VARIATION IN THE INPUT

Studies in the Acquisition of Word Order

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Input Factors in Early Verb Acquisition: Do Word Frequency and Word Order Variability of Verbs Matter?

Anja Kieburg and Petra Schulz

Abstract While simplex verbs show word order variability in main clauses and subordinated clauses in standard German, the verb particle of morphologically complex particle verbs is syntactically less variable: It generally occurs in sentence final position. Acquisition data reveal that telic verb particles appear in German-speaking children's speech around 14 months of age, even earlier than the first simplex verbs. Using a longitudinal design, we examine whether children's early preference for telic verb particles can be explained by word frequency and/or word order variability in the ambient language. The analysed data comprises 5,001 utterances from three mothers recorded in eight 1-h home sessions when the children's ages were 14, 16, 18, and 20 months. While simple input frequency does not influence children's early verb acquisition, it is shown that the factor 'word order variability', i.e. less syntactic variation in the input, favours children's early acquisition. Thus, it is concluded that children seem to adhere to learning mechanisms that make use of the parental input in a specific way, by taking into account the structural properties of the target language.

Keywords Early verb acquisition · Endstate-orientation · Telic verb particles · Simplex verbs · Word frequency · Word order variability · Parental input

1 Introduction

Verbs differ from nouns in a number of aspects that are of relevance not only for linguistic theory but also for language acquisition. Unlike nouns, verbs do not express reference to objects, but express relationships between objects via predication. Verbs often designate events that are transient, such as *open*, and hence less readily extracted as perceptual units than objects, which are typically

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non-transient. Thus, the event designated by verbs such as *open* is more difficult to grasp than the object referred to with nouns such as *door*. What is more, often the event designated by a verb is complex. The verb *open*, for example, designates an event, where a component passes through a transition from a process of being opened to an endstate of being open. In addition, the relationship between verbs and the event type they designate is often ambiguous. An event like 'move a broom across the floor causing leaves to change their location on the floor' could be expressed as *sweep* or *clean*. Only the latter verb, however, expresses the endstate of being clean. These facts among others should make verb learning difficult.

Despite the difficult acquisition task the child is faced with, German-speaking children use verbs already in their second year of life. Typically they log into the verb lexicon with verb particles like *auf* 'open' that can be semantically classified as telic, and some time later start producing non-telic verb particles, simplex verbs, and particle verbs (Mills 1985, Behrens 1998, Schulz et al. 2001, Schulz et al. 2002, Penner et al. 2003, Schulz 2005). Moreover, telic verb particles are the most frequent verb expressions in the speech of 1-year-olds (Schulz 2003, 2005). This finding has been accounted for by drawing on language-internal properties of the target language (cf. Schulz et al. 2001, 2002, Penner et al. 2003).

In this chapter, extending previous work (Kieburg 2005, Kieburg and Schulz 2008), we will investigate whether and how different input factors such as word frequency as well as word order variability have a bearing on the early verb acquisition of German-speaking children. In line with continuity assumptions of language acquisition (e.g., Pinker 1984) and contrary to the view that children's earliest linguistic productions do not show evidence of abstract syntactic categories (e.g., Tomasello 2000), we assume that at least by age one children possess a knowledge of lexical categories such as 'verb'. Many studies on early syntax acquisition (e.g., Tracy 1991, Weissenborn 1994) have shown that children obey the structural constraints for verb positions from early on. This finding seems difficult to account for, if language learning is based on purely surface properties of the ambient target language. Furthermore, given that the learner is equipped with the ability to assign words in the input to their lexical category, e.g., by making use of prosodic and morphological cues including finiteness or tense markers (Golinkoff et al. 2001), the question arises of how the frequency patterns and the specific structural properties within this word class contribute to the child's acquisition path. More specifically, in this study we will address the following questions: (1) Does the frequency with which particle verbs, simplex verbs, and verb particles appear in the parental input influence the order of verb acquisition? (2) Does the fact that particle verbs, simplex verbs, and verb particles differ with regard to their word order variability shape the child's acquisition path? Furthermore, we will explore how the two factors are connected.

In order to address these questions a longitudinal study was conducted, in which the parental input to three children between the ages of 14 and 20 months was analyzed with respect to the verbs used. Following previous research into frequency, word frequency was calculated using three different measures: types, tokens, type token ratio (TTR). The second factor 'word order variability' has traditionally been addressed focusing on the saliency of certain positions such as the edge of an utterance (e.g., Tardif et al. 1997), without taking into account the underlying structure of an utterance. Under the view that children have knowledge not only of categories but also of the structural positions able to host verbal elements, it can be asked whether differences regarding this structural word order variability can account for the acquisition patterns observed in children. Therefore, word order variability was calculated based on (a) the possible surface positions a verb appeared in, ignoring the underlying sentence structure (henceforth called surface perspective) and (b) the two syntactic positions hosting verbal elements in German: V2 and Verbend (henceforth called structural perspective).

For the first factor word frequency the results reveal that simple word frequency, i.e. measured via token or type frequency does not play a causal role in children's early verb acquisition. With regard to the more complex frequency measure TTR we found partial evidence that word frequency may influence the order of verb acquisition. Concerning the second factor word order variability, the results for the structural as well as the surface perspective reveal that less syntactic variability favours the early acquisition of verb particles in German speaking children.

The paper is organized as follows. Section 2 sketches the classification of verb categories in German according to their morpho-syntactic properties. Section 3 deals with semantic properties of verb categories in German. Section 4 gives an overview of verb acquisition, focusing on the acquisition of verb particles and simplex verbs in German-speaking children. Section 5 summarizes the various factors that have been proposed in the literature to play a role in the acquisition of the early lexicon. Section 6 presents our study on word frequency and word order variability of verb categories in the input. The results of this study are discussed in Section 7. Section 8 concludes with implications of these findings for further research.

2 Morpho-Syntactic Properties of Verb Categories in German

West Germanic languages differentiate between simplex verbs such as *spielen* 'to play' (1) and complex predicates, which consist of a verb root and an affix as shown in (2) and (3). Complex predicates can be further distinguished according to the type of affix they host. In particle verbs such as *aufmachen* 'to open', the affixal particle can be separated from the verb root in verb second structures such as (2b), but not when some other finite verbal element, such as a modal verb, occupies the verb second position as in (2a). In prefix verbs such as *enthüllen* 'to uncover', the prefix cannot be separated from the verb root, as illustrated in (3a) and (3b) (cf. also Behrens 1998).

(1)   Er will   mit   dem   Ball *spielen.*
       he wants   with the   ball *play*
       'He wants to play with the ball'

(2)   a.   Er will   die Flasche *aufmachen*
          he wants the bottle   *open.make*
          'He wants to open the bottle'

       b.   Sie *macht* die Flasche *auf.*
          she *makes* the bottle   *open*
          'She opens the bottle'

(3)   a.   Er will   das Geheimnis *enthüllen.*
          he wants the secret   *un.cover*
          'He wants to uncover the secret'

       b.   Sie *enthüllt*   das Geheimnis.
          she *un.covers* the secret
          'She uncovers the secret'

Note that the separated verb particle may appear without the verb root in informal requests (4a) or questions (4b). Importantly, the meaning is equivalent to the particle verb structures in (4a') and (4b').

(4)   a.   Tür   *auf!*
          door   *open*
          'Open the door'

       a.'   *Mach* die Tür *auf*!
          make the door *open*
          'Open the door'

       b.   Alle *weg?*
          all   *gone*
          'Is everybody gone?'

       b.'   *Sind* alle *weg?*
          are all *gone*
          'Is everybody gone?'

Verbs in German are assumed to be base generated in verb final position (cf. Koster 1975). German is a XVO language that shows verb second (V2) word order in finite main clauses (5a). In subordinate clauses, the finite verb remains in verbend (VE) position, as shown in (5b).

(5)   a.   Peter *kauft* den Apfel.
          Peter *buys*   the apple

       b.   Anna weiß,   dass Peter den Apfel *kauft.*
          Anna knows   that Peter the apple *buys*
          'Anna knows that Peter is buying the apple.'

It is well known that the structural position of the verb and its surface position with regard to the other elements of the sentence do not necessarily correspond. For example, V2 may coincide with the sentence final position (6a), and VE with a prefinal sentence position (6b).

(6)   a.   Peter *schläft.*
          Peter *sleeps*

       b.   Peter hat den Apfel *reingelegt* in die Tasche.
          Peter has the apple *in-put*   in the bag
          'Peter put the apple in the bag.'

