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Learning to produce complement predicates with shared semantic subjects

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Abstract

Many sentences of adult English are analytic constructions, namely clauses with a matrix verb complemented by a dependent predicate that does not have an expressed syntactic subject. Examples are subject and object control, raising to subject or object, periphrastic tense, aspect and modality, copular predication and *do*-support. In this article the authors test a suggestion derived from Dependency Grammar that despite differences in detail, all such constructions are governed by a common principle of structure sharing which young children master when they produce such sentences. Analytic sentences and telegraphic sentences were examined in the speech of 439 young children, mean age 2;3.11 (*SD* = 0;4.02). The production of different analytic constructions was significantly associated, raising the probability of each other by 32% on average. Telegraphic sentences overtly expressing the input's covert predicate–argument relations also positively predicted the production of analytic sentences. These results suggest that children learn a general principle of sharing arguments, common to constructions with dependent predicates, making transfer and facilitation possible.

Keywords

Control, Dependency Grammar, *do*-support, periphrastic tense/aspect/modality, predicate–argument relations, raising, structure sharing, syntactic development, telegraphic speech

Introduction

At an important stage in the history of developmental theory, children's early word-combinations were thought to be the expression of relations between semantic categories

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such as agent and action, or action and object (Brown, 1973). However, right away there were some doubts about the generality of the production rules as the data fit a pattern of item-specific learning better (Bowerman, 1976, p. 157). Soon there developed a wide consensus that children construct their early multiword utterances and especially their earliest two-word sentences with the help of a rudimentary syntax that deals with the expression of the relation between specific predicate words and their semantic arguments (Deuchar & Quay, 1998; Gentner, 1978; MacWhinney, 1982; Ninio, 1988; Vihman, 1985). Predicates are words with the logical makeup of functions with arguments, possessing a requirement that the arguments be specified in the sentence. Words from most form-classes can serve as predicates and can have semantic arguments (Allwood, Andersson, & Dahl, 1977). In early sentences of English-speaking children we find exemplars of a varied range of predicate words combining with their semantic arguments, among them verbs (*see bird*), adjectives (*animals hungry*), adverbs (*car there*), prepositions (*to school*), determiners (*more juice*), common nouns (*it doll*) and proper nouns as in *that Thomas_Engine*.

Subsequently, it has been proposed by several researchers that the predicate–argument combinations in children's early speech are in fact syntactic Head-Dependent couplets, produced by the asymmetrical combining operation of Dependency or Merger (Green, 1997; MacWhinney, 1982; Ninio, 2006; Powers, 2002; Radford, 1990; Robinson, 1986; van Langendonck, 1987).

Dependency Grammar

Dependency is an asymmetrical operation combining two words, in which the combination shares the grammatical features of the Head and not of the Dependent entering the combination; Dependency Grammars propose that this is the building-block of syntactic structure (Hudson, 1990; Tesnière, 1959). Dependency is analogous to the operation Merge of Noam Chomsky's (1995) Minimalist Programme (Epstein, 1999), except that the Dependency formalism uses only words and thus seems better suited to describe children's early speech.

Syntactic structure is usually represented by trees in which the nodes are the units generating the structure and the edges (arcs) represent relations between units. A typical tree-structure illustrating Merge is (1), representing the phrase '*saw it*' as in '*The man saw it*' (based on N. Chomsky's (1995) example (11), p. 247):

(1)


This means the head-word '*saw*' is combining with '*it*', and the combination '*saw it*' (a verb phrase) is syntactically similar to '*saw*' (a verb), not to '*it*' (a pronoun).

The recursive application of the operation Merge creates the complete tree-structure of the sentence. There is no limit on the number of times the operation Merge may be applied in an iterative fashion, so that potentially it can generate an infinitely large syntactic structure.

Like Merge, Dependency is an asymmetrical operation between two syntactic elements, in which the combination shares the grammatical features of the Head and not of the Dependent unit entering the combination (Hudson, 1990). The tree-structure (2) represents the same phrase '*saw it*' as (1), in a Dependency-type notation:

(2) saw
\
it

In this case, too, the Head unit and the resultant combination are labelled identically by the label of the Head unit. The difference is that the Dependency tree only uses one single node to represent both: the single node labelled '*saw*' is to be seen both as the Head element '*saw*' and the combination of '*saw*' and '*it*'.

According to theory, the syntactic structure of a sentence as a whole is built up from such pairwise dependency relations between individual pairs of words. Two restrictions are placed on the dependency structure of a grammatical sentence: first, every word (but one) must have a head, and second, every word has only a single head. The exception is the *root*, namely, the highest word of the sentence, which does not have a head.

Analytic constructions in English

Given that children's earliest two-word sentences consist almost exclusively of predicates and their arguments, it appears that children's initial syntax operates on the principle that sentences are constructed to express the predicate–argument relation as a Head-dependent relation. However, when children move beyond the earliest two-word long sentences, they need to change their conception of syntax. A large proportion of adult sentences longer than two words are *analytic constructions*, namely single clauses with two or more predicate expressions in a chained structure. These constructions historically evolved as part of the development of English from a morphologically rich language to an analytic language, in what Sapir (1921) called the 'analytic drift'. Such clauses have an inflected verb serving as the root of the clause, and a nonfinite predicate complementing it, which can be a verb (infinitive, participle, gerund), or a predicative complement (noun phrase, adjective phrase, adverb or prepositional phrase). The linguistics literature distinguishes among many different syntactic patterns in sentences where there is a nonfinite predicate complementing the matrix verb, differentiating between matrix verbs that are verbs of control (e.g. *try, ask*) which semantically select their subject, and raising verbs (*seem, appear*) which do not, as well as auxiliaries (*be, have, can, may*), periphrastic *do* and copular verbs (*be, become*). In addition, some control verbs are subject-control (*try, like*), some are object-control (*ask, tell*); some raising verbs are raising-to-subject (*seem, appear*) and others are raising-to-object (*believe, consider*). Auxiliaries and copulae are usually considered subject-raising verbs (e.g. Bresnan, 1982). Raising and control and their various subtypes are extensively discussed by N. Chomsky (1981), Haegeman (1994), Pollard and Sag (1987) and many more.

