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Towards a lexically specific grammar of children's question constructions

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Abstract

This paper examines early syntactic development from a usage-based perspective, using transcripts of the spontaneous speech of two English-speaking children recorded at relatively dense intervals at ages 2;0 and 3;0. We focus primarily on the children's question constructions, in an effort to determine (i) what kinds of units they initially extract from the input (their size and degree of specificity/abstractness); (ii) what operations they must perform in order to construct novel utterances using these units; and (iii) how the units and the operations change between the ages of two and three. In contrast to nativist theories of language development which suggest that children are working with abstract syntactic categories from an early point in development, we suggest that the data are better accounted for by the proposal that children begin with lexically specific phrases and gradually build up a repertoire of increasingly abstract constructions.

Keywords: interrogative constructions; language acquisition; usage-based approaches; piecemeal learning; lexically specific units; high-density developmental corpora

Children's question constructions: Towards a lexically specific grammar

1. Introduction

There is a considerable body of research showing that much of English-speaking children's early multiword speech consists of rote-learned phrases or lexically based patterns with slots (see e.g. Braine 1976; Ewing 1982; Hill 1984; Johnson 1983; Ninio 1988; Peters 1983; Schlesinger 1982), and a number of these researchers have suggested ways in which the early stages of language development may involve building up networks of low-scope constructions rather than the acquisition of abstract rules. More recently, Lieven et al. (1997) found that, on average, 60 percent of the utterances of the 11 children (aged 1;8 – 2;8) in their study could be accounted for by the child's first 25 lexically based patterns such as *There's a X*, *I want a Y*, *Z it*, where X, Y and Z are slots which the child fills with (usually) appropriate words, while a further 31 percent were frozen phrases. Tomasello (1992), in a diary study of all his daughter's constructions with verbs produced between the ages of 15 and 24 months, analysed the development of such patterns in considerable detail, and concluded that constructions build up around individual verbs and independently of each other. New developments in the argument structures associated with particular verbs were much better predicted by what the child had said previously with that particular verb than by any process involving the verb class as a whole. Johnson (1983) and Dąbrowska (2000) have made very similar observations about children's use of WH words and auxiliaries.

Of course, naturalistic data can only be indicative: it is possible that the rather stereotypical nature of children's early multiword speech derives from production limitations, discourse pressures, or from the restricted contexts of recording. Thus, naturalistic studies cannot prove that children's underlying linguistic representations are lexically specific. However, experimental research also seems to suggest that the complexity and abstraction of adult grammar is the endpoint of a long developmental process. Although children as young as 1;6 show sensitivity to certain aspects of linguistic form, they need a great deal of linguistic experience before these sensitivities develop into mental representations that will enable them to use a novel verb in structures in which they have not previously heard it: for many children this does not occur until age 3;0 or even later (see Tomasello 2000 for a review).

Existing naturalistic studies, including Lieven et al. (1997), also suffer from another problem: nearly all are based on very thin sampling, usually about one hour every two or three weeks, representing a small proportion of a child's waking and talking life. Although the figures for frozen phrases and lexically specific patterns are strikingly high, it should be remembered that a frozen phrase was defined in Lieven et al. (1997) as something that the child had never been recorded as saying before and with no previously produced segments. Clearly, as the authors point out, all or some proportion of these could have been constructed *ab initio* and the thinness of the sampling means there is no way of telling.

To address this problem, Lieven et al. (2003) conducted an analysis similar to that described in Lieven et al. (1997), but used a much denser corpus (sampling density of just under five hours per week for six weeks, giving a total of 28 hours

of recording). The aim of the study was to relate all the multiword utterances produced by a two-year-old child in the last hour of recording to this child's previous utterances. Lieven and colleagues found that 63 percent of the multiword utterances in the final recording were not novel (i.e. they had been said before in exactly that form), and that three-quarters of the remaining 37 percent could be related to something the child had said before by just one operation, such as substituting a word into a slot or adding a word to the beginning or end of a previous utterance.

The purpose of the analysis conducted by Lieven and colleagues was to estimate the degree of creativity/stereotypicality of the child's utterances and to give some indication of the sorts of processes that might be involved in the construction of utterances at this early stage of language development. They were not aiming to develop a realistic account of language production or to provide a detailed characterization of the child's linguistic knowledge. Indeed, there are two problems with their method that would have to be overcome before any attempt could be made to do so.

The first problem is that the method does not provide an explicit description of the child's linguistic knowledge. For instance, Lieven and colleagues propose that the novel utterance *Let's move it around* is derived from a previous utterance *Let's move it* by adding *around* (which also occurred in the child's earlier utterances). But this presupposes that the child knows that *around* must be added at the end of the first utterance and not the beginning – or, for that matter, inserted between *let's* and *move*. Similarly, Lieven and colleagues derive *I want a paper* from an established schema, *I want a W* by substituting *paper* for *W*. This works

fine for the example they are discussing, but it is not clear what would prevent the child from substituting non-nouns into the slot, which would result in ungrammatical utterances such as **I want a over, *I want a like, *I want a they.*

The second, and related, problem is that the method is too unconstrained since the five operations defined by the authors made it possible, in principle, to derive any utterance from any string of words simply by adding, deleting or moving words around as required. This problem was mitigated by the requirement that each utterance had to be matched as closely as possible to a prior utterance, but a few derivations were intuitively very implausible. For example, the utterance *What's that funny drawing down there?* was derived from *What's that lying down?* in three steps:

(1) A derivation from Lieven et al. (2003)

Original utterance:	What's that lying down?
Substitute *funny* for *lying:*	What's that funny down?
Insert *drawing:*	What's that funny drawing down?
Add-on *there:*	What's that funny drawing down there?

In this paper, we address these problems by (i) reducing the types of operations allowed and (ii) constraining them so that they can apply only to units of a specified type and manipulate them in strictly defined ways. We then make a first attempt to develop an explicit and psychologically realistic account of language production in children. This will consist of two components:

- an inventory of a child's constructions (stored form-meaning pairs)

- an explicit characterisation of the operations necessary to produce novel utterances using these constructions.

An inevitable consequence of constraining the operations in the ways described above is that in some cases the derivation may not be successful: that is to say, it may not be possible to derive an utterance using previously attested constructions. We regard this as a strength, since it will allow us to determine to what extent our grammar is descriptively adequate.

Our aim in the long run is to develop a grammar that could account for all of a child's utterances at a given point in time, but in this study we confine ourselves to syntactic questions, i.e. utterances involving either a preposed auxiliary and a subject (for yes/no questions) or a preposed WH-word and at least one other word. We will, however, seek to provide an account capturing the details of the internal organization of these utterances, including the internal structure of the NPs and VPs they contain, not just the position of WH words and auxiliaries.

We decided to concentrate on question constructions for two related reasons. First, they are potentially problematic for approaches that emphasise low-level, lexically specific patterns because the word order in questions is different from the word order in declaratives. Therefore, if a child attempted to use a lexically specific pattern for a declarative sentence (e.g. EATER-*eat*-EATEN) in an object question, this would result in errors, since in object questions the expression referring to the thing eaten comes at the beginning of the clause rather than after the verb. Secondly, questions, and other constructions with non-canonical word order, have played an important role in the development of generative theories of language; and the fact that children produce such constructions is often regarded

as evidence that they have mastered abstract syntactic rules such as subject-auxiliary inversion and WH movement. This view, however, would be seriously undermined if it turned out that children's utterances could be accounted for in lexically specific terms.

1.1. Syntactic development in a CG framework

Our view of language and language acquisition is broadly derived from constructionist approaches to the nature of linguistic representation (Croft 2001; Fillmore and Kay 1993; Goldberg 1995; Langacker 1987a, 1991, 2000), which maintain that speakers' grammatical knowledge is captured in terms of partially underspecified form-meaning pairings called constructional schemas. These can be very general (e.g. *AUX NP VP?* which indicates that a yes/no question consists of a auxiliary followed by the subject followed by an untensed verb phrase) or quite specific (e.g. for example, *Can I VP?* captures the speaker's knowledge about how to ask for permission to do something). Thus, in constructionist approaches, unlike in generative approaches, interrogatives are not derived from a structure with declarative word order; instead, the interrogative word order is specified directly in the schema.