Generally speaking, while V2 and VE are the two structural options for verbal elements, according to the surface perspective in German there are three positions the verb can appear in: at the beginning, in the middle, and at the end of a sentence (henceforth sentence initial, sentence medial, and sentence final). As this will become important for the two analyses of word order variability carried out in Section 6, the differences between surface and structural perspective will be illustrated in the following in more detail. For ease of comparison with the surface perspective, the structural perspective will employ the topological field model (e.g., Höhle 1986), which remains open with regard to the specific functional projections postulated for V2 and VE structures in German (cf. Table 1).

Table 1 A simplified topological field model of German

	Sentence bracket		Sentence bracket	
Prefield	Left sentence bracket	Middle field	Right sentence bracket	Postfield
(6a) Peter	schläft	–	–	–
(6b) Peter	hat	den Apfel	reingelegt	in die Tasche
(5b)	dass	Peter den Apfel	kauft	–

Regarding the morphologically complex particle verbs, in main clauses the finite verb root occurs in the left sentence bracket, while the verb particle occurs in the right sentence bracket as seen in (7a). From the surface perspective, in (7a) the verb root occurs in sentence medial and the verb particle in sentence final position. In subordinated clauses such as (7b), the finite particle verb, which

forms one complex word, occupies the right sentence bracket, which in this example coincides with the sentence final position.

(7)   a.   Peter *isst* den Apfel *auf*.
           Peter *eats* the apple *up*
      b.   Anna weiß, dass Peter den Apfel *aufisst*.
           Anna knows that Peter the apple *up.eats*
           'Anna knows that Peter eats the apple up.'

Importantly, the right sentence bracket hosts the verb particle of a particle verb, either separated from the verb root as in (7a) or affixed to the verb root as in (7b). Note that verb particles that appear without a verb root as in (4a) and (4b) above are also located in the right sentence bracket. Taking a surface perspective, the verb particle may thus appear in sentence final position as in (7a). Whether the position of the verb particle in (7b) is sentence final as well, is unclear. In order to classify *auf* as being 'at the end of the sentence', the particle verb has to be treated as one element.

In extraposition structures such as (8) the difference between the structural and the surface perspective is evident as well. In colloquial German, the *postfield* may host extraposed constituents such as prepositional phrases (see Haider 1995 for constraints on extraposition), preceded by the verb particle, which occupies the right sentence bracket, just as in (7a). From a surface perspective however, unlike the verb particle in (7a), the verb particle in (8) appears in sentence medial position.

(8)   Du *machst* das *rein* in   die Kiste.
      you *make*   this *into* into the box
      'You put this into the box.'

Non-separated particle verbs occupy the right sentence bracket as illustrated with a simple subordinate clause in (7b) and with a modal or an auxiliary added as shown in (9). From a surface perspective, the picture looks more diverse. While in (7b) the particle verb appears in sentence final position, in (9) it appears in sentence medial position.

(9)   a.   Anna weiß, dass er die Flasche *aufmachen* möchte.
           Anna knows that he the bottle *open.make* wants
           'Anna knows that he wants to open the bottle.'
      b.   Anna weiß, dass er die Flasche   *aufgemacht* hat.
           Anna knows that he the bottle   *open.made* has
           'Anna knows that he has opened the bottle.'

Aside from the left and right sentence bracket as the typical positions hosting the verbal elements, the *prefield* may host the particle verb or the verb particle when they are topicalized, as demonstrated in (10a–b). Note that these topicalized structures are marked (see also Lüdeling 2001: 53) and occur less frequently. From a surface perspective, both the particle verb (10a) and the verb particle (10b) appear in sentence initial position.

(10) a.   ?*Zugemacht* hat er die Tür.
           close.made has he the door
           'He has closed the door.'
      b.   ?*Zu* *macht* er die Tür!
           close *makes* he the door
           'He closes the door.'

In short, the verb particle of a complex predicate is located in the right sentence bracket or – in specific contexts – in the *prefield*. From a surface perspective, the verb particle may appear in sentence final, and – more marked – in medial, or initial position.

Turning to simplex verbs, let us first look at their position in main clauses. Finite simplex verbs are located in the left sentence bracket, as illustrated in (5a), repeated here as (11), corresponding to a sentence medial position.

(11) Peter *kauft* den Apfel.
      Peter *buys* the apple

Nonfinite simplex verbs occur in the right sentence bracket as can be seen in (12a–b); the left sentence bracket is occupied by the modal or the auxiliary carrying the finiteness features. (12b) illustrates that in colloquial German the simplex verb may be followed by an extraposed constituent (Haider 1995: 9); the prepositional phrase occurs in the *postfield*. From a surface perspective, the simplex verb appears in sentence final position in (12a) and in sentence medial position (12b).

(12) a.   Er will/   hat mit ihr *sprechen/gesprochen*.
           he wants to/has with her *talk/   talked*
           'He wants to talk/has talked to her.'
      b.   Er hat *gesprochen* mit ihr.
           he has *talked*   with her
           'He talked to her.'

Moreover, simplex verbs may occur in sentence initial position, as shown in both examples (13) and (14). However, the structural position of the verb differs.

In requests (13a) and yes/no questions (13b), the simplex verb occupies the left sentence bracket, and the *prefield* is unfilled. In answers to wh-questions such as (13c), in colloquial German the subject may be omitted, resulting in the same structure as for (13a–b): the *prefield* is empty, and the simplex verb is hosted by the left sentence bracket. In contrast, in (14) the topicalized non-finite simplex verb is hosted by the *prefield,* and the finite auxiliary occupies the left sentence bracket.

(13)   a.   *Gieß* die Blumen!
             water the flowers
       b.   *Gießt* du die Blumen?
             water you the flowers
             'Are you watering the flowers?'
       c.   Question: Wo ist Jan gerade?
                          'Where is Jan at the moment?'
             Answer: *Liegt* im Bett.
                          lying in bed
                          'He is lying in the bed.'

(14)   Question: Was hat Jan mit den Blumen gemacht?
                   'What has Jan done with the flowers?'
       Answer: *Gegossen* hat er sie.
                   watered   has he them
                   'He watered them.'

In subordinated verb final clauses, simplex verbs occupy the right sentence bracket, as shown in (5b), repeated here as (15).

(15)   Anna weiß, dass Peter den Apfel *kauft.*
       Anna knows that Peter the apple *buys*
       'Anna knows that Peter is buying the apple.'

In the example above, the right sentence bracket coincides with the sentence final position. If, however, the embedded predicate also contains an auxiliary or a modal as in (16), the simplex verb appears in sentence medial position. Hence, although the simplex verb occurs in the right sentence bracket followed by no other constituent occupying the *postfield*, this does not necessarily mean that the simplex verb concurrently occurs in sentence final position.

(16)   Anna weiß, dass er einen Apfel *kaufen* möchte/*gekauft* hat.
       Anna knows that he an   apple *buy*   wants/*bought* has
       'Anna knows that he wants to buy/has bought an apple.'

Furthermore, in subordinated clauses the *postfield* may be filled by an extraposed constituent as shown in (17) below, following the simplex verb in the right sentence bracket. Thus, from a surface perspective, both in (16) and in (17) the simplex verb appears in sentence medial position.

(17)   Ich möchte nicht, dass er Ball *spielt* in dem Zimmer.
       I   want   not   that he ball *plays* in the room
       'I don't want, that he is playing ball in the room.'

In short, the simple verb may be located in the left and in the right sentence bracket and – in specific contexts – in the *prefield*. From a surface perspective, the simplex verb may appear in sentence initial, medial, or final position.

Summarizing, German simplex verbs show more word order variability regarding their sentence position than verb particles of morphologically complex particle verbs, both from a structural and from a surface perspective. Verb particles generally occupy the right sentence bracket, while simplex verbs may occupy the right and the left sentence bracket. Verb particles generally occur sentence finally, while simplex verbs may occur in sentence initial, medial, and final position. Following a surface perspective, Tardif et al. (1997) argued that the sentence final position is salient. However, this view disregards the underlying syntactic positions that the child may be aware of. In addition to the morpho-syntactic differences, verbs also differ semantically. These semantic properties are described in the next section.