Although there is no argument that the different sentence types containing a nonfinite complement predicate have various specific characteristics, they share a basic

feature. In English, dependent predicates do not get an overt, expressed subject of their own (Quirk, Greenbaum, Leech, & Svartvik, 1985, pp. 75, 820). They do have, as all predicates, a semantic subject-argument, which is the entity they predicate something of. This unexpressed but understood subject can only be co-referential with the subject or the object of the matrix verb. Bresnan (1982), followed by Hudson (1990, 2014), proposed that all these dependent predicates can be treated as the manifestation of the same syntactic relation which Bresnan called '*X-complement*', and Hudson, either '*incomplement*' or a '*sharer*' verb complement. In this syntactic pattern, the predicate complement shares its semantic subject with the matrix verb. Whether the shared argument will be the matrix verb's subject or object is determined by a very simple principle. If the matrix verb has an object, this is the phrase co-referential with the predicate's semantic subject, otherwise it is the matrix verb's subject. The only exceptions are the verbs *promise* and *threaten*, whose predicate complements always take the verbs' subject as their semantic subject, even if *promise* or *threaten* have an object. Hudson points out that the 'sharer' pattern is found with auxiliary verbs, copular verbs, periphrastic *do* of support, raising-to-subject verbs, raising-to-object verbs and verbs of control. Namely, whenever there is a nonfinite predicate complement to a matrix verb, regardless of specifics the predicate's subject argument is unexpressed but co-referential with the matrix verb's subject or object. We shall call such sentences 'analytic constructions'.

The principle that is claimed to underlie all of the analytic constructions is an anomalous syntactic relation between the lower predicate's subject and the matrix verb's subject or object, which does not have an overt effect on the surface structuring of the sentence but does determine the co-reference of the lower predicate's argument with either the subject or the object of the matrix verb, with obvious semantic effects. At an earlier stage of his theory, Hudson (1990) treated this covert relation as a bona fide syntactic dependency, which generated a double head for the matrix verb's complement as it was given as a subject also to the lower predicate. His Word Grammar was notorious for being the only type of Dependency Grammar that allowed a word to have two heads. In the last few years he switched to a treatment of this relation as 'sharing', underlined by an unexpressed, covert syntactic relation (Hudson, 2014).

Importantly, the sharing that Hudson proposes is a semantic sharing, and there is no regular syntactic-dependency relation between the nonfinite complement predicate and the matrix verb's subject or object. In other words, there is a predicate–argument relation without a parallel overt and expressed syntactic relation between the dependent predicate and its subject-argument. In order to satisfy the semantic need of the dependent predicate for its primary argument, the listener has to turn to the expressed syntactic subject or object of the finite verb governing the nonfinite predicate.

The principle of subject sharing – or co-indexing as it is called in Head-driven Phrase Structure Grammar (Pollard & Sag, 1987), Lexical-functional Grammar (Bresnan, 1982) and so on – is not a general cognitive principle but a purely linguistic one. It is needed for such constructions as control and NP-equi by different theories of grammar, but it appears not to have extra-linguistic parallels. If children indeed acquire such a principle, it is specific for their syntactic system.

Development of the syntactic principle of subject sharing

The possibility that all constructions with a dependent nonfinite predicate are governed by a single syntactic principle has important implications for developmental theory as it creates a dimension of similarity between them. We are assuming that the learning of the syntactic behaviour of verbs and other words with syntactic potential is lexical-specific, that is, occurs individually for each word. The reason is the fundamental lexical-specificity of syntax. The information of how many complements a verb takes and what kind, needs to be entered in its lexical entry (Bresnan, 1978). Despite a certain degree of relatedness to verb semantics, linking from meaning to syntactic expression is not consistent enough to turn lexical indication of subcategorization unnecessary.

Lexical-specific learning of syntactic structures does not mean the different items are isolated; rather, old items facilitate new items' acquisition by transfer based on analogy (Abbot-Smith & Behrens, 2006; Keren-Portnoy & Keren, 2011; Ninio, 2006). What is called the identical-element theory of transfer attributes the degree of transfer between the source and the target tasks to the overlap of shared task-components, namely, to the extent to which elements, features, or principles are shared by them (Singley & Anderson, 1989).

It is important to stress that the ability to notice similarities and to use them in transfer of learning is a general cognitive bias of the learning system and it does not imply that the learners engage in abstraction or categorization. Instead, a source-task can provide anchor for transfer to a great many different target-tasks, the degree of transfer depending on how much of their elements, features, or principles are shared by them. For example, in a study by Abbot-Smith and Behrens (2006), the acquisition of the German *sein*-passive using the auxiliary *sein* '*be*' with a complement participle was shown to have received a great deal of transfer from several previously learned and formally similar constructions using either the relevant auxiliary, the participle or both. This does not mean that before facilitation between them could occur, the children needed to form categories containing the *sein*-passive and for example, the *sein* copula construction, just because both use the auxiliary *sein* '*be*'.