Until recently, there has been rather little attempt to work out in detail how language development might proceed from this perspective (notable exceptions are Dąbrowska 2000, 2004; Goldberg 1999; Israel et al. 2000; and Tomasello 1992, 2003). Here we start from a particular constructionist theory, Cognitive Grammar (CG) as developed by Langacker (1987a, 1991, 2000). Our approach is based on three main assumptions:

- *Assumption 1: Human beings store symbolic units (i.e. pairings of a phonological form and a semantic representation).* Figure 1 gives examples of different types of symbolic units.[1] These can be concrete and simple (1a: *door*) or complex (1b: *open the door*). Complex symbolic units consist of smaller units (e.g. *open, the door*), which are also pairings of a phonological form and a "chunk" of semantic structure. Symbolic units can also be partially schematic (1c: *open NP*) or even wholly schematic (1d: *V NP*). As argued by Langacker (1987a, 2000; see also Bybee and Scheibman 1999) all four types co-exist in the grammar, which is thus highly redundant. Note that the schematic units have the same structure as the more concrete units (i.e. 1d has the same structure as 1b and 1c).

Figure 1: *Examples of symbolic units*

- *Assumption 2: Language acquisition involves the acquisition of symbolic units, both concrete and schematic.* Schematic units are generalizations over more concrete units or actual utterances. Since both kinds of units are represented in the same format and have the same structure (cf. above; see also Langacker 1991, 2000), this process involves strengthening the shared features while abstracting away from the differences. For instance, the frame *Shall I PROCESS?* is a generalization over utterances such as the following:

(2) [from Annie 3;0][2]

*MOT: shall I try ?

*MOT: shall I jump in ?

*MOT: shall I look after baby ?

*MOT: shall I be Mummy ?

All these utterances share certain aspects of meaning (an offer to do something) and phonological form ([ˈʃælaɪ] followed by a slot into which an expression specifying the type of activity can be inserted). Similarly, *open THING* is a generalization over expressions such as *open it, open the door, open the gate,* etc.

- *Assumption 3: The production of novel expressions involves the combination of symbolic units using two operations: juxtaposition and superimposition.*

JUXTAPOSITION involves linear composition of two units, one after another. Note that the two units can be combined in either order:

(3) Derivation of a novel expression using juxtaposition

now + *are you downstairs?* → *now are you downstairs?*

or *are you downstairs now?*

why are you holding me? + *Daddy?* → *why are you holding me Daddy?*

or *Daddy why are you holding me?*

The linear juxtaposition signals that the meanings of the two expressions are to be integrated, but the construction itself does not spell out how this is to be done, so it must be inferred by the listener (in the first example, *now* is understood to designate the time of the situation designated by the clausal unit; in the second example, *Daddy* is the addressee[3]).

In SUPERIMPOSITION**,** one unit (which we call the "filler") elaborates a schematically specified subpart of another unit (the "frame"). For instance, the units *shall I PROCESS?* and *open that* can be superimposed to derive the novel expression *shall I open that?*. Superimposition happens simultaneously at both the phonological and the semantic poles of the two expressions. In Figure 2, this is shown by the dotted lines linking corresponding elements: OPEN-D(ISTAL) DEICTIC elaborates the PROCESS subpart of the semantic structure OFFER SPEAKER PROCESS, and the phonological form [ˈəʊpənˌðæt] elaborates the underspecified subpart of [ˈʃælaɪ…]. (Again, the diagram is simplified: for example, it does not explicitly represent the fact that the speaker is to be construed as the agent of the action).

Figure 2: *Superimposition of a typical frame*

(shall I PROCESS?*) and filler (*open that*)*

The filler must match the properties specified in the frame: the *shall I PROCESS?* frame requires a filler which designates a PROCESS, in the technical CG sense, that is to say, a temporal relation (see Langacker 1987a, 1987b, 1991).

If *I open that* is also available as a unit, the matching process is probably easier because of the overlapping material (the symbolic unit SPEAKER/[aɪ]).

It is also possible for both units to be partially schematic and elaborate different parts of each other. Figure 3 depicts two complex and partially schematic symbolic units, *open THING* and *PROCESS them.* Again, superimposition takes place simultaneously at the semantic and the phonological poles of the expression. At the semantic pole, 3PL (third person plural) elaborates the schematically specified patient of OPEN THING, and OPEN elaborates the schematically specified process in the semantic representation of PROCESS 3PL. At the phonological pole [ˈəʊpən] elaborates the slot in [… ðəm] and at the same time [ðəm] elaborates the slot in [ˈəʊpən …].[4]

Figure 3: *Superimposition with mutual elaboration of the symbolic units* open THING *and* PROCESS them

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In subsequent discussion, we will treat phonological and semantic integration as a single process of symbolic superimposition, and will use *italics* to represent symbolic units, with appropriate labels indicating slots. We will use semantic labels (THING, PROCESS, etc.) for the slots rather than traditional grammatical category labels to emphasise the fact that the categories of expressions which can be inserted into them are semantically based. Thus, when *open THING* and *PROCESS them* are superimposed, *open* elaborates the PROCESS slot in the second unit, and *them* elaborates the THING slot in the first unit.

For the purposes of this exploratory analysis, we assume that the child can make semantic generalisations about the content of these slots and fill them with semantically appropriate material and we constrain our derivations by insisting on a semantic match between the items that create the slot and those that are inserted into it. In some cases, there is good evidence for an underlying basis to these slots in the developmental literature. For instance, children show object categorisation skills before they can speak (Mandler 1992) and can substitute novel object names into frames from about 1;9 (Tomasello et al. 1997). In addition, and despite the fact that much of their language production with verbs seems specific to individual verbs (Tomasello 1992), even two to two-and-a-half year-old children may begin to form generalizations about fairly narrow semantically defined subclasses of verbs (Clark 1996; Pine et al. 1998).

1.2 Research questions

The aim of this paper is to provide an explicit description of two children's grammatical knowledge of syntactic questions and their internal structure at ages 2;0 and 3;0 on the basis of data from four high-density developmental corpora. We will attempt to do this using *only* lexically specific units (with or without slots). Our reasons for doing this are twofold. First, we believe that developing maximally explicit and complete descriptions of children's linguistic abilities is of central importance for understanding language development. Secondly, using only lexically specific units will allow us to throw some new light on the question of how abstract children's linguistic representations are. If we find that a large proportion of the children's utterances cannot be derived without more general

knowledge, this would constitute *prima facie* evidence that they possess such knowledge. If, on the other hand, our attempt is successful, this would considerably strengthen the case for constructivist approaches to language acquisition which maintain that abstract knowledge is acquired in a bottom-up manner by generalizing over stored exemplars and low-level schemas. To address this issue, we will need to answer three key questions:

- How much of the child's linguistic output is novel?
- How much of the child's linguistic output can we explain using *only* lexically specific units and the two operations?
- How do the child's linguistic abilities change between the ages of two and three?

2. Method

2.1 Participants

The data consist of four high-density developmental corpora for two children, Annie and Brian, each recorded for 6 weeks at the age of 2;0 and 3;0. The two children lived in a large metropolitan area in England and came from middle-class backgrounds. Their mothers spent most of the week alone with them, though fathers, other adults and a research assistant were sometimes present for recordings. Annie was 2;0 and Brian was twelve days older at the beginning of the study. Annie was a relatively precocious language learner, with a MacArthur CDI vocabulary of 391 at 2;0, just below the 75th percentile, and a Mean Length of Utterance (MLU) in words of 1.95. Brian was less precocious: at 1;11.14, his CDI score was 122, approximately at the 25th percentile, and his MLU at the start of

the study was 1.45. At the end of the study, Annie's MLU in words for the last week was 3.48 and Brian's was 2.68. The mothers were employed by the investigators as research assistants during the course of the study. The mothers knew that they and their children were participating in a study of linguistic development, but were not aware of the specific phenomena that were to be investigated.

2.2 Data

The mothers made one-hour tapes of themselves and their children in relatively typical interactions in their home five days per week over a period of six weeks. Four out of the five weekly recordings were on audiotape; the fifth was on video. This resulted in 30 hours of recording for Brian at age 2 and at 3 and Annie at 3. During the first series of recordings of Annie, illness prevented 2 sessions, so the Annie 2 corpus only contains 28 transcripts. The recordings were then transcribed in CHAT format (MacWhinney 1995). For full details of the method of recording and of transcription, see Lieven et al. (2003). The Annie 2;0 corpus is the same as that used in Lieven et al.

