

Models of Inflection

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The Acquisition of Past Participles: One or Two Mechanisms?

1. Introduction

In the linguistic and psychological literature, the formation of the English past tense is the current topic for the debate between symbolists and connectionists concerning the number and kinds of mechanisms which guide the acquisition of regular and irregular morphology. Traditionally, two separate mechanisms are assumed to exist: rote, or more recently, associative and rule learning. Symbolists (e.g., Pinker & Prince, 1988; Pinker, 1991; Marcus, Pinker, Ullman, Hollander, Rosen & Xu, 1992; Marcus, 1995) argue that irregular items are lexically represented and learned associatively or by rote. Regular inflection is achieved with the help of a rule. A U-shaped behaviour pattern results from the interaction between the two mechanisms. All early forms are produced correctly because each is stored as a whole in the lexicon. Then the child discovers the suffixation rule for regular inflection and applies it to irregulars as well. When an irregular form is used often, the application of the rule is blocked. Insufficient use of a form results in failure of the blocking device. Hence, overregularizations occur (e.g., *goed*, *comed*). Finally, the exceptions to the rule are recognized. Irregulars are stored in the lexicon, whereas regulars are formed using a rule. Properties of children's grammatical systems are responsible for the transition from rote to rule learning, independently of the lexical development.

Recently, connectionists have offered an alternative account for the acquisition of inflection (e.g., Rumelhart & McClelland, 1986; Plunkett & Marchman, 1991, 1993). They have developed models both capable of memorizing patterns and generalizing regularities with the help of one single mechanism. When simulating the acquisition of the English past tense these models show many U-shaped patterns of error which add up to a U-shaped behaviour pattern comparable to children's output (see Plunkett & Marchman, 1991, 1993). Though only one associative mechanism is used, non-linear behaviour results. The onset of overregularizations is said to be triggered by a sufficient number of regulars in the lexicon which allows for the abstraction of general patterns. Thus, a relationship between lexical and morphosyntactic acquisition is assumed. It is suggested that the development in both domains is governed by the same learning mechanism (*critical-mass hypothesis*, see Plunkett & Marchman, 1993).

The first overregularizations may be related to growth in vocabulary size. Incremental increases in new regular verbs correlate with qualitative shifts in the way forms are treated (Marchman & Bates, 1994). But first overregularizations are also related to the proportion of regular and irregular verbs in the lexicon. The level of generalization in simulations was gene-

rally low as long as the percentage of regulars remained below 50% (Plunkett & Marchman, 1993: 54). In other words, when a sufficient number of verbs was reached and the proportion of regulars exceeded the 50% mark, the network model was able to generalize regular patterns so that overregularizations were produced. Thus, in contrast to earlier models (e.g. Rumelhart & McClelland 1986), the regularization process does not depend on high frequency numbers of regulars. Furthermore, as Plunkett & Marchman (1993, in press) point out repeatedly, sensitivity to the phonological shape of the stem is an influencing factor on the acquisition of inflectional morphology.

Interestingly, relations between lexical and morphological development were not found in Marcus et al.'s (1992) investigation of the spontaneous speech of 83 children. Evidence of a sudden non-linear increase of new verbs ('spurt') or changes in the proportion of regulars has not yet been found in naturalistic studies of individual children (Pinker & Prince, 1988; Marcus et al., 1992).

One purpose of this paper is to present data from continuous observation of the acquisition of German verbs by A. which show a sudden acceleration in verb growth, a clear change in verb vocabulary composition and a relation between structural and quantitative changes in the verb vocabulary and the onset of overregularizing.

The second aim is to compare results obtained from different data samplings: continuous longitudinal data from one child (Elsen, 1991), longitudinal data from periodic recordings of several children (e.g., Marcus et al., 1992, Clahsen & Rothweiler, 1993, Weyerts & Clahsen, 1994) and parental report information on a large population (Marchman & Bates, 1994). To what extent limited real-life data can be compared with network results is a question to be addressed.

The discussion of learning mechanisms is based on the English past tense. In spoken German the past tense (*Präteritum*) is quite rare and is being replaced by the present perfect which is formed with the help of *haben* 'to have' or *sein* 'to be' and the past participle (*Partizip Perfekt*), e.g., *ich bin gegangen* 'I have gone', *ich habe genommen* 'I have taken'. This investigation will therefore focus on the acquisition of participles. In the following paragraphs, some basic facts about the formation of the German *Partizip Perfekt* are provided.