Our hypothesis is that since the various analytic structures are inherently similar due to the common syntactic principle underlying them, this similarity will cause facilitation in the individual learning of each of these structures. Transfer of learning causes structures to be statistically tied together due to the raised conditional probability of production. There is no claim children otherwise form an abstract category of analytic constructions, or an abstract concept of subject sharing.

Until recently, studies of the acquisition of nonfinite clauses have focused on specific patterns. Thus, some studies examined the development of control constructions (e.g. C. Chomsky, 1969; Landau & Thornton, 2011; Maratsos, 1974; Wexler, 1992), but the strategies children use for interpreting the understood subject proposed in these studies are specific to control constructions (e.g. Goodluck & Behne, 1992), and cannot be applied to other analytic constructions with a different syntactic structure such as copular sentences.

In a change of approach, a significant number of recent studies have investigated the intersection of different analytic structures predominantly in the development of

comprehension, including subject-control, raising-to-subject and copular sentences (Hirsch, Orfitelli, & Wexler, 2008; Mateu Martin, 2016), raising-to-subject copular sentences and passives (Orfitelli, 2012), and raising-to-object and object-control (Kirby, 2009), and see also Becker (2014) regarding links between several analytic structures in development. It was found that the class of analytic structures form subclasses within development in the language of children above 4 years, when prior to this age, children usually fail in dealing with such constructions in the experimental contexts employed. These studies show that analytic constructions do not develop separately in development, but form subclasses according to some shared features. These subtypes may well differ in level of complexity and therefore at average age of acquisition. The process of semantic sharing suggested by Hudson (2014) may be the general principle that underlies the acquisition of all such constructions, regardless of their specific features.

In this study, we shall test the hypothesis that all analytic constructions with dependent predicates are connected in acquisition, and that such a general principle is involved in their learning. First, we test the independence of the different constructions in young children's speech at around 2 to 3 years of age. The null hypothesis is that there is no significant association between each and every construction, rejecting the claim they all share a common feature. The alternative hypothesis is that the production of all different constructions is positively related, so that if a child produces one of the analytic constructions, there is a high probability he or she will produce other ones, too, at this early age.

It is expected, though, that not all analytic constructions are similar to all others to the same degree. In particular, we expect the two subtypes of co-referentiality to form two major subtypes: structures where the unexpressed subject is co-referential with the matrix verb's subject on the one hand, and with the matrix verb's object, on the other hand. On the simplest of bases, object-control and raising-to-object appear to be more difficult to comprehend than subject co-referentiality, as in the former cases the syntactic relations which are co-referential are not the same, while in the latter, they are the same as if omitting the lower subject were some kind of coordinate-reduction. We expect therefore that the analytic structures involving objects will be less facilitated by the ones involving matrix subjects (and vice versa), and also more difficult to acquire. In a similar vein, control and raising structures may differ in degree of difficulty as well as less likely to facilitate each other than constructions with the very same syntactic structure. Indeed, Limber (1973) found that in the speech of three children structures with co-referential subjects were acquired earlier than ones with objects, and control was earlier than raising. Limber did not test copular structures or *do*-support and we shall also want to check if her results are replicated on a larger sample.

The second way we test the hypothesis of a general principle of semantic sharing underlying children's mastery of analytic constructions is by examining the relationship between sentences where such a sharing is maintained and sentences where the child generates a direct syntactic relationship between the nonfinite predicate and the matrix verb's subject or object. Sentences where the matrix verb is omitted and only the dependent predicate is retained, together with the relevant subject or object, are called 'telegraphic sentences' (Brown, 1973). Analytic sentences have a matrix verb and a nonfinite predicate; telegraphic sentences do not have a matrix verb and only have a nonfinite

predicate. For example, the analytical sentence '*I am hungry*' has its telegraphic analogue in the sentence '*I hungry*'. Telegraphic sentences operate on the initial syntactic principle characteristic of children's two-word combinations, namely, that semantic predicates and arguments are to be expressed as syntactic heads and dependents.

In a counter-intuitive way, our hypothesis is that by generating telegraphic sentences, children demonstrate that they identify the covert semantic relation in analytic sentences, i.e. between the nonfinite predicate and the matrix verb's subject or object. Being aware of the hidden semantic relation although it is masked and unexpressed in full analytic sentences in the input is a pre-condition to producing analytic sentences. Expressing it shows children recognize this relationship exists even when the lower predicate's subject is given with a different verb as its governor. If, on the other hand, children do not produce telegraphic sentences at this early stage of development, it is less likely that they understand the semantics of analytic sentences. This hypothesis predicts a positive association between the generation of telegraphic sentences and full analytic sentences with expressed matrix verbs. The alternative hypothesis is that telegraphic sentences are an error of omission competing with, and negatively related to, complete analytic sentences.

To summarize, we shall test two hypotheses positing the presence of basic syntactic principles to do with predicate–argument relations and their expression in early child language.