2.3 Procedure

Each corpus was divided into 2 parts: a test corpus, which consisted of the last 2 transcripts in Annie's case and the last 5 in Brian's, and a main corpus, which contained all the remaining transcripts. We took more transcripts for Brian in order to ensure that there were a sufficient number of questions in his test corpora. (Syntactic questions accounted for only 2.3 percent of the utterances in Brian's test corpus at age 2, and 5.6 percent at age 3. For Annie, the corresponding figures

are 12.3 and 16.4 percent respectively.) Information about the size of the eight subcorpora is given in Table 1.

Table 1: *Numbers of utterances and words in each corpus*

The aim was to write an inventory of constructions (i.e. a grammar) for each child at age 2 and 3. Ideally we would have done this on the basis of the main corpus and then tested it on the test corpus, but this was not feasible because of the size of the main corpus. We therefore attempted to derive the questions in the test corpus by searching all the utterances in the relevant main corpus (including those produced by adult speakers) for the component units of these questions, and then using the two operations described above.

The procedure was as follows:

- We extracted all child syntactic questions from each test corpus. (In the subsequent discussion, these will be referred to as the "target utterances".)
- For each target utterance, we identified its component units in the main corpus.
- We determined whether the target utterance could be derived by juxtaposing or superimposing the component units

2.3.1 Component units

A component unit is an expression which shares lexical material with the target and is attested at least twice in the main corpus (excluding imitations and self-repeats). In other words, we are assuming that children have stored all units that

occur with a frequency of 2 or more in the corpus. We address the issue of whether this is realistic in the Discussion.

We identified two types of units:

- FIXED PHRASE: any word or continuous string of words corresponding to a "chunk" of semantic structure (i.e. designating a THING, PROCESS, PROPERTY, LOCATION, DIRECTION, etc.) which occurs at least twice in the main corpus. The phrase did not have to occur in isolation: we assume that the child is able to analyse utterances into their component units, at least partially. Thus, we regard the following two utterances as evidence that the expression *go to the bathroom* is available to the child as a unit which can be inserted into a PROCESS slot:

(5) Fixed phrase as component unit (Annie 3)

*CHI: it's time &ta girl to go to the bathroom and wash her hands.

*CHI: before the boys go to the bathroom.

- FRAME WITH SLOT: a string consisting of one or more fixed phrases and one or more slots of a specified kind (e.g. THING, PROCESS, PROPERTY etc.) corresponding to a "chunk" of semantic structure. A slot was established if at least two *different* expressions belonging to the same semantic category occurred in the same position in the frame. As with fixed phrases, frames did not have to occur in isolation in order to qualify as units. Thus, the following utterances are evidence for a *get THING ready* frame:

(5) Frame with slot as component unit (Annie 3)

*MOT: shall we get you ready to go out?

*MOT: well we're go-ing to <get the eh> [//] get the room ready , are'nt we?

*MOT: well we're just about to get Cinderella ready for the ball.

Note that in this case all three precedents come from the mother. Whether or not it is realistic to assume that the child has access to units which are attested only in the input is another issue we will address in the Discussion section.

If the target utterance contained a word or compound that occurred in the immediately preceding discourse (i.e. one of the last 5 utterances), we assumed that it was available to the child even if it did not occur at all in the main corpus. For example, in the following exchange the child clearly "borrowed" the word *dairy* from the mother's utterance, so despite this being the first and only occurrence of this lexical item in the data, it is allowed as a component unit.

(6) Word in the immediately preceding discourse (Brian 3)

*MOT: +, let me just go to the dairy # and get some milk .

*CHI: what's a dairy ?

There were 17 instances of such "borrowing" of individual words from the preceding discourse.

2.3.2 Slots

Slots are component units in a larger structure which are unspecified phonologically and also have relatively abstract semantics (e.g. THING, LOCATION). They were defined on the basis of variation in established frames in the main corpus. For example, the utterances in (7) were regarded as evidence that (1) the child has a *find THING* schema and (2) she can use different fillers in this schema and therefore has a THING category.[5]

(7) Type variation in the *find THING* frame (Annie 2)

*CHI: find it .

*CHI: find little spoon .

*CHI: find the newspaper-s .

*CHI: find the paper-s .

*MOT: let-'us find a Tigger at the gate .

*MOT: let-'us go and find him .

For the sake of simplicity, we will use the same labels (THING, PROCESS, etc.) to refer to slots in different constructions. This should not be interpreted as a suggestion that these categories are available to the child from the very beginning: as we will argue in section 4.4, they emerge gradually from the child's linguistic experience and may initially be construction-specific.

2.3.3 Deriving the target from the component units

As explained earlier, there are two strong restrictions on the application of the operations: superimposition is allowed only when the filler has the properties required by the slot, and juxtaposition, when the components can occur in either order. However, even with these restrictions there were often several different ways of deriving the same utterance from the component units. When this was the case, we assumed the simplest derivation (the one with the fewest units); and when there were two or more equally simple derivations, we assumed that the child used the largest units available. We discuss the psychological reality of these additional assumptions in section 4.3.

2.3.4 Examples of successful derivations

(8) Where can he park? (Annie 3)

Attested components	Child	Adults
where can he park?	1	0
where can THING park?	5	0
where can he PROCESS?	3	0

Components	Operation	Result
where can THING park?	Superimpose	where can he park?
where can he PROCESS?	(THING = he,	
	PROCESS = park)	

Annie produced this question once before in exactly the same form, so it is not really a novel expression. However, because it only occurred once we assume that it is not available as a unit and must therefore be constructed. The component units are: *where can THING park?* (produced 5 times by the child with two different fillers in the THING slot) and *where can he PROCESS?* (produced 3 times by the child with two different fillers in the PROCESS slot).

To derive the target, the child must superimpose the two frames so that *where* in the first frame corresponds to *where* in the second frame, *can* corresponds to *can, he* in the second frame elaborates the THING slot in the first frame, and *park* in the first frame elaborates the PROCESS slot in the second frame. Notice that the target utterance could also be derived by superimposing *he* in the first frame or *park* in the second frame, but, as explained in the preceding section, we used the largest available units.

(9) Shall we get them ready then? (Annie 3)

Attested components	Child	Adults
shall we PROCESS then?	4	7
get them PROPERTY?	1	2
get THING ready	0	3

Components	Operation	Result
get them PROPERTY get THING ready	Superimpose (THING = them, PROPERTY = ready)	get them ready
get them ready shall we PROCESS then?	Superimpose (PROCESS = get them ready)	shall we get them ready then?

The derivation of this utterance requires two applications of superimposition:

- *get them PROPERTY* and *get THING ready* are superimposed so that *get* matches up with *get, them* elaborates the THING slot in the second frame, and *ready* elaborates the PROPERTY slot in the first frame; the result is the novel expression *get them ready*;
- *get them ready* is superimposed over the PROCESS slot in the utterance-level construction *shall we PROCESS then?* to derive the target utterance.

Note that the two operations can apply in either order.

3. Results

This section is divided into two parts. In section 3.1 we present the overall quantitative results. In section 3.2 we look in detail at those utterances for which our method fails to produce a successful derivation.

3.1 Overall quantitative results

3.1.1 How much is new?

We cannot answer this question directly, since we do not have a full record of the children's linguistic experience. However, we can determine how much is definitely *not* new. Table 2 provides information about the number of tokens of questions that are either immediate imitations of a preceding adult question or immediate or delayed self-repeats by the child (utterances which are, by assumption, available to the child as preconstructed units and thus non-creative). As we can see from the table, such non-creative utterances constitute from 75 percent (Brian 2) to 21 percent (Annie 3) of the question tokens produced by the children. Note that both children use fewer non-creative utterances at 3;0 than at 2;0 and that, at both ages, Annie uses fewer than Brian.