3 Semantic Properties of Verb Categories in German

Verbs designate events including states such as *being poor* and actions like *walking around, sweeping,* or *opening*. Verbs differ in terms of the temporal make-up of the event they designate (cf. Comrie 1976). While some events have a terminal endpoint built into them leading to a natural culmination point, some events are without such a terminal endpoint allowing the event to continue indefinitely or stop at any moment in time. Verbs designating events with terminal endpoints are referred to as telic verbs, and verbs designating events without such an endpoint are called non-telic. Following Pustejovsky's (1995) model of event typology, events can be distinguished according to their complexity. Verbs like *walk* designate a single event, while verbs like *open* and *sweep* designate a complex event, i.e. a transition from a process to a state. Telic verbs like *open* designate a complex event, called endstate-oriented transition, with the endstate subevent being more prominent than the process subevent. In contrast, non-telic verbs like *sweep* designate a complex event, called process-oriented transition, where the process subevent is more prominent than the endstate subevent. In telic verbs, the endstate is entailed by the verb meaning (18a), and the endstate cannot be cancelled (18b).

(18)   a.   She opened the bottle. entails 'the bottle is open'
         b.   She opened the bottle, *but it is still closed.

Non-telic transitional verbs like *sweep* designate events with an endstate often implicated (19a), but not entailed (19b) (cf. Jeschull 2007, Schulz and Ose 2008, for an analysis in terms of pragmatic vs. semantic telicity).

(19)   a.   She swept the floor, and the floor was clean.
         b.   She swept the floor, but the floor wasn't clean.

Finally, verbs like *laugh* or *walk around* designate events without a terminal endpoint. For the purposes of this study, verbs like *sweep, laugh*, and *walk around* will be called non-telic.

Telicity is determined by the lexical semantics of the verb and/or by the event-semantic properties of other elements in the sentence (cf. Krifka 1989). The event type of simplex verbs like *find* or *open* or *laugh*, for example, is determined by their lexical semantics. In the case of particle verbs, the verb particles may contribute to the event marking of the complex verb hosting the particle. Assuming for the purposes of classification that the verb root is formed by a light verb like *machen* 'make', several types of verb particles can be distinguished regarding their telicity properties. Some particles mark the prominent endstate of a transition (e.g., *auf* 'open', *aus* 'out'), while others are ambiguous, marking the process or the endstate of a transition (e.g., *rauf* 'up', *runter* 'down'). Furthermore, some particles are atelic, as they exclusively mark the process (e.g., *rum* 'around'). In the present study, the first group of verb particles is referred to as telic and the second group as non-telic, including both ambiguous and atelic particles.

Before we look at the input properties of the syntactic and semantic categories described in this section and in Section 2, an overview of the early acquisition of simplex verbs and verb particles will be given in the next section.

4 Verb Particles and Simplex Verbs in Child Language

German-speaking children start using verb expressions already in their second year of life (e.g., Mills 1985, Behrens 1998, Kauschke 2000, Schulz 2003, 2005). Comparing children's production of simplex and complex verbs, Behrens (1998) found that simplex verbs are generally the first verbs to appear, but that both simplex and particle verbs are used frequently already before age 2, while prefix verbs are used only rarely.

Isolated verb particles play an important role for early verb acquisition as they often assume the function of a full verb (cf. Mills 1985). This is illustrated in (20) (from Penner et al. 2003: 298):

(20)   Adult: Was soll ich denn damit machen?
                 'what should I do with that'
         Child: AUF!
                 open
                 'open it'

In one word utterances such as in (20) the verb particle is assumed to be located in the right sentence bracket. Clear evidence for this structural position is provided by two-word utterances containing verb particles or simplex verbs as (21a–b) below (from Tracy 1991: 166f.):

(21)   a.   Child tries to take adult's shoe off:
            shoe *on ... off*
            'put the shoe on – eh off'
         b.   Brezel *essen.*
            Pretzel *eat*
            'I want to eat Pretzels'

Studies of children's early verb lexicon based on data from spontaneous speech corpora and from the parent report RELATIONAL WORD INVENTORY (RWI, cf. Schulz, 2002, unpublished manuscript) showed that isolated verb particles are first used between the ages of 14 and 18 months (Penner et al. 2003, Schulz 2003, 2005). The results of these studies indicate that most children log into the verb lexicon with isolated verb particles only, and that few children start out simultaneously with simple verbs and isolated verb particles. In line with previous findings, Schulz (2003) found that the verb particles are used in the function of a full verb. Particle verbs occur some time later, around 18 months of age (Penner et al. 2003).

Examining the frequency of verb particles, particle verbs, and simplex verbs in the early verb lexicon of German-speaking children between the ages of 14–18 months, Schulz (2005) found that 66% of the children's spontaneous early verb expressions were typically isolated verb particles such as *auf* 'open' or *ab* 'off', compared to only 7% simplex verbs, and 2% particle verbs. Notably, a quarter of the verb expressions were other non-adultlike complex verbs formed by the light verb *machen* 'make' and a child expression such as *heia*, meaning *going to sleep,* or *ei,* meaning *caress.* Presumably, these verbs function as precursors to other complex predicate types. Thus, verb particles make up nearly two thirds of children's early verb lexicon, while simplex verbs and particle verbs play a minor role in the early stages of child verb acquisition.

With regard to the semantic classification of the verb particles used, telic verb particles such as *auf* 'open', *aus* 'out', and *ab* 'off' were used more frequently than ambiguous verb particles like *hoch* 'up'. Atelic particles did not occur at all.

Comparing the event type of verb particles used first by the child according to the RWI, Schulz (2005) found that 90% of the children log into the verb lexicon with telic particles.

To account for these acquisition findings, Schulz and colleagues (see Schulz et al. 2001, 2002, Penner et al. 2003) suggested a learning strategy of endstate-orientation that guides children's early verb learning. The strategy of endstate-orientation works as follows. When logging into the verb lexicon, children first focus on the event structure of the verb rather than on other properties such as its syntactic arguments. More specifically, the language learner focuses on event types with an unambiguous event structure. Because of their prominent end-state, endstate-oriented transitions possess an unambiguous event structure and are therefore preferred by the children. As mentioned above, endstate-oriented transitions are expressed by telic verbs. Within the class of telic verbs, telic particle verbs like *aufmachen* 'to open' or *zumachen* 'to close' express the complex event more transparently than morphologically simple verbs like *öffnen* 'to open' and are therefore among the first telic verbs to be used. Telic particle verbs are composed of a (light) verb encoding the process component like *machen* 'make' and a verb particle encoding the telicity like *auf* 'open'. When acquiring their first verb expressions, children produce first the prominent subevent of the particle verb, i.e. *auf* 'open' or *zu* 'closed', before producing the full particle verb.

Note that the strategy of endstate-orientation described above is based on linguistic properties of the German verb system that are assumed to guide children's early verb learning. In other words, these specific features of the target language are prominent for the child from a linguistic perspective. The strategy of endstate-orientation is therefore closely connected to the so-called 'language-driven processes' (Behrend 1995), which are learning algorithms that are based on the child's knowledge of the architecture of the verb lexicon. This knowledge primarily concerns the internal organization of specific modules such as argument structure and event structure as well as their interaction with syntactic, morphological, and semantic features. In this learning process, aspects of the learning environment such as frequency of a certain structure in the input to the child play a minor role in explaining the order of verb acquisition.

According to Behrend's classification of verb learning mechanisms, in addition to language-driven processes, two other types of learning processes can be distinguished: child-driven processes and environment-driven processes. According to Behrend, child-driven processes are pre-existing perceptual, cognitive, or linguistic strategies or constraints that the child brings to the learning context like the *manner bias* (cf. Gentner 1978). The notion of environment-driven learning processes emphasizes the role of the environment of the language learner and includes factors such as frequency, timing, or variability as well as real world characteristics of verb usage in the input to which the child is exposed (cf. Behrend 1995). In the present study we explore the possible role of environment-driven learning processes in accounting for children's early verb acquisition. We will argue that not all of the factors characterized as environment-driven can in fact be subsumed under what is traditionally referred to as input-driven (cf. Tomasello 2003). The following section introduces various input factors that have been identified in the literature as influencing the early acquisition of the lexicon.

5 Input Factors in Previous Research on Lexical Acquisition

Mainly the noun-verb-difference across different languages has been studied from an input perspective, while little research has been done to examine the role of the input in the early verb acquisition by German-speaking children. Several properties of the input have been argued to influence the child's acquisition of the lexicon: word frequency, overall amount of input, saliency of the sentence position, morphological transparency, and variability of the linguistic environment. Common to these accounts is the notion that '... the process of acquiring a lexicon is clearly a process of learning from experience, and the relevant experience must be conversational interaction, because that is the context in which exposure to language occurs' (Hoff and Naigles 2002: 418).