Method

Participants

The participants were 439 English-speaking children, 226 males and 213 females. The mean age of the children when generating the utterances analysed was 2;3.11, *SD* = 0;4.02. English-language child samples were taken from the CHILDES (Child Language Data Exchange System) archive (MacWhinney, 2000), which is a public domain database for corpora on first language acquisition. All participants were observed in naturalistic, dyadic interaction of children with their parents. The observations were of normally developing young children with no diagnosed hearing or speech problems, and native speakers of English. We systematically sampled from the English transcripts in the CHILDES archive all the projects involving typically developing young children in which the children were under 3;6. This process resulted in the selection of children from 33 research projects in the CHILDES archive: the British projects Belfast, Howe, Korman, Manchester and Wells, and the American projects Bates, Bernstein-Ratner, Bliss, Bloom 1970 and 1973, Brent, Brown, Clark, Cornell, Demetras, Feldman, Gleason, Harvard Home-School, Higginson, Kuczaj, MacWhinney, McMillan, Morisset, New England, Peters-Wilson, Post, Rollins, Sachs, Suppes, Tardif, Valian, Van Houten and Warren-Leubecker (MacWhinney, 2000). From these projects, we selected the observational studies of 471 different parent–child dyads; 32 children did not produce multiword sentences, leaving 439 children as the sample for this study. We restricted the contribution of each individual child to 300 multiword sentences, starting from the first observation in which they produced them. This took 14.7 days on average. Thus the data came

from the first observations in which children in the sample produced multiword, syntactically connected sentences. The starting point was the first record of that child producing multiword utterances in the totality of their CHILDES data. We used at the most each child's first 300 multiword sentences, taken consecutively, or less if the child did not produce that many during his or her observations. The data did not come from the first-ever two weeks long period in each child's data as some children were observed for a long time before they started to generate multiword combinations and these observations were irrelevant for the present study that dealt with syntax. On average, once a child generated his or her first multiword sentence that we included in the database, it took two weeks to generate the first 300 multiword sentences. For some children it took only one observation, others took longer than two weeks to complete this stock of sentences; hence two weeks is an average in the sample, not a criterion. The mean MLU in words based on the last 50 utterances observed was 2.10, $SD = 0.48$, range: 1.52–3.74.

Materials

For each utterance marked in the original transcriptions as one uttered by the child, we checked the context to make certain that the line was indeed child speech (and not, for example, an action description or parental sentence). Children's utterances were included only if they were spontaneous, namely not immediate imitations of preceding adult utterances. Utterances which were altered versions of previous parental sentences, e.g. by the omission of certain words, were included in the speech corpora. Only complete and intelligible sentences were considered for the current study; utterances marked in the transcriptions as cut off or unfinished, or as containing uninterpretable words (transcribed as xxx or yyy) were excluded.

Syntactic annotation for grammatical relations

Sentences were parsed manually for syntactic structure, using the Dependency Grammar method. We based our dependency analyses on the detailed descriptions of Hudson's English Word Grammar (Hudson, 1990) with its online update (Hudson, 2014). For parsing and the classification of analytic constructions we consulted descriptive grammars of English, and in particular Quirk et al. (1985).

Syntactic annotation of the sentences was done by graduate students at the Hebrew University with training in linguistics. It relied on extensive coding instructions and a very large collection of annotated exemplars. We checked for reliability by having three pairs of coders blindly recode 1900 utterances. Each pair recoded a different set of utterances, one pair recoded 700 utterances and two pairs, 600 each. A checking of all reliability codes showed that the agreement of each coder with the others was above 95% on the detailed classification of analytic and telegraphic structures as analytic or telegraphic copular, *do*-supporting, tense/aspect auxiliary and so on. Sentences which were neither analytic nor telegraphic (e.g. *close the door*), are not included in the reliability statistics. Throughout coding, all problem cases were discussed and resolved. Ultimately, each coded utterance was double-checked by another coder.

Analytic constructions identified and classified

We identified all sentences of three words and longer in which there was an analytic construction consisting of a subject and a tensed verb complemented by a subordinate uninflected predicate. We included all constructions headed by finite verbs including lexical verbs such as *I want to go home*, auxiliary verbs such as *She is eating*, copular verbs as *It is big*, and periphrastic *do* as in *I don't want to sit there*. When the matrix verb was uninflected (i.e. a root infinitive), the sentence was nevertheless included and considered an analytic structure. For example, we included *baby want to do, he don't like the kitchen* and *do this open?* as they were considered analogous in structure to the sentences *he wants to wash the car, he doesn't have any clothes on* and *how does it open?* in the corpus. Similarly, we ignored other morphological errors throughout such as omitted plurals, mistaken person in pronouns and so forth. Unlike some other theoretical approaches that consider both inflectional morphemes and full word units such as auxiliary verbs to belong to the same syntactic category, in Dependency Grammar there is a clear cleavage between words and bound morphemes. Omitting a word is considered a syntactic error whereas omitting an inflectional morpheme, a morphological error. As the focus of this study is the mastery of the word-constituents building up an analytic construction, we decided on an inclusive definition of children's productions of this type, ignoring morphological mistakes as well as unrelated syntactic errors such as omitted determiners. Only verbs receiving a nonfinite predicate complement were included, but not verbs followed by an infinitive of purpose such as *He went to open the door*, or by a descriptive gerund such as in the sentence *He came running*. If there were two or more subordinate predicates, each was considered to define a separate analytic construction.

We classified analytic constructions into the following six categories: (1) Subject-control constructions with lexical verbs such as *like*, *love*, *try* and *want*; (2) Raising-to-object constructions with the verbs *make* and *want*; (3) Raising-to-subject constructions with the copular verbs *be*, *become*, *seem*, *look*, *sound* and so forth; (4) Raising-to-subject constructions with the tense and aspect auxiliaries *be*, *have*, *do*, *keep*, *continue*, *use*, etc; (5) Raising-to-subject constructions with the modal auxiliaries and semi-auxiliaries *can*, *may*, *will*, *would*, *shall*, *should*, *must*, *ought*, *need*, *dare*, *have*, *have got*, *let*, *try*, *want*, *like*, *go*, *went*, *make* and more; (6) Raising-to-subject constructions with periphrastic *do*-support in questions, negation and emphasis.