Table 2: *Non-creative questions in the test corpus (tokens)*

3.1.2 How much can we account for using only lexically specific units?

Table 3 indicates how often the derivation was successful and gives details about the number of operations needed to derive the utterances in each corpus. Utterances were traced back as types: in other words, if a child said *What's that?* twenty times in the test corpus, this was only counted once; and we excluded all imitations and self-repeats. As we can see, about 90 percent of the question types in each test corpus can be derived from the lexically specific units identified in the main corpus using the two operations defined above. Of these, from 11 to 36

percent are zero-operation utterances, that is to say, direct repeats of utterances that occurred at least twice in the main corpus. At 2;0, the majority of both children's novel utterances require only one operation for a successful derivation (55 percent for Brian and 66 percent for Annie). In the three-year-old corpora, there are considerably more utterances requiring two or (especially in the case of Annie) more operations, although a large proportion of the children's questions can still be derived by applying a single operation. A full list of the component units necessary to perform the derivations is given in the Appendix.

Table 3: *Number of operations needed to derive the children's utterances (types)*

3.1.3 The development of the slots

As is evident from Table 3, one important difference between the children at age 2;0 and at 3;0 is that the utterances produced by the three-year-olds tend to require more operations. This is probably a consequence of a larger working memory, although the availability of longer prefabricated chunks and a larger lexicon may also play a role. As we can see from Table 4, while the 2-year-olds substituted predominantly into THING slots (and, in Brian's case, occasionally into UTTERANCE slots as well), the 3-year-olds show a greater variety of slots: THING, UTTERANCE, PROCESS (both children), LOCATION, DIRECTION, PROPERTY (Annie). This is probably due to the fact that they have more knowledge about the internal structure of pre-assembled units. About 6 percent of

utterances for both children at 3;0 gave evidence of slots of a more heterogenous and possibly complex type (see footnote to Table 4 and the Appendix).

Table 4: *Slots participating in superimposition*

These results accord with our knowledge and intuitions about the differences between two-year-olds and three-year-olds: three-year-olds would be expected to have a more differentiated set of semantic categories, to be less dependent on the production of whole utterances as rote chunks, and to be able to hold longer chunks and more operations in working memory. However, it will be necessary in future research to develop methodologies that control for the content and size of the lexicon as well as length of utterance for these intuitions to gain quantitative support.

Thus, approximately 90 percent of the question types in the test corpus can be derived by juxtaposing or superimposing the pre-assembled units identified in the main corpus. This confirms that children's early questions are highly lexically specific. On the other hand, it leaves a substantial residue (about 10 percent) where our method failed. This raises an important question: do the failed derivations provide any evidence of more abstract knowledge? To answer this question, we need to examine these problematic utterances in more detail.

3.2 Problematic utterances

Across the four test corpora there are 19 utterances that cannot be derived from attested units. Of these, three are purely lexical failures where the child used a

word that either did not occur at all in the main corpus or occurred only once. Clearly, the fact that the child used a word constitutes reliable evidence that he/she knows it: few people would argue with the claim that the child must have heard (and possibly also produced) the word before, but we simply did not catch it on tape.

Applying this argument to complex units makes it clear that apparent syntactic failures could also be an artefact of sampling: in other words, if a child produces a novel syntactic combination which cannot be explained in lexically specific terms, he/she could be using a more abstract construction *or* he/she could be using a frame which is simply not attested in the main corpus because the latter is only a partial sample of the child's experience. With this caveat in mind, we now turn to the syntactic failures and discuss them in groups according to the reasons for which we cannot derive them.

Table 5: *Syntactic fails*

In Table 5 we present a complete list of all the syntactic fails, along with the relevant component units attested in the main corpus and reasons for failure. As we can see, derivations fail for a variety of reasons, the most frequent being

- inappropriate filler (examples (2), (9), (11), (12), (14), (15)): the filler does not match the semantic requirements of the slot, e.g. in (2), *football* is inserted into a PROCESS slot;[6]

- no type variation (examples (1), (3), (4), (9), (10), (13), (14)): the relevant position in the attested components is always filled with the same lexical material;
- frequency criterion fails (examples (5), (6)): the attested component occurs only once in the main corpus and hence, by assumption, is not available as a preconstructed unit;
- omission of a constituent present in the attested components (examples (1), (8), (12), and (13)).

It is important to note that the utterances listed in the table are not particularly complex in comparison with other utterances produced by our children; in fact, some are very simple. Furthermore, most are "near misses": that is to say, although they cannot be derived from the component units using our method, they do have very close precedents in the main corpus. Finally, a very high proportion (62 percent) of the problematic utterances are ill-formed by adult standards (compared to 20 percent of the successful derivations). All of this suggests that these utterances involve the children going beyond what they already know, or extrapolating from their existing linguistic knowledge, rather than applying rules they have already mastered.

4. Discussion

Previous research has suggested that children's earliest constructions are lexically specific frames. In this study, we investigated this claim for syntactic questions. We developed a set of explicit criteria for identifying lexically specific units and, using much denser corpora than has previously been possible, we investigated

whether utterances produced by two- and three-year-olds can be derived by juxtaposing and superimposing such units. While a number of previous researchers have made suggestions as to how children might build up multiword utterances through combining already existing utterances (c.f. Elbers 2002; Ewing 1982; Hill 1984), they have usually concentrated on the rather early stages of multiword speech and have not really had the data to give an exhaustive account of how this process might work.

Using a criterion of two precedents in the main corpus (taken from both the adults' and the children's speech), we were able to derive 87-91 percent of the children's questions in the test corpora. Aside from lexical fails, most of the remaining utterances appear to involve extension of well-attested form-function patterns rather than utterances requiring a radically different grammar. Our suggestion is that, rather than assembling their questions from atomic elements according to abstract syntactic rules and then applying further syntactic transformations such as WH fronting and inversion, these children combined partially specified symbolic units using the two operations described above.

This appears to be true of the children's questions at age 3 as well as age 2. The three-year-olds' output is less stereotypical and repetitive in that they superimpose over a wider range of slots and are able to apply a larger number of operations per utterance. In spite of this, we were able to account for only marginally fewer of the questions at 3;0 (87-88 percent) than at 2;0 (91 percent).

The idea that children's early questions may be rote-learned and/or semi-formulaic is not new (cf. Brown 1973; Johnson 1983; Peters 1983; Pinker 1984; Richards 1990; Radford 1990; Stromswold 1990). However, in contrast to most of

these researchers, (i) we see this process continuing for much longer and (ii) we see it as central rather than as a primitive strategy to be dropped as soon as the child develops the syntactic processes associated with questions. We will discuss these issues in section 4.4 below. First, we address the question of the psychological reality of some of our assumptions.

4.1 Is the frequency assumption realistic?

Is it realistic to assume that the child stores all component units which occur with a frequency of two or more in the main corpus? There are two points to bear in mind when addressing this question. First, the children have been learning language for considerably longer than the six weeks during which we recorded them. Second, while our corpora are very large in comparison with those used by other researchers, they still represent only about 7 percent of the utterances the children heard and produced during a six-week period. Therefore, assuming our sample to be representative, the estimated real frequency of expressions that occur twice in the corpus is about 29 during the six-week observation period.

Of course, it is possible that some utterances with an attested frequency of 2 really did occur only 2 times in the child's linguistic experience, so it is important to see to what extent our account is dependent on the frequency assumption. Accordingly, we conducted a second analysis of the interrogative utterances produced by the most advanced child in our sample, Annie at age 3, in which we used only component units with an attested frequency of three or more.

Of the 68 question types in the Annie 3 test corpus, 19 had component units with an attested frequency of 2. If we raise the threshold to three, the utterances

can still be derived, but require one additional operation. For example, in our original analysis, Annie's utterance *shall I comb your hair?* was derived in a single operation by superimposing the fixed phrase *comb your hair,* which occurs twice in the corpus, over the PROCESS slot in *shall I PROCESS?*. If *comb your hair* is not available as a ready-made unit, it must be assembled by superimposing *comb POSSESSIVE hair* (which has an attested frequency of 5) and *your THING* (attested 1254 times). Thus, the adoption of a more rigorous frequency criterion does not undermine the success of our method.

4.2 Is it realistic to assume that components which were attested only in the adults' utterances are available to the child?

If a unit can be derived from the input then it is learnable, at least in principle. Thus the fact that a novel expression can be derived using units attested in parental utterances shows that the relevant knowledge could have been acquired from the input. It is also important to note that even if *all* utterances that children produced were imitations (either immediate or delayed) of adult utterances, the first use of each expression would, by definition, not have precedents in the child's speech.

