five year limit on renewal of approvals allows the Committee to fully re-review research in an environment where legislation, guidelines and requirements are continually changing, for example, new child protection and privacy laws).

4. All amendments to the project must be reviewed and approved by the Committee before implementation. Please complete and submit a Request for Amendment Form available at the following website:

http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/forms

5. Please notify the Committee immediately in the event of any adverse effects on participants or of any unforeseen events that affect the continued ethical acceptability of the project.

6. At all times you are responsible for the ethical conduct of your research in accordance with the guidelines established by the University. This information is available at the following websites:

http://www.mq.edu.au/policy/
http://www.research.mq.edu.au/for/researchers/how_to_obtain_ethics_approval/human_research_ethics/policy

If you will be applying for or have applied for internal or external funding for the above project it is your responsibility to provide Macquarie University's Research Grants Officer with a copy of this letter as soon as possible. The Research Grants Officer will not inform external funding agencies that you have final approval for your project and funds will not be released until the Research Grants Officer has received a copy of this final approval letter.

Yours sincerely,

P.P. C Ross

Dr Peter Whiteman
Deputy Chair
Faculty of Human Sciences Ethics Review Sub-Committee
Human Research Ethics Committee

www.mq.edu.au

Government of **Western Australia**
Department of **Education**

Your ref :
Our ref : D14/0326286
Enquiries :

Ms Kelly Rombough
Department of Cognitive Science
Australian Hearing Hub
16 University Avenue
MACQUARIE UNIVERSITY NSW 2109

Dear Ms Rombough

Thank you for your application received 16 April 2014 to conduct research on Department of Education sites.

The focus and outcomes of your research project, *Grammatical knowledge in children with Specific Language Impairment,* are of interest to the Department. I give permission for you to approach the Principal of the South East Metropolitan Language Development Centre (SEMLDC) to invite her participation in the project as outlined in your application. It is a condition of approval, however, that upon conclusion the results of this study are forwarded to the Department at the email address below.

Consistent with Department policy, participation in your research project will be the decision of the SEMLDC, the children in that school and their parents. A copy of this letter must be provided to principals when requesting their participation in the research. Researchers are required to sign a confidential declaration and provide a current Working with Children Check upon arrival at Department of Education schools.

Responsibility for quality control of ethics and methodology of the proposed research resides with the institution supervising the research. The Department notes a copy of a letter confirming that you have received ethical approval of your research protocol from the Macquarie University Faculty of Human Sciences Human Research Ethics Sub-Committee.

Any proposed changes to the research project will need to be submitted for Department approval prior to implementation.

Please contact Dr Adriaan Wolvaardt, Research and Evaluation Officer, on (08) 9264 5512 or researchandpolicy@education.wa.edu.au if you have further enquiries.

Very best wishes for the successful completion of your project.

Yours sincerely

ALAN DODSON
DIRECTOR
EVALUATION AND ACCOUNTABILITY

25 June 2014

151 Royal Street, East Perth Western Australia 6004