We did not find in the corpus lexical raising verbs such as *seem* or *appear*; object control verbs such as *ask, tell, make, force*; and passive constructions such as *That was given to me by my cousin*. In the rest of the article, the six subtypes analysed are the ones defined above. We shall return to the constructions not occurring in the corpus in the discussion.

Identifying telegraphic sentences with omitted auxiliaries, copulae and control verbs

We checked all multiword sentences produced by children for sentences including a subject and a nonfinite verb or predicate in semantic relation but lacking a finite matrix verb, which we classified as telegraphic sentences of the six types of analytic

constructions defined above. The classification of the missing inflected verb by type was based on the following criteria:

1. The transcription of the sentence in the CHILDES archive includes an overt marking that there is an omitted auxiliary, copula or other matrix verb in the sentence. Such markings can be one or more of the following: the word is given in round parentheses (1a), square parentheses (1b,c), marked by a proclitic '0' (1b–f) or marked by a '*' as an error within square parentheses (1b–e):

   (1) a. I('ll) fall.
   b. They [* 0are] driving.
   c. Baby [* 0is] sleepy.
   d. Tank 0was [*] coming.
   e. Where 0are [*] prams.
   f. What 0is that?

2. The missing word is unmarked in the transcript but can be retrieved from the child's or the parent's following utterances that paraphrases it with the inclusion of the relevant word (2a), answers the question asked (2b) and so on:

   (2) a. Child: What that?
   Mother: What is that?
   b. Child: Where Mary go?
   Mother: She's gone home.

3. The missing word can be retrieved from the linguistic and interactive context with high certainty, for instance, questions without *do*-support such as *You have a pen?*; negation without *do*-support as in *I not want potty*; missing tense/aspect auxiliary for a sentence with a present participle as in *I sitting on you*; missing modal auxiliary *can* when the context identifies the utterance as a request as in *I have another cookie?* followed by the parent's permission or refusal and so forth.

As we did for analytic structures, we ignored morphological mistakes in the form of the nonfinite predicate. This means that sentences with nonfinite base verbs (i.e. root infinitives) were included even when the correct sentence required a different uninflected form. For instance, one of the utterances included in the corpus in the category of telegraphic sentences was *where daddy go?* instead of *where has Daddy gone?* the child omitting the aspectual auxiliary *has* and using the bare infinitive *go* instead of the participle *gone*. Another example is *Neil sit* instead of *Neil is sitting* (judging by the mother's clarification question *Who is sitting*?). In addition, we considered sentences with a bare root complement as telegraphic when the sentence required *to* but it was omitted, because *to* counts in Dependency Grammar as a verbal form and it should have been the immediate, matrix-verb type, head of the infinitive. For instance, in the following example we counted *want* as a matrix verb, but the sentence was counted as telegraphic because of the omitted *to* that should have headed another analytic structure. The child said *Jonathan*

Table 1. Number of children producing and token frequency of six types of analytic constructions (*N* = 439).

Analytic construction	No. children	Tokens	Tokens per child
Subject-control	174	627	3.6
Raising-to-object	35	55	1.6
Copular sentences	347	4929	14.2
Tense/aspect auxiliaries	217	1292	6.0
Modal auxiliaries	165	631	3.8
Do-support	199	789	4.0

want come up instead of *Jonathan wants to come up* (judged by the mother's response which was *come up then*).

Sentences that could be interpreted neither by the parent nor by the investigator were excluded from the corpus. Many of these were marked in the transcripts by a question mark in square parenthesis, as *Dolly Andy in [?], Dog down stairs [?]* and *Food in there [?].*

Results

Analytic constructions in children's speech

Children produced six types of analytical constructions. Some examples of copular sentences (3a,b), periphrastic constructions for tense and aspect (4a,b), for modality (5a,b) and for *do*-support (6a,b), and sentences with subject control (7a,b) and raising-to-object (8a,b) in children's speech are:

(3) a. That one is purple.
b. Are you ready?
(4) a. He's crying.
b. I'm going to eat.
(5) a. Doggie can dance.
b. You have to sit up there in that chair.
(6) a. Does this work?
b. I don't like chicken.
(7) a. He wants to wash the car.
b. I like to stay with my mother.
(8) a. I want it to ring.
b. I just let him drink a water.

Table 1 presents the number of children producing the six types of analytic constructions and the token frequency of each.

The five constructions where the understood subject is co-referential with the matrix verb's subject – copular sentences, periphrastic constructions for tense and aspect, for modality and for *do*-support, and sentences with subject control – were each produced by

Table 2. Conditional probability of children producing an analytic construction given they produce another construction, and the value of the chi-square statistic testing the independence of the two, by type of construction produced (N = 439).