On the other hand, the fact that a particular unit could, in principle, have been learned from the input does not entail that the child did actually learn it. In order to determine to what extent our derivations depend on units attested in the input, we conducted a second analysis in which we used only child utterances as the source of attested units. Table 6 shows the number of successful derivations and

of lexical and syntactic fails that occur if we use only units attested at least once or at least twice in the child's utterances.

Table 6: *Numbers and proportions of lexical fails, syntactic fails and successful derivations when test utterances are derived from units attested in the child's own utterances*

The leftmost column in each group shows the number of utterances that could not be derived because of purely lexical failure, the child's use of a previously unattested word. As pointed out in Section 3.2 above, if the child uses a word, she has obviously learned it from someone. The middle column in each group shows cases in which the utterance cannot be derived because a complex lexically-specific component unit is not attested in the main corpus (in other words, at least one word is used in a different construction in the test corpus). As we can see, each more restrictive analysis reduces the proportion of utterances we can derive by about 10-15 percent with an overall mean of 62 percent of the children's utterances accounted for even when we require two precedents in the child's own speech. The majority of these successful derivations require either the same number of operations as the original derivation or one extra one.

Considering that we are reducing the size of the main corpus quite massively by removing the adult data, it is interesting that such a large proportion of the children's test utterances are still derivable. This indicates that that there is considerable overlap in the components that mother and child are using. This is reflected also in a study by Rowland et al. (2003) which shows that the frequency

of questions in the input, analysed in terms of lexical specificity, is correlated with the order of emergence of these same questions in the children's speech. Note, too, that restricting the pool of available precedents to child utterances alone has a proportionally much greater effect on lexical fails than on syntactic fails: the former increase eightfold (from 3 to 25) while the latter increase less than threefold (from 16 to 42).

4.3 Do speakers always use the largest and lexically most specific unit?

Many target utterances could be derived in more than one way from the component units attested in the main corpus. For example, *do you want some grapes?* could be produced (i) by combining *do you want THING?* and *some grapes*; (ii) by combining *do you want some THING?* and *grapes*; or (iii) by combining *do you want some THING?* and *some grapes*. We regard this as a strength: it is perfectly possible that different speakers, or even the same speaker on different occasions, will construct the same utterance in different ways. Note that many linguists, including Bolinger (1975), Fillmore (1979) and, more recently, Jackendoff (1997) and Culicover (1999) have suggested that adults, too, store prefabricated phrases.

In this paper, our main focus was to determine whether children's utterances could be derived using lexically specific units that we know the children have encountered in the past, not to determine exactly how they did it. To be able to provide a definitive answer the latter question, we would need to know more about how such units are retrieved and processed; and in any case, the answer can only be expressed in probabilistic terms: given a particular learner's

linguistic experience, he/she is most likely to assemble utterance X using method A. However, in order to be able to conduct our analysis, we did have to make certain assumptions about which derivation to use when there was more than one possibility. Specifically, we assumed that, when several derivations were possible in principle, learners prefer the one which is the simplest (i.e. involves the most specific units, and hence fewest operations) and the one which uses the largest units available. These assumptions are somewhat controversial, and hence deserve some justification.

Clearly, speakers have no way of knowing ahead of time which derivation is the simplest. However, it does seem reasonable to assume that they access a number of candidate units and try several methods of assembling the utterance in parallel, and the simplest one wins the race. This, of course, is an idealisation: in reality, the "race" is constrained by the relative activation levels that result from previous use and input, which may sometimes lead to more complex derivations. In particular, while the use of more specific units results in simpler derivations, such units are also less frequent, and hence more difficult to retrieve (for example, *do you want some THING?* is less frequent than *do you want THING?*). Thus, there is a trade-off between retrieval and on-line computation. The more general a construction, the more expressions fit its description. This means that instances of more general units are encountered more frequently, and hence such units are more entrenched and easier to retrieve. However, the use of general units in production requires more operations, and hence places more demands on the computational system. More specific units, on the other hand, are more difficult to retrieve, but their use is computationally less demanding.

The assumption that speakers use the largest unit available is potentially even more problematic: one could argue that larger (more complex) units are more difficult to manipulate, and hence learners are more likely to use smaller units. There are, however, two reasons for preferring the solution we have decided on. First, from a processing point of view, the number of chunks present in working memory seems to matter more than the size of the chunks (Miller 1956); and as hinted earlier, using larger, partially overlapping chunks may make it easier to match the corresponding parts. For example, the last of the three methods of deriving *do you want some grapes* discussed above may be easier because the overlapping phonological material (i.e., the word *some*) offers an additional clue about where to put *grapes*: thus, superimposing *do you want some THING?* and *some grapes* is rather like putting together two jigsaw puzzle pieces which have pictures of a part of the adjoining piece attached to them.

Assuming that language users prefer larger units also helps explain why children make relatively few government and agreement errors. For example, let us suppose that the child wants to describe a situation involving someone opening several contextually identifiable objects, and has the units *open THING, PROCESS them,* and *they* in her repertoire. One way she could assemble the expression is by superimposing the third person plural pronoun onto the THING slot in the *open THING* frame, which would result in the ungrammatical expression **open they.* If, however, she uses the *PROCESS them* frame (which captures the generalisation that the form *them* is used when the pronoun refers to the object of the action designated by the verb), she will produce the adult-like *open them.*

Similarly, for agreement, suppose the child wants to ask whether the interlocutor is in the bathroom and the available frames are *BE THING in the bathroom?* and *are you LOCATION?,* as well as the simple lexical items *is, are, am,* etc. Superimposing the two frames produces a well-formed sentence (*are you in the bathroom?*); but superimposing single words over *BE* and *THING* could result in utterances such as **is you in the bathroom?*. Thus, the commitment to using large units prevents our grammar from overgenerating on a massive scale, while also explaining why learners sometimes do overgenerate (for example, when the larger unit is not available).

4.4 Developing abstract representations

We have shown that it is possible to account for the majority of the children's interrogative utterances using only lexically specific units. Even relatively complex utterances such as *Why are you holding me, Daddy?*, *Do you want to come to my home today?,* and *You don't need to go to the bathroom, do you?* could be derived from component units attested in the main corpus using our method. Of course, the same data could also be interpreted in terms of more abstract syntactic representations and operations such as inversion, WH movement, and DO-support. However, we believe that our account is preferable to theories which require such abstract knowledge, for several reasons. First, it postulates only units which are learnable from the input, at least in principle, and hence does not require any assumptions about innate linguistic representations. Secondly, there is a general consensus that early questions such as *What's that?* and *Where's THING gone?* are formulaic, so our account does not require the

postulation of any new types of units. Finally, our approach allows us to suggest a consistent course of development from the earliest fully formulaic questions through to the much more complex constructions of the three-year-olds.

Although our account emphasizes lexically specific phrases, this should not be interpreted as a suggestion that children lack grammatical knowledge. To be able to apply the operations, they must have acquired substantial knowledge about constituency (i.e., analysed the stored units into parts and determined how each part contributes to the meaning of the construction as a whole) and about the categories of units which can occur in a given slot in a construction. For example, we suggested earlier that in order to derive *shall we get them ready then?* the child had to superimpose *get them PROPERTY* and *get THING ready*, and superimpose the result over the PROCESS slot in *shall we PROCESS then?.* To be able to do this, the child must be able to establish correspondences between items in different constructions and ensure that these items are semantically compatible (*them* is a kind of THING, *get them ready* is a kind of PROCESS, and so on).

Both kinds of knowledge can be gained by generalising over actual usage events. The child can learn about the internal structure of lexically specific units by noting that utterances sharing certain chunks of phonological structure also share aspects of their meaning (for example, utterances beginning with *shall we …?* are used to suggest some joint activity). Knowledge about categories can be acquired by generalising over the items that occur in particular slots. In the earliest stages of acquisition, such knowledge is probably construction-specific: for example, the child might learn about the kinds of fillers that can occur in the slot in the *Shall we …?* construction. Later this becomes more general as the child

notices that the same sorts of expressions occur as fillers in a variety of constructions, e.g. S*hall we …? Shall I …? Can I …? Will you …?* and so on. As we have seen, younger children substitute predominantly into THING and UTTERANCE slots. At age 3, we see a wider range of slots and concomitantly, a much expanded expressive repertoire. This echoes earlier research showing that even children as young as 1;9 are able to substitute novel nouns into established frames, while the ability to do this with verbs develops considerably later (Tomasello et al. 1997), although even two-year-olds begin to generalise over semantically based subclasses of verbs (Pine et al. 1998).