Among these input factors, the role of word frequency has received the most attention and has been investigated in a variety of learning contexts. Brown (1958) was among the first to consider word frequency as an explanation for the order of acquisition of noun classes, more precisely for the fact that basic level nouns like *bird* are produced earlier than subordinate nouns like *sparrow*. Brown assumes that highly frequent words in the input, i.e. basic level nouns, correlate with the children's cognitive requisites and are therefore acquired earlier than other nouns. Word frequency has also played a key role in the controversy regarding the question of why nouns seem to be acquired before verbs. Goldfield (1993), for example, argued that a high noun type frequency in the parental input causes the early noun bias in English-speaking children. Additionally, cross-linguistic studies (e.g., Tardif et al. 1997, Choi 2000) found that language specific differences in the initial production of nouns and verbs are due to word frequency in the input. With regard to the category of verbs, Naigles and Hoff-Ginsberg (1998) observed a positive correlation between the frequency of verb categories in the input and the children's verb production 10 weeks later. While most of these studies examined either type or token frequency, Sandhofer et al. (2000) analyzed the proportion of both types and tokens in parental input to explain the early noun bias in English-speaking children and the early verb bias in Chinese-speaking children. They found that a high number of tokens combined with a low number of types favoured verb acquisition, while a high number of types combined with a low number of tokens favoured noun acquisition. This proportion of number of types and number of tokens corresponds to the type-token ratio (abbreviated as TTR), calculated by dividing the number of types by the number of tokens

(e.g., Richards and Malvern 1996). Thus, a high TTR for nouns in the input explains English-speaking children's early noun production, and a low TTR for verbs favours Chinese-speaking children's early verb production.

Concerning the factor 'overall amount of input', Pearson et al. (1997) found that the size of the lexicons of Spanish-English bilingual 1- and 2-year-olds depended on the amount of input that the children were exposed to in each language. Furthermore, it has been reported for English-speaking children that the rate of lexical growth correlates with the overall amount of language input (Huttenlocher et al. 1991).

With regard to the input factor 'saliency of the sentence position', Tardif et al. (1997), among others, claimed that words that appear at the edge of an utterance, i.e. sentence initial or sentence final, are more accessible to children and are therefore acquired earlier than words in medial sentence positions. When Tardif et al. compared the spontaneous speech of English- and Chinese-speaking mothers they found that nouns were used significantly more often than verbs in sentence final position by English-speaking mothers, while Chinese-speaking mothers used significantly more verbs than nouns in final position. According to the authors, these data can account for the finding mentioned above that English-speaking children have more nouns than verbs in their productive lexicon, while Chinese-speaking children produce more verbs than nouns.

In addition, the early noun bias of English-speaking children has been explained by the input factor 'morphological transparency' (Gentner 1982, Tardif et al. 1997). According to Gentner (1982), words that always appear in more or less the same morphological form, are morphological transparent and hence easier to acquire than morphologically more variable words. Unlike verbs, nouns in English are claimed to be morphologically transparent and are therefore assumed to be learned earlier.

In sum, the results from previous studies highlight several input factors that could play a role for the acquisition order and for the composition of the child's early lexicon. Importantly, investigation of factors such as frequency of nouns or verbs presupposes that the child has knowledge of the respective categories, while the underlying structure of the utterances may be ignored by the child. Even the input factor 'saliency of the sentence position' only pays attention to what we referred to as the surface perspective (cf. Section 2). Looking at word order variability from a structural perspective has not been the focus of this line of research. Note that this mode of analysis goes beyond the notion of classical environment-driven language mechanisms, as it combines characteristics such as saliency with structural properties of the target language that adult speakers provide in the input.

Therefore, in the present study, we will explore the influence of two major input factors, 'word frequency' and 'word order variability', on German-speaking children's early verb lexicon. Word frequency will be examined using three different measures: types, tokens, and TTR. Word order variability will be examined using two measures: surface and structural sentential positions, as

detailed in Section 2. More specifically, the following two hypotheses can be formulated:

> *Frequency Hypothesis:* Frequent verbal elements in the parental input, to be defined via token, types, or via TTR, influence the composition of the verb lexicon and the order of acquisition of verb categories in German-speaking children.
>
> *Word Order Variability Hypothesis:* Verbal elements that show less variation in the input, to be defined either from a surface or a structural perspective, are favoured in the acquisition of verb categories in German speaking children.

Assuming that the child is equipped with knowledge of categories such as 'verb' and that by age 1 the child is aware of the two possible structural positions for verbal elements, we expect that rather than frequency restricted syntactic variation plays a role for early acquisition.

6 The Study

This study is based on the analysis of the parental input of three German-speaking children in their second year of life. The data stems from the large longitudinal German Language Development (GLAD) study in Berlin, which investigates children's language acquisition and precursors of language impairment between birth and age four (cf. acknowledgment).

6.1 Data Sample

The sample included three caregiver-child dyads chosen from the spontaneous speech corpus of the GLAD study. The children (two girls, one boy) and their families spoke German as their only language. All the families belonged to the lower middle class and lived in Berlin. Data collection involved observations of spontaneous interactions between the child and other interaction partners present in the children's homes, such as for example mother, father, grandparents, siblings, and the research assistant. All utterances made by these conversation partners in the child's presence were considered as input to the child. As the mother was the primary caregiver in all three families, the mothers contributed overall 72% of the utterances in the children's ambient language. For reasons of readability, in the following, the term 'parental input' is used to refer to all utterances in the child's presence. Bimonthly video recordings were made for each child, starting at the age of 12 months and ending at the age of 30 months. Each session lasted approximately 60 min and was recorded by a research assistant with a portable video camera. The sessions typically involved free play with toys as well as everyday situations like getting dressed or meal and

snack times. Since the primary aim of the GLAD study was to collect language data from the children, the child's interaction partners were not aware that their utterances would be of interest. For the present study, we analyzed the parental utterances across 8 speech samples: four samples of one mother-girl dyad at the child's age of 14, 16, 18 and 20 months and two samples each of the other two mother-child dyads at the age of 14 and 20 months (see Table 2). This selection was based on two factors: The spontaneous speech of the participating children had previously been analyzed, and the age range was chosen so that the children started producing verb particles and verbs.

Table 2 Spontaneous speech samples studied

Child	Number of analyzed samples	Age (months)	Transcript code
Anne	4	14, 16, 18, 20	A14, A16, A18, A20
Maria	2	14, 20	M14, M20
Tim	2	14, 20	T14, T20

6.2 Data Analysis

For each session, first all adult utterances containing a verb (i.e. full verb, modal verb, auxiliary, or copula), a verb particle, or a preposition[1] were transcribed. Additionally, all remaining utterances were counted to compute the overall number of utterances in that recording. The computation of the number of adult utterances was based on the following assumption: A unit for analysis roughly corresponds to a main clause or to a conversational turn. Maximally, it consisted of a sentence with one full verb such as *mach die Tür zu* 'close the door', or of a phrase like *auf dem Tisch*; minimally it consisted of a single word like *zu* 'closed' or *Tasse* 'cup'. Thus, complex sentences were counted separately. For reasons of readability in the following the term 'utterance' is used throughout.

To facilitate multiple analyses, the utterances were divided into several subcategories. There were two main categories: WITH FULL VERB OR VERB PARTICLE and WITHOUT FULL VERB AND WITHOUT VERB PARTICLE. Furthermore, utterances with a full verb or verb particle were subdivided into more specific categories: SIMPLEX VERBS (e.g., *schlafen* 'to sleep'), PARTICLES WITHOUT VERB ROOT

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[1] In German, some lexemes such as *auf* 'open' are ambiguous wrt. their lexical class; they could be a preposition as well as a verb particle. To control for misclassifications, in our analysis we also analysed all occurrences of prepositions. Confirming Behrens' (1998) results, we did not find any structural ambiguity between utterances containing a verb particle and utterances containing a preposition. The most frequently produced verb particles did only partly match the most frequent prepositions *mit* 'with', *auf* 'on', and *in* 'in', of which only *mit* and *auf* exist both as verb particles and as prepositions in German. For further details see Kieburg (2005).

(e.g., *auf* 'open'), PARTICLE VERBS (e.g., *aufmachen* 'to open'), and OTHER COMPLEX VERBS (e.g., *kaputtmachen*, broken.make, 'to break'). The category of particle verbs was subdivided into PARTICLE VERBS SEPARATE (e.g., *machen auf*, make open, 'to open') and PARTICLE VERBS NON-SEPARATE (e.g., *aufmachen*, open.make, 'to open'). Finally, there were two meta-categories, combining relevant basic categories. The meta-category ALL SEPARATELY PRODUCED VERB PARTICLES contained all the verb particles of the categories PARTICLE VERBS SEPARATE and PARTICLES WITHOUT VERB ROOT. The meta-category ALL VERB PARTICLES OR PARTICLE VERBS contained all verb particles, regardless of whether they were produced separately or non-separately.