Other construction	% if yes	% if no	Chi-square*
Subject-control (total 39.64%)			
Copular sentences	45.82	16.30	26.48
Tense/aspect auxiliaries	51.15	28.38	23.79
Modal auxiliaries	61.82	27.69	48.62
Do-support	57.29	25.00	47.40
Copular sentences (total 79.04%)			
Subject-control	91.38	70.94	26.48
Tense/aspect auxiliaries	95.39	63.06	69.24
Modal auxiliaries	93.33	70.44	32.59
Do-support	90.45	69.58	28.60
Tense/aspect auxiliaries (total 49.43%)			
Subject-control	63.79	40.00	23.79
Copular sentences	59.65	10.87	69.24
Modal auxiliaries	74.55	34.31	66.71
Do-support	68.84	33.33	54.88
Modal auxiliaries (total 37.59%)			
Subject-control	58.62	25.10	48.62
Copular sentences	44.38	11.96	32.59
Tense/aspect auxiliaries	56.68	18.92	66.71
Do-support	56.78	21.67	57.19
Do-support (total 45.33%)			
Subject-control	65.52	32.08	47.40
Copular sentences	51.87	20.65	28.60
Tense/aspect auxiliaries	63.13	27.93	54.88
Modal auxiliaries	68.48	31.39	57.19

*$p < .001$.

a large proportion of the sample, and the average number of tokens per child was about 4 or more. Among these constructions, the one with the highest frequency is copular sentences, which were produced by 79% of the sample and had 14 tokens per child on average. The construction with the lowest frequency was the raising-to-object structure, which was very rarely produced and when it was produced, had an extremely low token frequency per child. As such low frequencies do not allow meaningful generalization, in the following we shall not analyse this pattern further. As in all the remaining five patterns the understood subject is co-referential with the subject of the matrix verb, the hypotheses and conclusions of the study apply only to the development of the subject part of the sharing principle.

In order to test the first hypothesis regarding the independence of the different constructions, we compared the conditional probability of a child producing some type of analytic construction, given that the child produces, or does not produce,

each of the other constructions. The probability applies to the earliest period of the production of three-word and longer sentences which makes up the corpus. For this sample, the period covered was two weeks on average. Table 2 presents the results, organized by type of construction. To explain in more detail how the probabilities were computed, let us take for instance the probabilities of subject-control sentences conditional on copular sentences. A total of 174 children, that is, 39.64% of the sample of 439, produced subject-control sentences. Next, we break up the sample into children who produce (347) or do not produce (92) copular sentences. Now we can compute the conditional probabilities of producing subject-control sentences given that the children produce (or not) copular sentences. Among children who produced copular sentences, there are 159 children who also produced subject-control sentences; among children who did not produce copular sentences, 15 children did produce subject-control sentences. That is, if there are copular sentences in the child's speech the probability of concurrent subject-control sentences is 45.82%, and if there are no copular sentences, the concurrent probability of subject-control sentences is only 16.30%.

In all cases, the conditional probability of children producing some type of construction was higher if the child also produced some other analytic construction, relative to when the child did not produce the other construction. The gains were 32% on average, ranging between 20% and 49%. To test the significance of these differences, chi-square tests of independence were performed between all pairs of constructions. The children were placed in four cells of a 2×2 table according to the production or not of each pair of analytic constructions. The null hypothesis was that the placements were independent. All the tests were significant at the $p < .001$ level, $N = 439$, at 2 degrees of freedom. The results indicate that despite their differences of detail, all types of analytic constructions acquired by young children in the early stages of grammar are significantly associated. Thus, we reject the first null hypothesis of this study, namely, that there is no significant association between each and every construction, rejecting the claim they all share a common feature. This refutes the conception that each type of analytic construction reflects a critically different structural principle which is learned in a way unrelated to other analytic constructions. Instead, the learning process appears to reflect a common component of these constructions, which is in most probability the principle of co-referencing a non-overt semantic subject with the syntactic subject of the matrix verb.

To further test the psychological reality of such a general principle in children's syntactic system, we turned to examining the relationship between the production of telegraphic sentences with omitted matrix verbs and production of analytic sentences with the matrix verb expressed. We predicted that there would be a positive association between a child producing telegraphic sentences where there is a direct syntactic relation between a nonfinite predicate and what should be the matrix verb's subject. The alternative hypothesis is that there is no such association or else it is a negative one as the patterns are in competition. As the claim is that all telegraphic sentences with an omitted matrix verb reflect the child's awareness of the semantic relation between the nonfinite predicate and the subject, we shall test the hypothesis with respect to the production of telegraphic sentences in general.

Table 3. Number of children producing and token frequency of five types of telegraphic constructions (N = 439).

Analytic construction	No. children	Tokens	Tokens per child
Subject-control	16	113	7.1
Copular sentences	293	2596	8.9
Tense/aspect auxiliaries	153	606	4.0
Modal auxiliaries	17	34	2.0
Do-support	85	214	2.5

Table 4. Conditional probability of children producing analytic constructions, given production of telegraphic sentences of any kind, and value of chi-square test of independence (N = 439).

Construction produced	Telegraphic sentences produced		Chi-square*
	% if yes	% if no	
Copular sentences	85.76	60.34	33.28
Tense/aspect auxiliaries	56.66	29.31	25.53
Modal auxiliaries	44.27	18.97	23.30
Do-support	51.70	27.59	20.03
Subject-control	45.51	23.28	17.64

*$p < .001$.

Of the sample of 439 children, 323, or 73.58%, produced a telegraphic sentence with omitted matrix verbs. Some examples of such sentences produced by the sample are (1a–f) and (2a,b). The most children produced telegraphic versions of copular sentences (66.74% of the sample); next in frequency came omitted tense/aspect auxiliaries (34.85%), then omitted periphrastic *do* (19.36%). There were very few omitted modal auxiliaries (3.87%) and verbs of control (3.64%). There were no telegraphic sentences with omitted raising-to-object verbs. Table 3 presents the number of children producing five types of telegraphic constructions and the token frequency of each.