So the child is building up the abstractness of particular slots within constructions, abstracting across semantically related slots in different constructions and creating a wider range of slots. Frames such as *Can I PROCESS?* are generalizations over actual utterances. Later in development, children also acquire more abstract schemas such as *Can THING PROCESS?* and, later still, a fully abstract schema such as *GRP THING PROCESS?* (where GRP stands for a symbolic unit designating a schematic process functioning as a grounding predication, i.e. a tensed auxiliary). These more abstract units enable children to produce an even wider range of question types. In a CG framework such schemas would be regarded as generalizations over frames, acquired in much the same way as the earlier, more restricted generalizations, as in both cases, the more abstract unit has the same overall structure as the units which served as the basis for generalization (see Dąbrowska 2000 for a more detailed discussion about how such abstract constructions may develop). There is some evidence that the three-year-olds in our sample might be developing such constructions, as a few

utterances require component units with two slots (e.g. *Has THING PROCESS?, but where can THING PROCESS?*). It is clear, however, that such constructions are added to learners' productive repertoire fairly late, after they have already acquired a large number of fixed phrases and frames with slots, suggesting that perhaps a "critical mass" of instances is required before generalization takes place.

Another aspect of linguistic knowledge which develops relatively late is the ability to combine constructions which are partially incompatible. Questions about a non-subject argument, for example, involve superimposing a WH frame (e.g. *what GRP THING PROCESS?*) and a verb frame (e.g. *THING do THING*). These constructions are incompatible in that the former specifies that the noun phrase designating the direct object of the verb should occur in the sentence initial position, while the latter requires that the object come after the verb. There are two ways of superimposing these units, corresponding to two different higher-level constructions (see Dąbrowska 2004). In ordinary questions, the WH frame is the PROFILE DETERMINANT for the utterance (i.e. it is the component unit which is schematic for the composite unit; see Langacker 1987a, 1991), and therefore its requirements predominate: the resulting construction has the illocutionary force of a question and interrogative word order (e.g. *What has he done?*). In the so-called echo questions (*He has done what?*) the verb is the profile determinant, and the composite structure has declarative word order and a semi-declarative meaning.

There is some evidence that the children we studied were starting to be able to combine partially incompatible constructions by age 3. Our test corpora contain 16 WH questions about a non-subject argument with a verb other than the copula,

all produced by the three-year-olds. Eleven of these, according to our analysis, involve using a fixed phrase, adding an element to a fixed phrase, or substituting into a THING slot in an established frame. The remaining five (two from Annie 3 and three from Brian 3) involve substitution into a PROCESS slot, and thus require superimposition of constructions with partially incompatible specifications. The fact that the children left out the VP constituent corresponding to the questioned element (they did not ask questions such *what he done it?* or *what has he done it?*) shows that they have acquired the relevant knowledge, although the relative rarity of such derivations (2.5 percent of the three-year-olds' questions) suggests that this is probably a fairly recent development.[7]

5. Conclusions

In this study, we developed an inventory of lexically specific constructions in the speech of two children at ages 2 and 3 on the basis of a relatively large corpus of the child's linguistic experience, and then attempted to derive a sample of the children's multiword utterances using these constructions and two simple operations, juxtaposition and superimposition. Our grammar worked well, accounting for about 90 percent of all the interrogative utterances produced by the children. Most of the remaining 10 percent appear to be extensions of well-attested patterns rather than utterances requiring a radically different kind of knowledge.[8] Of course the fact that a speaker's behaviour can be accounted for in terms of relatively specific constructions does not entail that speakers do not have abstract knowledge. Indeed, any corpus of data that can be accounted for in lexically specific terms can also be accounted for (more economically) using more

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general rules (plus some lexically specific constructions to accommodate exceptions). The great advantage of lexically specific grammars is their psychological plausibility. Unlike abstract rules such as WH movement and subject-auxiliary inversion, lexically specific constructions can be learned from the input and hence do not require innate grammatical representations. Language learners have plenty of evidence for most constructions that they produce; and it is predominantly when they attempt to go beyond the conventions that they have already acquired that they make errors.

Clearly there is much work remaining to be done. The type of analysis that we have conducted could not have been carried out on a less dense corpus, but even the corpora that we used comprise only about 7 percent of what the children said and heard during a relatively brief period. Furthermore, we have only looked at syntactic questions, and there are many issues about how these relate to the child's non-interrogative constructions. It is also going to be very important to determine exactly how much children know about grounding, and to look at other constructions involving non-canonical word order and morphological phenomena, in English and especially in languages with a richer morphology and a less rigid word order.

Table 1: *Numbers of utterances and words in each corpus*

	Brian 2		Annie 2		Brian 3		Annie 3	
	Main	Test	Main	Test	Main	Test	Main	Test
Total number of utterances								
Child	10831	2429	11029	846	13599	3119	14569	1149
Adults	20209	5025	20379	1312	29355	5290	22505	1717
Total number of words								
Child	16678	4050	23297	1936	33241	7851	45378	4206
Adults	96086	26607	68293	4692	154728	27887	85429	6087

Table 2: *Non-creative questions in the test corpus (tokens)*

Corpus	Non-creative	Total questions	% Non-creative
Brian 2	33	44	75
Annie 2	42	86	49
Brian 3	61	105	58
Annie 3	21	98	21

Table 3: *Number of operations needed to derive the children's utterances (types)*

Number of operations	Brian 2		Annie 2		Brian 3		Annie 3	
	N	(%)	N	(%)	N	(%)	N	(%)
0	4	(36)	5	(11)	11	(25)	11	(14)
1	6	(55)	30	(66)	19	(43)	19	(25)
2	-	-	4	(9)	7	(16)	16	(21)
3	-	-	1	(2)	2	(5)	17	(22)
4+	-	-	-	-	-	-	5	(6)
Successful derivations	10	(91)	40	(91)	39	(87)	68	(88)
Fails	1	(9)	4	(9)	5	(11)	9	(12)
Total	11	(100)	44	(100)	44	(100)	77	(100)

Table 4: *Slots participating in superimposition*

Type of Slot	Brian 2		Annie 2		Brian 3		Annie 3	
	N	(%)	N	(%)	N	(%)	N	(%)
THING	5	(83)	37	(97)	25	(68)	49	(41)
UTTERANCE	1	(17)			3	(8)	6	(5)
PROCESS			1	(3)	5	(14)	37	(29)
DIRECTION					1	(3)	12	(11)
LOCATION					1	(3)	7	(6)
PROPERTY							4	(3)
Other*					2	(5)	8	(7)
Total	6	(100)	37	(100)	37	(100)	123	(100)

*Other: Brian 3: WH-word; AUX (omitted)
Annie 3: 4 POSSESSIVE; 3 BE; 1 GO

Table 5: *Syntactic fails*

Utterance	Attested components in main corpus	Freq.	Reasons for failure
Annie 2;0			
(1) Was it?	Was it THING? Was it PROPERTY? Was it PROCESS-ing?	6 A 2 A 2 A	Omitted constituent
	Is it?	15 A	No type variation in initial position
(2) *Do you want to football?	Do you want to PROCESS?	2 C	Inappropriate filler in PROCESS slot
(3) Which ones go by here?	Which THING go here?	2 C	No type variation in final position
(4) Which ones go right on here?	See (3) above	See (3)	See (3)
Brian 3;0			
(5) *What's a@sc called a cotton-reel?	what-'is called mister+bed?	1 C	Fails frequency criterion
(6) *What's called the newsagent man?	See (5) above	See (5)	See (5)
(7) *What say my computer?	What say?	12 C	No slot following *say*
(8) * Where you been to?	Where GRP THING PROCESS to?	4 A	Omitted GRP (grounding predication, i.e. auxiliary)
Annie 3;0			
(9) Was that fine?	Is that PROPERTY?	13 A	No type variation in copula position
	Was that from there?	3 C	No type variation in final position; inappropriate filler in final position
(10) *What does make that? = ?What does that make?	What does that say?	5 C	Unclear if *what* is subject or object of *make*; no type variation in PROCESS slot; wrong word order (?)
(11) *Do you want to sleep to my house tonight?	Do you want to PROCESS? Want to sleep sleep LOCATION to my house	18 C 2 C 3 C 7 C	Inappropriate filler in LOCATION slot
(12) *Do you want sleep to my house tonight?	See (11) above	See (11)	See (11); omitted complementizer
(13) *And what that done?	what have you done?	2 A	No type variation in subject slot; omitted auxiliary
(14) Why's it in plastic?	Why is it snow on the buildings?	2 C	No type variation in copula slot; inappropriate filler in final slot
(15) Are they downstairs?	Are they THING? Are they PROPERTY?	5 A 6 A	Inappropriate filler in final slot
(16)*Where is Deepa come with you? = Why has Deepa come with you?	Where is THING PROC?	2 C	This can be derived but the meaning doesn't accord with the child's intention or adult's interpretation.