German past participles may take the suffix *-(e)t* or *-(e)n*. Both may combine with a change in the stem vowel (*Ablaut*). Some verbs show a change in the final stem consonant (*Grammatischer Wechsel*). The use of the prefix *ge-* is phonologico-rhythmically conditioned. It is used independently of suffixation when the first syllable of the finite base form is stressed (note that in German some prefixes can be separated from the base for the construction of the verbal constituent in verb-second sentences), e.g., *'arbeiten* 'to work' - *sie 'arbeitet* 'she works' - *ge-arbeit-et* 'worked', *'helfen* 'to help' - *sie 'hilft* - *ge-holf-en*, *'mit'arbeiten* 'to collaborate' - *sie 'arbeitet mit* - *mit-ge-arbeit-et*, but *'vorbe'reiten* 'to prepare' - *sie be'reitet vor* - *vorbereit-et*, *miß'trauen* 'to mistrust' - *sie miß'traut* - *mißtrau-t*, *ent'gehen* 'to escape' -

sie ent'geht - entgang-en. This study will disregard the use of the prefix because its acquisition is determined by phonologico-rhythmical factors alone.

The use of the suffix is morphologically conditioned. German verbs are usually grouped into three classes: weak, mixed, strong. Weak verbs form past participles by adding *-(e)t*, e.g., *kochen* 'to cook' - *ge-koch-t*, *hoffen* 'to hope' - *ge-hoff-t*. Mixed verbs (about 8 verbs) form the participle with the help of *-(e)t* and change of stem vowel, e.g., *rennen* 'to run' - *ge-rann-t*, *brennen* 'to burn' - *ge-brann-t*. Strong verbs (about 170) form past participles with the help of *-(e)n* and Ablaut, e.g., *gehen* 'to go' - *ge-gang-en*, *werfen* 'to throw' - *ge-worf-en*. The vowel alternations of present, preterite and past participle stems follow various patterns. 88 verbs show an identical preterite and participle stem vowel, 36 verbs show an identical present and participle stem vowel and 49 verbs show three different stem vowels (numbers according to Heringer, 1989). However, there are further verbs which show non-regular participle formation, e.g. auxiliaries and modals (about 6 verbs, depending on definition, e.g. *können* 'can' - *ge-konn-t*, *wollen* 'to want to' - *ge-woll-t*). In many syntactic constructions, the participles of modals appear as infinitives.¹ For participle formation, modals may use vowel change and *-(e)t*. But they show different patterns of stem vowel alternation and inflection in the present singular forms², among other things. A problem arises for some modals, e.g. *wollen* 'to want to', because they form their participles with the dental suffix, but show a different paradigm for the present tense. Auxiliaries like *sein* 'to be' and *haben* 'to have' have also to be treated separately, as they show suppletion (*sein*) or some mixed formations with Ablaut in the conjunctive and the dental suffix with assimilation, e.g., *haben - hatte - gehab-t* 'to have - had - had', *du hast* 'you have' (2nd sg present, instead of **du habst*), *sie hat* 'she has' (instead of **sie habt*), *ich/sie hatte* 'I/she had'(instead of **ich/sie habte*). The expression 'regular verb' is used for weak verbs, 'irregular verb' for others, as the formation of their participles is not predictable. As yet it is not clear to what extent the knowledge of morphological paradigms may influence the formation of past participles. In this paper, however, for figures 2 and 3 numbers of regular verbs include the modals *wollen* 'to want to' and *sollen* 'shall', as both use the dental suffix for the formation of preterite and participle without vowel change, comparable to regulars (though they do not show the present tense patterns of regular verbs). The term 'overregularization' refers to the substitution of the suffix *-(e)t* for *-(e)n*, irrespective of vowel alternation, e.g., *werfen* 'to throw' - *ge-werf-t* (rather than *geworfen*), *sein* 'to be' - *ge-wes-t* (rather than *gewesen*). A list of the child's first verbs and overregularizations is given in appendix I and II.