Our second hypothesis was that telegraphic sentences omitting matrix verbs from analytic constructions facilitate the mastery of analytic constructions. To test this hypothesis, we compared the conditional probability of a child producing the five types of analytic construction, given that the child produces, or does not produce, telegraphic sentences of any kind. Table 4 presents the results.

For all five subtypes of analytic constructions, the production of telegraphic sentences of any kind was positively associated with the production of analytic sentences. Independence was tested by chi-square and found highly significant at $p < .001$ in all five cases, N = 439, at 2 degrees of freedom. The distributions are not independent, that is, young children produce analytic constructions with a much higher probability if they also produce some kind of telegraphic combination with the matrix verb omitted. The gains in the conditional probabilities average 25%, falling within the range observed for the interrelations between the different analytic constructions.

Discussion

In this study we tested a developmental hypothesis derived from Dependency Grammar regarding sentences with a matrix verb and a dependent predicate. According to a proposal by Hudson (2014), there is a general rule of argument sharing that applies to any type of analytic sentence, be it raising or control, headed by lexical verbs, auxiliaries or copular verbs. We treated this proposal as having psychological reality, and hypothesized that producing analytic sentences of any kind involves a common principle that English-speaking children need to acquire in development. The commonality implies that all different constructions of this kind will be associated with each other in acquisition, regardless of differences of detail. We proceeded to test this hypothesis on the analytic sentences a large sample of children produced in the early stages of developing grammar, when the children's MLU in words was in the range of 1.52 to 3.75, with an average of 2.10 words per sentence. Because of their rarity at this early stage of development, the study could not cover constructions where the understood subject is co-referential with the matrix verb's object.

However, we found in the children's speech five different analytic constructions where the understood subject of the dependent predicate is shared with the matrix verb's subject, which are produced in the early stages of grammar with sufficient frequency to make testing possible. These were subject-control constructions with lexical verbs such as *try* and *want*; copular constructions with *be, become* and similar; constructions with tense and aspect auxiliaries such as *be* or *have*; constructions with modal auxiliaries and semi-auxiliaries, e.g. *can* or *have to*; and periphrastic *do*-support in questions, negation and emphasis.

We found, as predicted, that the production of these five different constructions in this early stage of grammar is not independent but, rather, significantly associated. The production of one type of construction with an understood subject raised the probability that a child would also produce the other constructions with an understood subject at the same early stage of development. These results provide support for the possibility that when young children learn to generate analytic sentences involving an understood subject, they indeed operate with a basic syntactic-semantic principle common to all such sentences. This conclusion is rather surprising as these different constructions are considered unrelated by previous researchers and it is thought that children need to master a different principle of construction and interpretation for each. Thus the principle of Minimal Distance Principle proposed by C. Chomsky (1969) is specifically for control but not for raising. The reason why such a positive association was not uncovered previously is probably due to the fact that the different types of construction are usually studied separately and rarely interrelated.

The production of the five analytic constructions was also found in this study to be positively associated with the production of telegraphic sentences by the same children, although the association was somewhat weaker than the interrelations between the analytic constructions. These results strengthen the conclusion that children who learn to generate grammatical sentences with a nonfinite dependent predicate, operate with a general principle that regulates the sharing of the covert subject with the matrix verb. Telegraphic sentences demonstrate an awareness on the part of the child of the covert

predicate–argument relation between the dependent predicate and the matrix verb's subject in input sentences, even if they do not yet master the rule of how to express this relation in a covert manner. The incorrect direct expression of the predicate–argument relation harks back to the principle of children's early two-word sentences, namely that semantic relations are to be expressed by syntactic relations. The semantic content expressed is a step in the direction of mastering the new principle of grammar, while the mode of its expression is still in the realm of the old principle. It should be mentioned that within nativist theories, alternative explanations have been offered to the phenomenon of telegraphic sentences as well as other sentences with missing components, such as Rizzi's (1993–1994) truncation hypothesis or Bloom's (1993) theory of performance limitations. However, the present explanation is part of an empiricist learning theory, without incorporating an element of an innate Universal Grammar.

In this study, we have seen some evidence, some more direct and some indirect, that children learn to produce all types of analytic sentences, be they subject-control, periphrastic tense, copular predication or *do*-support, by mastering a general principle apparently underlying the syntax of all such sentences. Our emphasis on a common principle involved in the process of acquisition does not imply that children do not need to learn the specifics of each construction separately, or that they do not need to learn the syntactic behaviour of each complement-taking verb separately. In actuality, the learning model states that every single matrix verb is learned separately in its specific syntactic construction, and that certainly implies the separate learning of subtypes of analytic constructions. This, however, does not refute the claim that the various analytic constructions built on different verbs share a similar principle, and that this basic similarity feeds into transfer of learning. That is, learning is individual and lexical-specific, whereas common, shared principles create similarity and transfer of learning between them. Individual, lexical-specific learning also implies that different subtypes of analytic constructions may be learned at varying ages, depending on their level of difficulty and similarity to other constructions. This is indeed the case.

Understanding general principles of grammar is a prerequisite for learning concrete grammatical rules and regulations, not a substitute for them. The conclusion to draw from the results of this study is that lexical-specific and construction-specific learning do not constitute the complete process by which children acquire grammar. Mastering general principles is part and parcel of the overall process.