6.2.1 Calculating Word Frequency

For each category, the number of tokens as well as the number of types was computed. The token analysis is purely quantitative, while the type analysis gives information on how many different simplex verbs, verb particles, and particle verbs the mothers use (Choi 2000). Thus, the type analysis can also indicate the degree of lexical diversity in parental speech. Note that all inflected forms of a specific verb were counted as belonging to the same type. Due to the fact that some complex verbs, i.e. particle verbs, are morphologically separated in certain sentence structures (cf. Section 2), this means that a particle verb such as *aufmachen* (open.make, 'to open') was counted as belonging to the same type as all inflected variants, including *macht auf* (make open, 'to open') and *aufgemacht* (open.made, 'opened').[2]

Three matrixes were used to measure word frequency. First, we determined the total token frequency for each verb category across all sessions by dividing the number of tokens per category by the number of all utterances. Second, following Sandhofer et al. (2000), we determined the relative token frequency per session for each verb category by dividing the number of tokens of one category by the sum of all tokens of simplex verbs, complex verbs, and verb particles. The relative type frequency was determined in a parallel fashion. Third, we determined the type-token ratios per session for each category by dividing the number of types by the number of tokens of one category.

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[2] Note that for the verb particle and particle verb subcategories, the type analysis is more complex than the token analysis. We could not simply add the number of types of two basic categories to arrive at the type number of the superordinate category: The separately counted verb types in the basic categories PARTICLE VERBS SEPARATE (e.g., *macht auf*, make open, 'open') and PARTICLE VERB NON-SEPARATE (e.g., *aufmachen*, open.make, 'open') were only one verb type in the category ALL PARTICLE VERBS (e.g., *auf + machen*, open + make). Instead we had to determine the number of types separately for each category. Furthermore, in the categories ALL SEPARATELY PRODUCED VERB PARTICLES the verb particles alone determined the particle type. Hence, a particle type in this category (e.g., *auf* 'open' or 'up') may label different events, as the verb root in the complex verb may differ (*aufmachen* 'open', *aufessen* 'eat up').

6.2.2 Calculating Word Order Variability

For the four basic categories SIMPLEX VERBS, PARTICLE VERBS NON-SEPARATE, SEPARATE VERB PARTICLE IN PARTICLE VERBS, and VERB PARTICLES WITHOUT VERB ROOT we counted the occurrences of the verb or the verb particle, respectively, across the eight spontaneous speech samples of the three mothers. We distinguished (a), following the surface perspective, between the three positions 'sentence initial', 'sentence final', and 'sentence medial', and (b) following the structural perspective, between V2 and VE (and *prefield*). In Table 3 examples from the spontaneous speech corpus are given for the four verbal categories and the classification regarding the surface sentence position.

Table 3 Examples of verb occurrences in the spontaneous speech samples from a surface perspective

Surface sentence position	SIMPLEX VERBS	PARTICLE VERBS NON-SEPARATE	SEPARATE VERB PARTICLE IN PARTICLE VERBS	VERB PARTICLES WITHOUT VERB ROOT
Initial	*hol* den ball (A14) 'fetch the ball'	*aufessen* die mama[a] (M14) 'the mum eats up'	n.a.	*rein* da (M14) 'in there'
Medial	wir *nehmen* den schuh (A16) 'we take the shoe' was sie *sagen* könnte (M20) 'what she could say' und er is *gekrabbelt* zu unserem Standtelefon (T14) 'and he crawled to our telephone'	soll ich die Tür *aufmachen* für dich (A14) 'shall I open the door for you'	*mach* mal fein wieder *rauf* da (T14) 'put on there'	soll das *rauf* auf dein brötchen (A18) 'shall this onto your bread roll'
Final	milch kannst du *trinken* (A18) 'you can drink milk' wenn du hier *spielst* (A16) 'if you play here'	jetzt nicht die tür *zumachen* (A14) 'don't close the door now'	*mach* mal *rein* (M14) 'put in'	wieder *ab* (M20) 'off again' *weg* (M20) 'away'

[a] Note that this ungrammatical structure – a particle verb in sentence initial position – is the only one attested in this corpus.

In Table 4 examples from the spontaneous speech corpus are given for the structural categories left and right sentence bracket as well as for the *prefield* which is highly marked.

Table 4 Examples of verb occurrences in the spontaneous speech samples from a structural perspective

Structural sentence position	SIMPLEX VERBS	PARTICLE VERBS NON-SEPARATE	SEPARATE VERB PARTICLE IN PARTICLE VERBS	VERB PARTICLES WITHOUT VERB ROOT
Prefield	*gegessen* hat er sie schon (T20) 'he did eat it, however'	*aufessen* die mama (M14) 'the mum eats up'	n.a.	*rein* da (M14) 'in there'
Left sentence bracket	*hol* den ball (A14) 'fetch the ball' wir *nehmen* den schuh (A16) 'we take the shoe'	n.a.	n.a	n.a
Right sentence bracket	was sie *sagen* könnte (M20) 'what she could say' milch kannst du *trinken* (A18) 'you can drink milk' wenn du hier *spielst* (A16) 'if you play here'	soll ich die Tür *aufmachen* für dich (A14) 'shall I open the door for you' jetzt nicht die tür *zumachen* (A14) 'don't close the door now'	*mach* mal fein wieder *rauf* da (T14) 'put on there' *mach* mal *rein* (M14) 'put in'	soll das *rauf* auf dein brötchen (A18) 'shall this onto your bread roll' wieder *ab* (M20) 'off again' *weg* (M20) 'away'

With regard to the morphologically complex predicates, we focused on the position of the verb particle as this verbal element rather than the verb root is produced first by the children. Therefore, for the category PARTICLE VERBS NON-SEPARATE a final position means that the whole complex verb is situated in the final position with the verb root following the verb particle. In contrast, for the SEPARATE PARTICLES in PARTICLE VERBS the classification as final corresponds to the verb particle only. In addition, single word utterances consisting of a verb particle, a particle verb, or a simplex verb were classified as 'sentence final' as well.

6.3 Predictions

Recall that there are two empirical facts about children's early verb acquisition in German that have to be accounted for. First, German-speaking children log into the verb lexicon using verb particles rather than simplex verbs or particle verbs. Second, the first verb particles used by children learning German belong to the class of telic verb particles (see Section 4). Following the hypothesis proposed for the input factor 'word frequency', the following two predictions can be derived. Note that for the semantic analysis necessary for testing P2, we examined the 10 verb particles and particle verbs used most frequently by the mothers and classified them as telic or non-telic, applying the semantic tests employed by Dowty (1979).

> *Prediction 1 (P1)*: The frequency of particle verbs and verb particles in the parental input should be higher than the frequency of simplex verbs, where frequency is measured via types, tokens, or the type-token-ration.
>
> *Prediction 2 (P2)*: There should be more telic than non-telic verb particles or particle verbs in the parental input.
>
> Regarding the input factor 'word order variability', recall that in standard German simplex verbs are syntactically more variable than verb particles that predominantly appear in the same position (see Section 2). If parents use verb particles and simplex verbs in their speech to 1-year-olds in the same way as suggested by this characterization, the following prediction can be derived:
>
> *Prediction 3 (P3)*: In the parental input verb particles and particle verbs occur in fewer different positions than simplex verbs, where position can be analysed from a surface or a structural perspective.

6.4 Results

The analysis of the parental input was based on 5,001 utterances across the eight spontaneous speech samples. Section 6.4.1 contains the results regarding the effect of word frequency, and Section 6.4.2 presents the results regarding the input factor word order variability.