Note: The figures given in the frequency column are for attested components in the Child's main corpus (C). Only if there are none are the frequency of attested components in the Adult corpus given (A).

Table 6: *Numbers and proportions of lexical fails, syntactic fails and successful derivations when test utterances are derived from units attested in the child's own utterances*

Derivations using	Child & Adult utterances (with 2 precedents)				Child utterances only (with 1 precedent)				Child utterances only (with 2 precedents)			
	Lex fail	Syn fail	Success	(%)	Lex fail	Syn fail	Success	(%)	Lex fail	Syn fail	Success	(%)
Brian 2	1	0	10	(91%)	1	0	10	(91%)	1	1	9	(82%)
Annie	0	4	40	(91%)	4	7	33	(75%)	9	8	27	(61%)
Brian 3	1	4	39	(89%)	10	4	30	(68%)	9	8	27	(61%)
Annie 3	1	8	68	(88%)	2	18	57	(74%)	6	25	46	(60%)
Total	3	16	157	(89%)	17	29	130	(74%)	25	42	109	(62%)

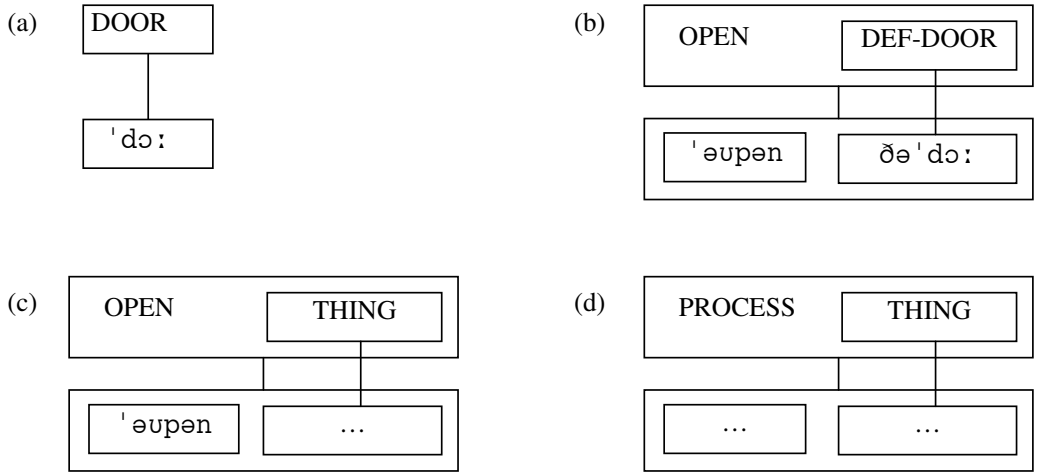

Figure 1: *Examples of symbolic units*

Note: Meaning is represented in CAPITALS at the top of the diagram and phonological form in phonemic transcription at the bottom. Boxes indicate unit status, and vertical lines represent symbolic relationships. To simplify the diagrams, boxes around symbolic units have been omitted.

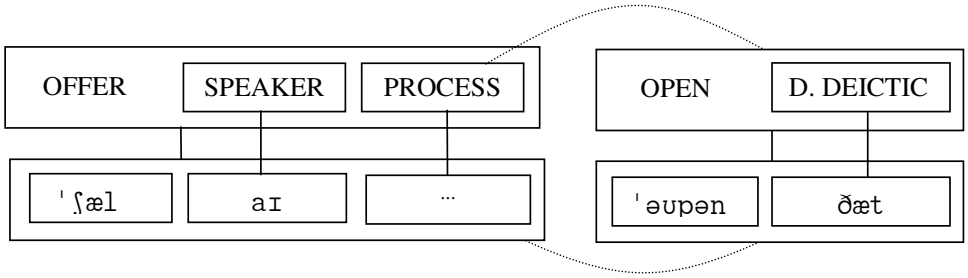

Figure 2: *Superimposition of a typical frame* (shall I PROCESS?*) and filler* (open that)

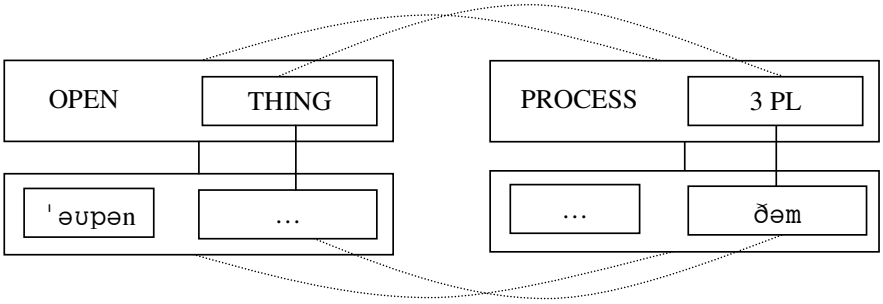

Figure 3: *Superimposition with mutual elaboration of the symbolic units* open THING *and* PROCESS them

Appendix: Attested Component Units used in the derivations and their frequencies in the main corpus

Question constructions

Unit	Brian 2		Annie 2		Brian 3		Annie 3	
	Child	Adults	Child	Adults	Child	Adults	Child	Adults
am I PRC-ing?							0	2
and what did THING do?							0	2
are they THINGs?							0	3
are we going DIR							3	2
are you LOC?							1	11
are you poorly?							5	1
but where can THING PRC?							4	0
can he PRC?							2	7
can I?							>50	>50
can I have THING?					3	22		
can I PRC?							>50	>50
can I PRC with you?							2	1
can I sit?							2	0
can I watch?							0	2
can PRC like THING?							7	11
can THING go DIR?							9	3
can we go DIR?							2	1
can we PRC?							5	6
do you want some THING?							5	7
do you want to come DIR ?							4	2
do you want to PRC?					3	44		
does it go like that?							2	0
has THING gone?							4	7
has THING PRC?							3	8
is it PROP and PROP?							0	2
is it LOC?							0	7
is it THING?							3	23
is this THING?	1	9					3	6
Mum, can I have THING?							5	0
now shall we PRC?							2	1
shall I be the THING?							2	6
shall I PRC?							>50	>50
shall I PRC one?							1	3
shall I show?							1	3
shall THING be THING?							2	10
shall we both?							2	0
shall we go and PRC?							0	3
shall we go DIR?							12	5
shall we PRC?							>50	>50
shall we PRC then?							4	7
what about THING?			0	43				
what about this THING?			0	3				

Unit	Brian 2		Annie 2		Brian 3		Annie 3	
	Child	Adults	Child	Adults	Child	Adults	Child	Adults
what are THING doing LOC?					0	4		
what are those?							0	2
what are you doing?					2	9		
what BE that LOC?							0	6
what can we PRC?							1	3
what did you hurt?							0	2
what for?					>50	1		
what happened?					6	13		
what I owe you?					10	1		
what I PRC?					9	1		
what is it?					0	24		
what PRC?					25	>50		
what THING?	9				>50	>50		
what THINGs?					6	17		
what say?					12	0		
what this?	7	0						
what to PRC?							0	8
what UTT in?					0	5		
what was that?							0	3
what's a THING?					0	8		
what's in that THING?					4	2		
what's THING?					>50	>50		
what's that?					16	31	27	30
what's that funny THING?			0	2				
what's that noise?					1	1		
what's that PRC?			3	1				
what's that?			>50	>50				
what's the THING?					1	39		
what's this?	14	35						
what's your name?							5	8
where?							>50	>50
where THING gone?	23	0						
where are THING?					1	5		
where are THINGs?							7	8
where are you?			3	11			3	8
where GRP THING come from?					1	3		
where can he PRC?							3	0
where can I PRC?							5	0
where can THING park?							5	0
where is it?							7	16
where THING?							38	0
where THING gone?	16	0						
where the Bow gone?	2	0						
where's a THING?			19	3				
where's Daddy?			8	3				
where's it gone?			11	2	6	3		
where's Annie?			9	0				