An anonymous reviewer suggested an alternative to our favoured explanation of the results in terms of a shared principle which helps transfer between different types of analytic constructions, namely that: 'A child who is at a stage where they have learnt one structure may also be at a stage where they have learnt others and therefore be more likely to produce more structures than a child who has not learnt to produce one or other form.' It is possible that such an alternative explanation is correct, however the learning model suggested in this article is based on a well-known process of transfer of learning between cognitive tasks sharing similar features (Singley & Anderson, 1989). Such similarity-based positive transfer has been found specifically for syntactic constructions, for instance by Abbot-Smith and Behrens (2006). As theoretical linguistics offers a principle that could serve as the dimension of similarity (e.g. Bresnan, 1982; Hudson, 2014), an explanation taking the constructions' similarity into consideration is thus very likely.

When we say children acquire a syntactic principle of subject sharing, we do not mean to imply that children form an abstract principle by extracting it by comparison and generalization from the concrete exemplars they are dealing with each time they learn how to express a certain matrix verb that shares its subject with a lower predicate complement. We refer to a much more humble kind of learning: we believe when children learn a new exemplar of analytic construction for a new matrix verb, they do so on a lexical-specific, individual learning process that acquires the pattern for that specific verb from sentences heard in the linguistic input.

However, during this lexical-specific learning, children notice the similarity and shared features of the present item with previously learned patterns, namely, other exemplars of analytic constructions in which there is also subject sharing, which the children have already learned. The noticed similarity facilitates the new learning, causing what is called transfer of learning, so that children learn the new exemplar of the analytic construction easier and faster than they would without the previous learning. The common feature of the different specific exemplars is that they all consist of a complement verb or other predicate that shares a matrix verb's subject; this common feature underlying transfer of learning is what we call the syntactic principle of subject sharing.

As in previous work on the acquisition of syntactic principles such as transitivity through lexical-specific learning (e.g. Ninio, 2006), the claim is that when children learn a particular lexical-specific rule of syntactic combination, for example, how to express the verb '*want*' with an object in a two-word combination, they thereby also acquire a usable principle which is then the basis for transfer of learning of similar lexical-specific patterns, that is, other verbs with a direct object. The principle is what feeds analogy, and it is simply the noticeable similarity between the structure of one verb with an object and another verb with an object, in the speech the child hears and learns from. The same process of internalization is thought to underlie children's acquisition of analytic constructions, each construction for each matrix verb learned individually in a lexical-specific manner, potentially serving as a source for transfer of learning for other verbs in similar patterns, which are also learned in a lexical-specific manner.

This also means that different subtypes of analytic constructions are not learned at the same time, but very possibly spread out over years, with each different matrix verb in its pattern learned in its own time. As the commonality between the new pattern to be acquired and the already-learned ones is based on analogy and similarity, it is more than possible that the less similar patterns are learned later, for instance, verbs with object-control when the earliest learned patterns are ones with subject-control. It is important to point out that in this model of learning there is no extraction, generalization or abstraction of a principle as there is in other models of syntactic development (e.g. Tomasello, 2000). Analogy-based processes are extensively discussed in the literature on cognitive processes, and see especially Hahn and Chater's (1998) lucid exposition of the difference between rule-based and similarity-based processes through which people perform acts of categorization.

Although there is a common principle of argument-sharing that applies to all analytic constructions, they separate into two clear subtypes: the first of constructions that share the lower predicate's unexpressed subject with the matrix verb's subject, such as raising-to-subject, subject-control, copular structures and *do*-support, and those that share the lower

predicate's unexpressed subject with the matrix verb's object such as object-control and raising-to-object. We have said in the Introduction that sharing a covert subject with a co-referential expressed subject is an easier structural operation than sharing a covert subject with a co-referential object, as an object is a different type of syntactic relation. This difference in level of difficulty predicts that young children will master the shared-with-object constructions later than the shared-with-subject ones. Our data support the distinction into two subtypes of analytic constructions, and the prediction that the ones involving co-referentiality with an object will be later in acquisition. As we have seen in Table 1, there were no object-control sentences in the corpus and very few raising-to-object ones. Interestingly, the verbs *make* and *want* are frequent in children's speech but, at this age, they occur mostly in simplex structures involving a nominal object complement; the raising pattern with these verbs is extremely rare. In addition, we did not replicate the claim by Limber (1973) that control is earlier than raising; rather, our data demonstrate that constructions involving raising (including here also copular structures and *do*-support which were no covered by Limber) are earlier than those involving control, hence suggesting another dimension at which the class of analytic constructions subdivides. We may conclude that more subtle distinctions than a single shared common structural principle are worthwhile to consider. Indeed, the recent generative literature regarding analytic constructions breaking into subtypes in development is very helpful in pointing to the reason for the differences in age at acquisition we also found. The clear presence of subtypes, potentially differing in difficulty, can explain why despite a common principle children do not begin the production of all types of analytic constructions all at once.

It is important to emphasize that the general principles of syntax discussed in this article have no connection with the nativist theory of 'Universal Grammar' which is said to consist of general principles, genetically inherited, that form the skeleton of human knowledge of language (N. Chomsky, 1986). It is unfortunate that the discourse of principles is mistakenly associated with innatist theories of acquisition and generally avoided by empiricist researchers. The present study demonstrates a gradual and sometimes faulty learning of general principles of syntax. These principles are not derived from Chomskian linguistics but from Dependency Grammar. The crucial difference may be that Dependency Grammar does not employ hidden entities and processes such as null-pronouns, movements, traces or transformations, and hence has no need for innate knowledge in order to master unobservable syntactic rules. Its units are words and their relations, and its rules are as close to the concrete behaviour of words in a sentence as can be. Such a linguistic method is optimally suited to serve as the framework of developmental theory, including, as in this article, for proposals of simple and learnable general principles.

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