6.4.1 Results for Word Frequency

As demonstrated in Fig. 1, 62% of the utterances contained a full verb or a verb particle. The total token frequencies reveal that 39% of the utterances contained a simplex verb and only 19% a particle verb. Verb particles without a verb root accounted for 3% of the utterances. Other complex verbs like *kaputt-machen* (broken.make, 'to break') were only found in 1% of the utterances and were not taken into account in the subsequent analyses.
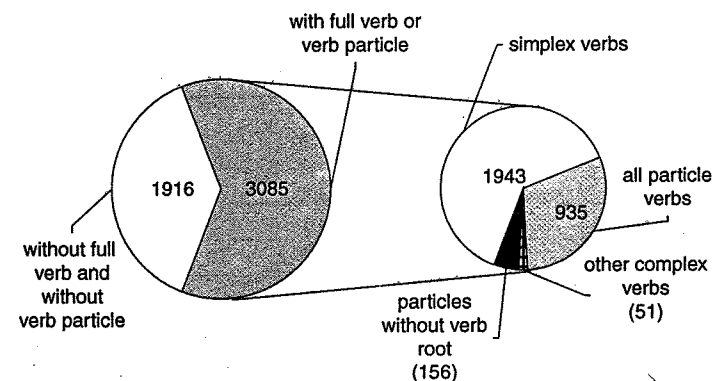
Fig. 1 Total token frequencies in parental utterances, $n = 5,001$ utterances (8 samples)

We also examined whether there were any differences in the parental verb category use depending on the children's age. The relative token frequencies per age (i.e. at 14, 16, 18 and 20 months) revealed no changes depending on the child's age. For all child ages, we found that the children's mothers produced nearly twice as many simplex verb tokens as particle verb tokens and very few verb particles. The relative type frequencies revealed that the degree of lexical diversity remained stable with regard to age. Therefore, in the subsequent analyses the factor 'child age' was not taken into account.

Verb Particles/Particle Verbs Versus Simplex Verbs

Prediction 1 (P1) states that the word frequency of verb particles and particle verbs in the parental input is higher than the word frequency of simplex verbs. In order to test (P1), we compared the frequencies of verbs and verb particles in the spontaneous speech of the three mothers. First, we examined whether individual differences exist with regard to the mothers' verb category use. As can be seen in Fig. 2, the mothers' input showed a very similar profile in each sample. Simplex verbs were used twice as often as particle verbs; verb particles without the verb root were used in about 5% of the utterances. Therefore, all input data were subsequently analyzed together.

Relative token frequencies: The relative token frequencies of the basic categories (see Table 5) and meta-categories (see Table 6) show a distribution that is similar to the total token frequencies reported in Fig. 1. The children were exposed to nearly twice as many simplex verbs as verb particles or particle verbs. The Friedman test indicated a highly significant effect of verb category ($\chi_r^2 = 22.200$, $p < 0.001$). A pair-wise comparison, using the Wilcoxon test, confirmed that the relative token frequency of simplex verbs in the input was significantly higher than the relative token frequency of verb particles or particle verbs ($Z = -2.521$, $p < 0.05$). In other words, among all utterances
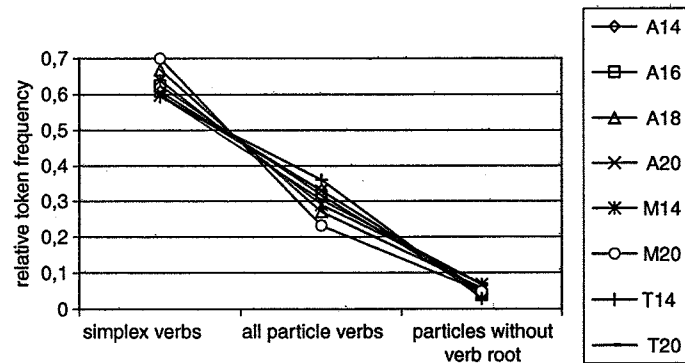
Fig. 2 Relative token frequency in parental input per transcript, $n = 8$ samples

with a full verb or a verb particle there were significantly more simplex verbs than verb particles or particle verbs.

Relative type frequencies: As shown in Tables 5 and 6, the mothers used nearly the same number of simplex verb types as separate or non-separate verb particle and particle verb types. The Friedman test showed a highly significant effect of verb category ($\chi_r^2 = 22.200$, $p < 0.001$). A pair wise

Table 5 Basic verb categories: Relative token frequency, relative type frequency, and TTR in parental input by means (standard deviation), $n = 8$ samples

Basic category	Tokens M (S.D.)	Types M (S.D.)	TTR M (S.D.)
SIMPLEX VERBS	0.63 (0.04)	0.47 (0.03)	0.34 (0.04)
PARTICLE VERBS NON-SEPARATE	0.14 (0.02)	0.23 (0.03)	0.75 (0.11)
PARTICLE VERBS SEPARATE	0.16 (0.03)	0.21 (0.03)	0.60 (0.08)
VERB PARTICLES WITHOUT VERB ROOT	0.05 (0.01)	0.06 (0.02)	0.50 (0.07)
OTHER COMPLEX VERBS	0.02 (0.01)	0.03 (0.01)	0.66 (0.19)

Table 6 Selected Meta-categories: Relative token frequency, relative type frequency, and TTR in parental input by means (standard deviation), $n = 8$ samples

Meta-category	Tokens M (S.D.)	Types M (S.D.)	TTR M (S.D.)
PARTICLE VERBS (PARTICLE VERBS NON-SEPERATE + PARTICLE VERBS SEPERATE)	0.30 (0.04)	0.39 (0.03)	0.57 (0.05)
ALL SEPARATELY PRODUCED VERB PARTICLES (PARTICLE VERBS SEPERATE + VERB PARTICLES WITHOUT VERB ROOT)	0.21 (0.04)	0.13 (0.01)	0.28 (0.05)
ALL VERB PARTICLES OR PARTICLE VERBS (PARTICLE VERBS NON-SEPERATE + PARTICLE VERBS SEPERATE + VERB PARTICLES WITHOUT VERB ROOT)	0.35 (0.04)	0.44 (0.03)	0.56 (0.05)

comparison using the Wilcoxon test indicated no significant difference in the relative type frequencies of simplex verbs and of verb particles or particle verbs ($Z = 2.521$, $p = 0.167$). However, when comparing the category ALL PARTICLE VERBS with the category SIMPLEX VERBS, the statistical analysis revealed that mothers produced more simplex verb types than verb particle types ($Z = -2.521$, $p < 0.05$).

Type-token ratios: The type-token ratios of each category were determined in order to examine whether an individual verb particle or particle verb occurs more often in the mothers' spontaneous speech than an individual simplex verb. Recall that the lower the TTR, the more often an individual word type is repeated in a specific data sample. The Friedman test revealed a highly significant effect of verb category ($\chi_r^2 = 22.950$, $p < 0.001$). A pair wise comparison using the Wilcoxon test indicated that the mothers of the three typically developing children repeated an individual simplex verb significantly more often than an individual verb particle or particle verb ($Z = 2.521$, $p < 0.05$). The mean TTR of simplex verbs was 0.34 (see Table 5), compared to a TTR of 0.56 for verb particles and particle verbs (see Table 6). However, when comparing the TTR of the category ALL SEPARATELY PRODUCED VERB PARTICLES with the TTR of SIMPLEX VERBS, a different result was achieved. The mothers produced an individual verb particle (TTR = 0.28) significantly more often than an individual simplex verb, $Z = -2.521$, $p < 0.05$. Recall that in the category ALL SEPARATELY PRODUCED VERB PARTICLES, a particle type was counted independently from the verb root, e.g., the particle *auf* 'open' could belong to *machen auf* 'to open' as well as to *essen auf* 'to eat up'. Thus, the number in this category does not refer to actual particle verbs, but to specific verb particles.

### Telic Versus Atelic Verb Particles/Particle Verbs

Prediction 2 (P2) states that there are more telic than non-telic verb particles or particle verbs in the input. Using the tests for determining telicity in Dowty (1979), we determined the semantic type of the 10 most frequently uttered verb particles or particle verbs in the mothers' spontaneous speech. As illustrated in Fig. 3, telic verb types occurred more often than non-telic verb types in each category.

The particle verb structures that the mothers produced most often were *herkommen* (here.come, 'to come here') and *kommen her* (come here, 'to come here'). The most frequently used verb particle without a verb root was *weg* 'off'. In sum, the particle verbs and the verb particles the children most often heard in the input were telic.

6.4.2 Word Order Variability

Following the Word Order Variability Hypothesis, prediction 3 (P3) stated that in the parental input verb particles and particle verbs should occur in fewer

Fig. 3 Total token frequency of the 10 most frequent verb particle and particle verb types in parental input, n = 5,001 utterances (8 samples)
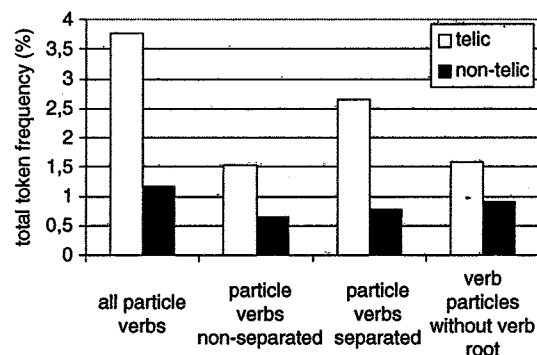
different positions than simplex verbs. To examine the variation both from the surface and from the structural perspective, we counted the number of occurrences of simplex verb, particle verb and verb particle tokens across the eight spontaneous speech samples in two ways. Table 7 shows the raw numbers and the percentile distribution in each of the verb categories across the three surface sentence positions initial, medial, and final.