¹ Cf. *Ersatzinfinitiv* in most grammars of German, for example *Er hat singen wollen* vs. **Er hat singen gewollt* 'he has wanted to sing' (cf. e.g. Engel ²1991: 463f.).

² For example, German verbs show *-e, -st, -t* in the present tense singular. Modals do not form the first and third person singular with the help of a suffix. Compare *ich sag-e -- du sag-st -- sie sag-t* 'I say -- you say -- she says' and *ich will-0 -- du will-st -- sie will-0* 'I want to - you want to - she wants to'.

In the following, several aspects of the girl's verb acquisition are presented and compared to reports on other children. A.'s data is discussed with regard to the dual-mechanism and single-mechanism account previously described. The predictions of the two approaches under discussion will be compared to the presented results: The two-mechanism approach states that the onset of overregularizations should not be related to measurable increases in the number of regular verb types and predicts a clear dissociation between the mechanisms which are responsible for lexical and morphological acquisition. In the single-mechanism account lexical and morphological acquisition is governed by the same basic learning mechanism so that interdependencies between both domains are expected. In particular, a non-linear critical mass relationship between lexical and morphological development should be found because the acquisition of a vocabulary of a certain size allows for the abstraction of general patterns. This leads to the production of the first overregularizations, that is, productive usage. Additionally, overregularizations should not appear in small vocabularies where irregular verbs outnumber regulars.

One important question is whether a morphological rule is really needed to account for the formation of past tense and past participles. The results of the investigation of A.'s language acquisition are very similar to those predicted by the network models. That is, although the data presented here does not rule out a symbolic account which assumes two different mechanisms for the acquisition of verb morphology, it can easily be interpreted with the help of the more simple one-mechanism account. These findings shed new light on the relevance of network simulations. They illuminate possible limits of fragmentary data samples.

2. Method

For this paper data is taken from a diary study of a German-speaking girl, A., an only child. The mother was the only observer-recorder. Data on pronunciation and essential linguistic and non-linguistic situations was collected continuously during the child's whole waking-time: all new items (all new words, all new word-forms, all novel pronunciations of established items) were documented (IPA phonetic transcription). Imitations were distinguished from deferred imitations and spontaneous productions. Notes were transferred to filing cards twice a day with additional comments on situation, frequency of use and changes in articulation. The entire inventory of sounds, words and word forms was checked three times a month. Estimations of relative frequency such as 'often, rare, none' were made. On this basis insights into non-linear use of a lexical item or morpheme were obtained. Continuous notes ended when A. was 2;5 and had completely acquired the phonological system. That is, she was able to distinguish and produce phonemes and replace foreign sounds by German ones in non-native words (Elsen, 1991). As the mother and child were together permanently throughout the study, a complete