Unit	Brian 2		Annie 2		Brian 3		Annie 3	
	Child	Adults	Child	Adults	Child	Adults	Child	Adults
where's Annie's THING?			2	2				
where's Mummy?			6	1				
where's Mummy's THING?			3	3				
where's my THING?			48	10				
where's THING?			>50	>50	47	>50		
where's THING gone?	4	>50	25	10				
where's THING's THING?			10	9				
where's the THING?			>50	>50				
where's the THINGs?			>50	>50				
which THING?							27	36
which THING go here?			2	0				
who PRC?							13	25
who this?	4	0						
who's that?					0	22		
WH-word are you?					1	15		
why?							>50	>50
why are you PRC-ing?							5	2
why did you PRC?							13	3
you don't PRC do you?							0	8

Other sentence-level constructions

Unit	Brian 2		Annie 2		Brian 3		Annie 3	
	Child	Adults	Child	Adults	Child	Adults	Child	Adults
and UTT?	40	>50			>50	>50	>50	>50
THING down there			0	3				
because you don't PRC?							0	3
but UTT?							>50	>50
for UTT?							3	6
hello UTT?							2	2
I bought THING?					2	0		
I love?					37	8		
UTT already?							26	11

Nominal constructions (excluding simple nouns)

Unit	Brian 2		Annie 2		Brian 3		Annie 3	
	Child	Adults	Child	Adults	Child	Adults	Child	Adults
a drink			8	16				
a poorly THING							6	5
all the THINGs							16	>50
any more THING					2	4		
big THING			>50	>50				
big THINGs							0	3
blue one							3	8
charity bag					0	1		
doctor's bag							2	2

Unit	Brian 2		Annie 2		Brian 3		Annie 3	
	Child	Adults	Child	Adults	Child	Adults	Child	Adults
her milk							0	3
more money					3	4		
Mummy Daddy							3	0
my Daddy			4	0				
my ear							4	3
POSS bed							6	5
POSS bedroom							3	4
pretend THING							16	7
snack time							0	1
some milk					5	8		
some money					7	11		
some more THINGs					11	16		
tennis racket			0	1				
that way					4	10		
the box			0	26				
the boy			0	2				
the doctor							7	10
the elephant			0	3				
the kitchen							5	11
the tape			0	9				
these letters					2	2		
this one			>50	>50				
this THING			>50	>50				
your house							0	3
your THING							>50	>50
she							>50	>50
ones			5	27				
THING for THING							>50	>50

Predicate-argument constructions

Unit	Brian 2		Annie 2		Brian 3		Annie 3	
	Child	Adults	Child	Adults	Child	Adults	Child	Adults
blow away					1	1		
bought it					1	0		
buy some THING					13	15		
comb your hair							1	1
come to my THING							5	0
come to PRC							2	4
do with that							2	0
don’t know where THING is							0	2
finish THING							0	14
found					19	34		
get THING ready							0	3
get THING up							2	2
get them PROP							1	2
get them LOC							7	3

Unit	Brian 2		Annie 2		Brian 3		Annie 3	
	Child	Adults	Child	Adults	Child	Adults	Child	Adults
go into THING							1	3
go into the THING							0	3
GO out							9	31
go this way							2	0
goes DIR					8	42		
going DIR							5	9
gone DIR							15	20
has got a THING							3	1
have all THING							1	1
holding THING							4	10
hop							2	1
lying down			0	5				
make it							6	22
pick THING							10	25
PRC after THING							11	4
PRC in here							8	14
PRC where THING is							2	3
PRC-ing me							6	9
put that there							11	2
sleep in THING							2	0
sleep LOC							4	2
take THING to playschool							0	2
take them DIR							1	9
to go in							26	15
watch TV							0	2
wear THING							10	9

Locatives and directionals

Unit	Brian 2		Annie 2		Brian 3		Annie 3	
	Child	Adults	Child	Adults	Child	Adults	Child	Adults
at your THING							0	17
downstairs							3	11
in our THING							3	8
in POSS ear							0	2
inside							12	42
out in the THING							1	1
outside							35	45
straight DIR							5	9
to ballet							2	2
to LOC							16	18
to playgroup							1	0
to playschool							5	9

Other constructions

Unit	Brian 2		Annie 2		Brian 3		Annie 3	
	Child	Adults	Child	Adults	Child	Adults	Child	Adults
[blowing noise]	8	1						
and get a THING							0	3
bow gone	4	0						
Daddad gone	2	0						
for big THINGs							1	3
just for big girls							1	1
like me							1	3
now			>50	>50	>50	>50	>50	>50
okay							>50	>50
that					>50	>50		
then					>50	>50		
there					>50	>50		
these							>50	>50
today							14	>50
tonight							2	11
your PRC					>50	0		

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Notes

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[1] For the sake of exposition the diagrams in Figure 1 are simplified and incomplete: they do not represent the agent nominal, the tense of the verb, or the internal structure of the nominal *the door*. We have also omitted the boxes around symbolic units. Readers familiar with the CG framework will also note one significant departure from standard Langackerian notation: while the subparts of semantic structure corresponding to the arguments of the verb are linked to their corresponding phonological structures (e.g. DEF-DOOR to *the door*), there is no direct link between the semantic representation of the verb and the corresponding phonological unit – only between the whole relational predication with its arguments (e.g. OPEN DEFINITE-DOOR) and the corresponding phonological structure ([ˈəʊpəndəˈdɔː]). This is meant to reflect the non-autonomous nature of verbs and other relational predictions (cf. Langacker 1987a, 1991): conceptually, verbs presuppose their arguments, and are typically learned and used in the context of utterances containing NPs corresponding to the latter. In other words, verbs are not single words, but constructions – e.g. *open* + SOMETHING OPENABLE (or OPENER+ *open* + SOMETHING OPENABLE).

[2] See Method section for details of corpora. *MOT = mother's utterance

[3] In fact, the linear order of the component units will sometimes depend on discourse factors, and this knowledge may be captured in a construction. Whether the child has yet formed such a construction, we leave open in this analysis.

[4] A reviewer pointed out that juxtaposition and superimposition are similar to adjunction and complementation. While there are some obvious parallels, the two pairs of terms are not fully synonymous. In particular, superimposition refers to a wider range of phenomena than complementation: for example, it is possible to superimpose a verb over a schema defined by the subject and object pronouns (such as *he PROCESS it*) , but the verb is not a complement of *he … it*. Furthermore, the traditional notion of complementation is unidirectional: if X is a complement of Y, Y cannot be a complement of X, while it is possible for two frames to elaborate different parts of each other (see example in text).

[5] The above discussion glosses over an important issue. We allowed substitutions of both grounded (e.g. *my cat, the black cat*) and ungrounded (e.g. *cat, black cat*) nominals into the THING slot, and both grounded (e.g. *sits, sat, is sitting*) and ungrounded (e.g. *sitting*) predicates into the PROCESS slot. This reflects the fact that the children often omitted determiners and used untensed verb phrases where tensed forms were required. However, they tended not to make the opposite error: for example, they did not substitute full noun phrases into constructions which already contained a grounding predication (e.g., they would not superimpose expressions such as *those grapes* over the slot in *do you want some THING?*). This suggests that the children did have some construction-general knowledge about determiners (i.e., they knew that determiners pick out an instance of the type designated by the noun), and possibly also about finiteness. To determine whether this is the case, it would be necessary to examine the children's use of grounding predications in the entire corpus, which is beyond the scope of this paper; in this respect, our account of the children's knowledge is not fully explicit.

[6] Note that this could also be an error of omission.

[7] Note that children sometimes do produce precisely these errors, suggesting that the ability to superimpose partially incompatible constructions takes time to develop.

[8] These results are remarkably similar to those of Johnson (1983). For instance, although she was working with much more limited corpuses, she found that she could account for over 95 percent of 6 children's *what* questions with just six frames.