Table 7 Number of occurrences (n) and percentile distribution (%) of simplex verb, particle verb and verb particle tokens in different surface sentence positions across the 8 samples

Sentence position	SIMPLEX VERBS n (%)	PARTICLE VERBS NON-SEPARATE n (%)	VERB PARTICLES IN PARTICLE VERBS SEPARATE n (%)	VERB PARTICLES WITHOUT VERB ROOT n (%)
Initial	390 (20%)	1 (0.002%)	0	5 (3%)
Medial	646 (33%)	72 (17%)	39 (8%)	10 (6%)
Final	907 (47%)	362 (83%)	460 (92%)	141 (90%)
Total	1,943 (100%)	435 (100%)	499 (100%)	156 (100%)

From a surface perspective the data shows that of the 1,943 occurrences of simplex verb tokens in the parental input simplex verbs were mostly produced in sentence final position (47%). They were also frequently used in medial (33%) and sentence initial position (20%). The main share of the 435 non-separated particle verb tokens occurred in sentence final position (83%). Seventeen percent were produced in medial sentence positions. There was one occurrence in sentence initial position (_aufmachen die mama_ (M14) see also Table 3), a sentence structure which is ungrammatical in Standard German. Of the 499 separately produced particle verb tokens there were no verb particles produced in sentence initial position.

The main share of these particles was produced in sentence final position (92%), while 8% were used in sentence medial position. Particles without a verb root were also mostly produced in sentence final position (90%); only 6% of the 156 particle tokens were produced in sentence medial position and 3% in sentence initial position.

Let us turn to the structural perspective. Table 8 shows the raw numbers and the percentile distribution in each of the verb categories across the possible structural positions.

Table 8 Number of occurrences (n) and percentile distribution (%) of simplex verb, particle verb and verb particle tokens in different structural sentence positions across the 8 samples
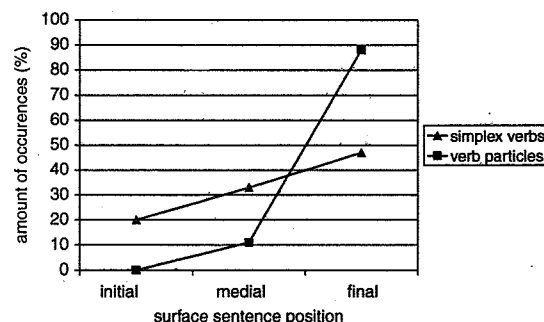
Structural sentence position	SIMPLEX VERBS n (%)	PARTICLE VERBS NON-SEPARATE n (%)	VERB PARTICLES IN PARTICLE VERBS SEPARATE n (%)	VERB PARTICLES WITHOUT VERB ROOT n (%)
Prefield	2 (0.001%)	1 (0.002%)	0	2 (1%)
Left sentence bracket	1,078 (55%)	0	0	0
Right sentence bracket	863 (44%)	434 (99%)	499 (100%)	154 (99%)
Total	1,943 (100%)	435 (100%)	499 (100%)	156 (100%)

As can be seen in Table 8, simplex verbs frequently appear in the left sentence bracket (55%) as well as in the right sentence bracket (44%). In contrast, as the structural position of the verb particle in particle verbs is grammatically restricted they almost always appear in the right sentence bracket in the categories particle verbs non-separate (99%), verb particles in particle verbs (100%) and verb particles without a verb root. Less than 1% of the simplex verbs were produced in the _prefield_ which also contains only the ungrammatical non-separate particle verb occurrence (see above) and 1% of the verb particles without a verb root.

Unlike simplex verbs verb particles can appear in three different morphosyntactic environments (i.e. in non-separated particle verbs, separated particle verbs, and as verb particles without verb root). Thus, in order to compare the word order variability of simplex verbs and verb particles in a different way, in a second analysis all occurrences of verb particles were combined. Figure 4 illustrates the variability of occurrences of simplex verbs across the different surface positions compared to the occurrences of verb particles.

The graph in Fig. 4 shows that in the parental input simplex verbs are used in more different surface sentence positions than are verb particles. Although both simplex verbs and verb particles occur most often in sentence final position, simplex verbs are also frequently used in sentence medial position and to a considerable amount in sentence initial position. Figure 5 illustrates the

Fig. 4 Variability of occurrences of simplex verbs and verb particles across different surface sentence positions

variability of occurrences of simplex verbs across the different structural positions compared to the occurrences of verb particles (i.e. of non-separated particle verbs, separated particle verbs, and particles without verb root).

As can be seen from Fig. 5, in concordance with the structural restrictions described in Section 2, almost all verb particles are attested to occur in the right sentence bracket (and only one in the *prefield*), while simplex verbs are attested in the left and the right sentence bracket, with a light predominance of the left sentence bracket. In sum, in the parental input studied here verb particles show limited word order variability, while simplex verbs show a greater diversity of sentence positions. This difference is more prominent in the structural than the surface analysis.
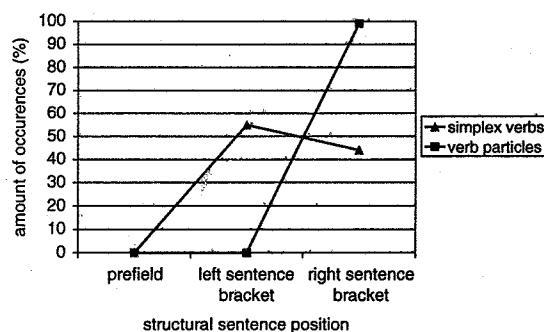

Fig. 5 Variability of occurrences of simplex verbs and verb particles across different structural sentence positions

7 Discussion

This study was designed to test the research questions of whether word frequency and word order variability of verb expressions in the input matter in the early acquisition of simplex verbs and verb particles by German-speaking

children. The input factors 'word frequency' and 'word order variability' will be discussed in turn.

In order to test prediction 1 (P1) derived from the Frequency Hypothesis, word frequency was calculated in three different ways: token, types, and type-token ratio. First, let us consider the results from the token analysis. Contrary to prediction, the token frequency of verb particles and particle verbs in the parental input was lower than the token frequency of simplex verbs. In fact, the mothers produced significantly more simplex verb tokens than verb particle or particle verb tokens, while in children's speech verb particles generally occur before simplex verbs and are used more frequently than simplex verbs. Thus, word frequency measured via token cannot explain the early verb acquisition in German-speaking infants. Naigles and Hoff-Ginsberg (1998) hypothesized that the more frequently a verb occurs in the parental speech, the more likely a child is to produce it several weeks later. Our design did not allow for a direct test of this hypothesis. However, since mothers' verb use was constant across the child's age (cf. Fig. 2), we can infer that this hypothesis is not confirmed for the verb acquisition order in German.

Next, let us turn to the type frequency in the parental speech. According to the Frequency Hypothesis, the type frequency of verb particles and particle verbs in the parental input should be higher than the type frequency of simplex verbs. However, the results from a type frequency analysis are not compatible with prediction 1 either. Although the children listened to a similar amount of verb particle, particle verb, and simplex verb types, they produced verb particles earlier and more frequently than simplex verbs. This result stands in contrast to the finding reported in Section 5 that a high number of noun types relative to a low number of verb types gives rise to the early noun bias in English-speaking children. Therefore, it can be argued that type frequency is not a causal factor in early verb acquisition.[3]

Third, let us examine the results for the type-token ration. Sandhofer et al. (2000) argued that a low TTR, corresponding to many repetitions of one type of verb, favours verb acquisition. Consequently, it was predicted that the TTR for verb particles and particle verbs is lower than the TTR for simplex verbs. Contrary to this prediction, the TTR for simplex verbs was significantly lower than the TTR for verb particles and particle verbs. In other words, the mothers of the three typically developing children repeated an individual simplex verb significantly more often than an individual verb particle or particle verb. However, when comparing the TTR of the category ALL SEPARATELY PRODUCED VERB PARTICLES with the TTR of SIMPLEX VERBS, it was found that the mothers produced a specific verb particle significantly more often than a specific simplex verb. The latter result seems to provide partial support for the Frequency Hypothesis. However, note that this finding directly follows from the German

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[3] Note, moreover, that type analyses have also been criticized on principled grounds. Richards and Malvern (1996), for example, pointed out that the number of types varies depending on the size of the language corpus.

verb particle inventory. In German, a limited number of verb particles can be combined with different verb roots to form a wide range of different particle verbs. In other words, the number of simplex verbs itself is much higher than the number of verb particles. It is therefore not surprising that mothers used few verb particles in combination with various verb roots repeatedly and more often than specific simplex verbs. Nevertheless, the frequent repetition of specific verb particle types in the input could favour their early acquisition in 1-year-old children and hence provide evidence that input factors influence the acquisition of different verb categories. Note, however, that the verb particles used by the mothers most frequently (i.e. *her* 'here', *hin* 'there', *rein* 'in', *weg* 'off') differed from those initially produced by their children (i.e. *auf* 'open', *ab* 'off', *aus* 'off', *an* 'on', *zu* 'closed'). Thus, the language learner, while being sensitive to categories such as 'verb particle', must clearly employ additional strategies in building her productive verb lexicon. In previous work we suggested the language driven mechanism of endstate-orientation (cf. Section 4).

In sum, with regard to the three methods of input analysis carried out in the present study, neither the type nor the token analysis nor the calculation of the TTR satisfyingly explained the order of acquisition of verb particles, particle verbs, and simplex verbs in children's speech and the composition of the early verb lexicon.

Now let us turn to the semantic analysis. As children initially prefer telic over atelic particles, following the Frequency Hypothesis it was predicted (P2) that there should be more telic than non-telic verb particles and particle verbs in the input. This prediction was born out. However, it should be taken into account that we classified only the 10 most frequent verb particles and particle verbs in the input. A further note of caution concerns the specific telic verb particles used by mothers and children. As mentioned above, the mothers used other telic verb particles than those initially preferred by the children. Thus, in line with the argumentation above regarding the TTR, it remains to be explained why the children produced other verb particles than the ones they most frequently heard in the input.

Let us now turn to the input factor 'word order variability'. According to the Variable Word Order Hypothesis it was predicted that verb particles show less syntactic variation than simplex verbs in the parental input (P3) and are therefore favoured in language acquisition. Two methods of analysis were used: calculating surface and structural sentence positions. From a surface perspective we determined the verb occurrences in sentence initial, medial, and final position. The results show that verb particles appeared in nearly 90% of the cases in sentence final position. They almost never appeared in sentence initial and rarely in sentence medial position. In contrast, simplex verbs were frequently used in sentence final, medial, and initial position. Thus, the three mothers under investigation used verb particles much more invariable than simplex verbs across the different surface sentence positions confirming prediction 3. The prominence of verb particles in children's early verb lexicon also supports the assumption that the sentence final position – that verb particles most often

appear in – is salient (e.g. Tardif et al. 1997). Note, however, as detailed in Section 2 that the notion of sentence positions such as 'final' is by far uncontroversial. First, the classification of verb particles according to their sentence position did not take into account the presence of a verb root. Therefore, the label 'sentence final' included verb particles that are affixed to the verb root as well as separated verb particles and verb particles without verb root. Sentence final particle verbs such as *aufmacht* 'opens' or *aufisst* 'eats up' may well be perceived differently by a child than a verb particle in sentence final position such as *auf* 'up'. Second, even if the child is able to identify sentence final verb particle structures such as *aufisst* 'eats up' and *isst ... auf* 'eats ... up' as morpho-syntactic variants of the same verb, she still has to realize that the same particle can be affixed to many different verb roots giving rise to a range of verbs including *aufisst* 'eats up', *aufmacht* 'opens', *aufsteht* 'gets up', *aufhört* 'stops', and *auftaucht* 'appears'. Third, the notion 'sentence final', disregards the internal syntactic structure of a sentence, as for example characterized by the topological field model.

In our structural analysis we determined the verb occurrences according to the topological field model, i.e. the left sentence bracket, the right sentence bracket (and the *prefield*). We found that verb particles appeared to 99% in the right sentence bracket and to less than 1% in the *prefield*. In concordance with the structural restrictions described in Section 2 they never appeared in the left sentence bracket. Hence, the difference in the syntactic variability between simplex verbs and verb particles is even more prominent than in the surface analysis. Verb particles show less syntactic variation than simplex verbs in the parental input. These results confirm the Variable Word Order Hypothesis.

Taken together, our results confirm that pure frequency measures of the input provided by the three mothers under investigation cannot sufficiently explain the acquisition order of the different verb categories observed in their 1- to-2-year-old children. The invariant word order of verb particles, on the other hand, was shown to favour their early acquisition.

8 Summary and Conclusion

This study addressed the question of whether input factors such as word frequency and word order variability matter in the early verb acquisition in German-speaking children. Based on the Frequency Hypothesis, it was predicted that the word frequency of verb particles and particle verbs in the parental input is higher than the word frequency of simplex verbs (P1) and that there are more telic than non-telic verb particles or particle verbs in the input (P2). Based on the Word Order Variability Hypothesis, it was predicted that verb particles and particle verbs occur in fewer different positions than simplex verbs.

Regarding word frequency in the input, prediction 2, but not prediction 1 was confirmed. The results of our study revealed that the order of verb acquisition and the composition of the verb lexicon in 1- to 2-year-olds is independent of simple word frequency, i.e. total token, relative token and type frequency, in parental input. With regard to the type-token ratio, we found partial evidence for the Input Hypothesis as an individual verb particle was repeated more often in the input than an individual simplex verb. However, since children initially produced different verb particle types than the ones occurring in the input, this result provides no support for a causal role of word frequency in verb learning. Similarly, even though mothers used more telic than non-telic verb particles or particle verbs in the input, the specific items used did not match the verb particles initially preferred by the children. Children, while being predominantly exposed to simplex verbs, log into the verb lexicon with telic particles like *auf* 'open' and *ab* 'off', a strategy that is compatible with the endstate-orientation (cf. Section 4).

Concerning word order variability in the input the advantage of an invariant word order for verb particles was confirmed. This difference was stronger for the structural than for the surface analysis. Note that this finding is in line with the constraints for verb and particle occurrences in standard German supplied by the target language. Thus, while simplex verbs frequently occur in V2 and VE structures, verb particles predominantly occur in the right sentence bracket and are hence syntactically more invariant. Note that this learning mechanism goes beyond the environment-driven processes as classified by Behrend (1995) and shows more parallels with what Behrend calls language-driven learning mechanisms.

In sum, our findings provide first evidence that input, calculated via simple frequency measures does not play a major role in the acquisition of verb order and the composition of the verb lexicon in 1- to 2-year-olds learning German, while restricted variability can account for children's early preference of verb particles. More specifically, the little syntactic variation in the input attested for verb particles that predominantly occur in the right sentence bracket seems to favour the early production of verb particles in children's spontaneous speech. Importantly, the structural position does not necessarily coincide with the sentence final position that has been assumed to be more salient than sentence medial positions. Therefore, it was argued that even though word order variability has been regarded as an input factor, once structural characteristics of the target language are taken into account, word order variability can be seen as a language-driven mechanism. In this respect, the results of this study provide a new account of the composition and acquisition of children's early verb lexicon that can be regarded as an alternative to the language-driven account of early verb acquisition, the strategy of endstate-orientation (Schulz et al. 2001, 2002, Penner et al. 2003) suggested in our previous studies. Recall that according to this learning strategy, German-speaking children initially focus on the verb's event-semantic structure and follow an endstate-orientation in acquiring the verbs' meanings. When learning languages that provide verb particles children

start with telic particles rather than with full verbs, since telic particles encode the event-semantic type 'Endstate' most transparently. They specifically favour telic particles of particle verbs with a light verb as the verb root as it does not contribute to the meaning of the complex verb. Note that only the latter account can explain why children start out with particles such as *auf* 'open', *ab* 'off', *aus* 'off', *an* 'on' and *zu* 'closed', and not with particles like *her* 'here', *hin* 'there', *rein* 'in' and *weg* 'gone'. The corresponding particle verbs are primarily *herkommen* 'come here', *hingehen* 'go there', *reingehen* 'go into' and *weggehen* 'go away' and do not encode the endstate as transparently as *aufmachen* 'open', *abmachen* 'untake', *ausmachen* 'put out', *anmachen* 'put on' and *zumachen* 'close'. Future research with a wider range of parental data is needed to see whether this observation can be generalized.

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