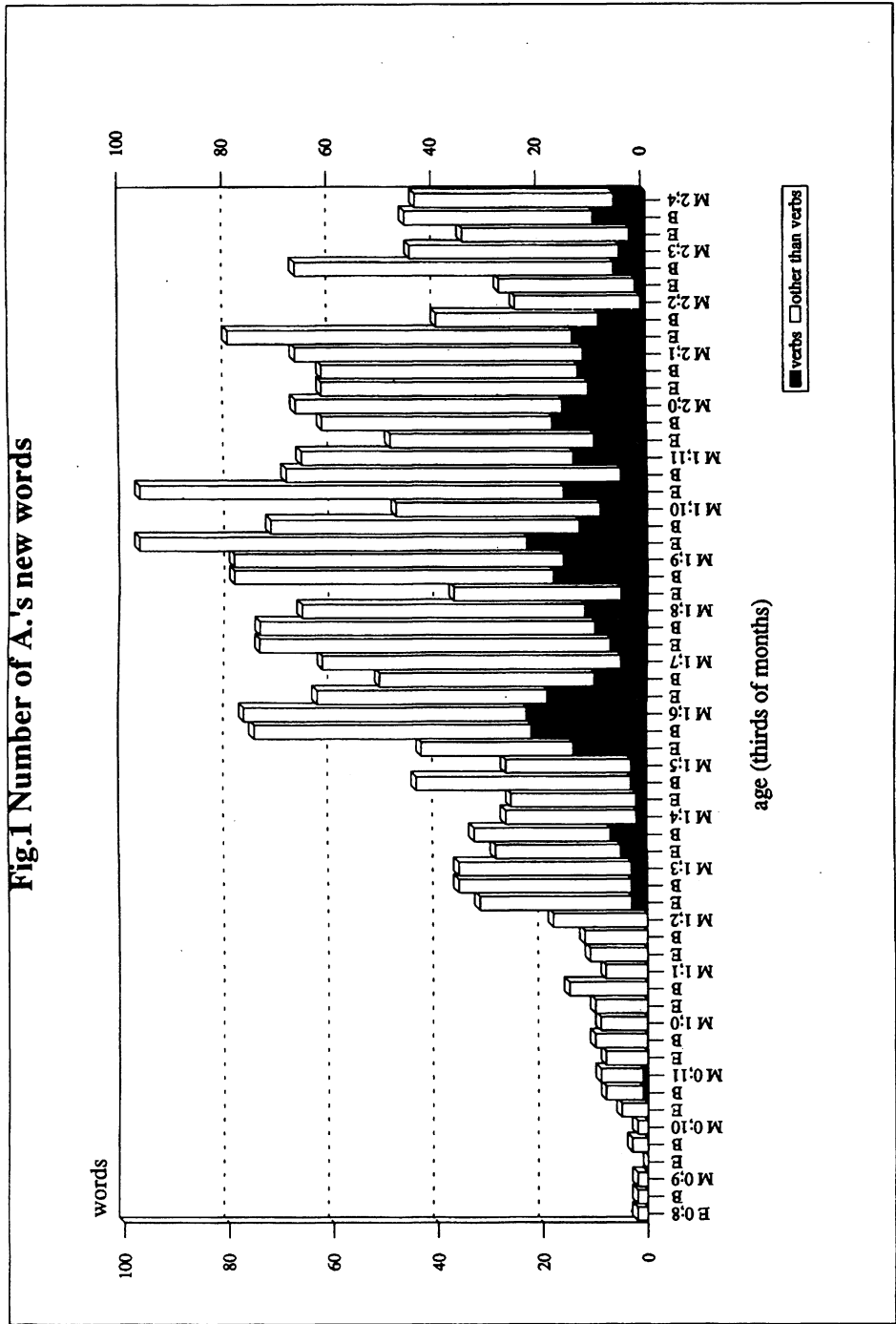
recording of words, word forms, and phonological development during this period of time was obtained. Although the study concentrated on phonology, notes included word forms and word combinations. Comments on situation and referents and information about frequency and mortality of individual lexical items were also recorded. Additionally, audio-recordings were taken twice, later once a month (from 0;4 up to age 8). Some audiotaped data were verified by sonagrams and checked with a trained phonetician. Interjudge agreements were over 80%. Audio-recordings as well as handwritten notes were used to describe the babbling-period and to allow checks on later development. After 2;5 data were collected first daily, then in greater intervals. The child's lexicon together with detailed data on phonological and lexical development up to 2;5 is given in Elsen (1991).

3. Results

The present data collection presents several aspects already observed for other children (see Dromi, 1987; Marcus et al., 1992; Clahsen & Rothweiler, 1993; Clark, 1993). Figure 1 shows the number of new words that were acquired during each third of month. Total vocabulary in types does not increase at a constant rate. Nouns dominate the lexicon (Elsen, 1996b). In general, early verbs are correctly inflected e.g. *fallen* 'to fall', *machen* 'to make', *weinen* 'to cry', *kleckern* 'to spill', *vergessen* 'to forget', *schreiben* 'to write', *essen* 'to eat'. Some, however, show incorrect participles right from the start, e.g. *verloren* 'lost', *gewesen* 'been'. Not all verbs are overregularized. Up to the beginning of 2;5, approximately 25% of the irregular verbs show overregularizations (sometimes one token) [see appendix II]. Less frequently, irregularizations of regular verbs are found (*-(e)n* added to a regular verb, use of a stem vowel which does not appear in the target present tense stems or both), for example *hingelogen*, correct *hingelegt* 'put down' (2;4,6), *gespritzen*, correct *gespritzt* 'syringed' (2;4,16). Invented verbs are inflected, e.g., *gedongt* 'has made 'dong'' at 2;1.6, *bähacht*, *hat gebähacht* 'has made 'bäh'' at 2;1.7. Sometimes the girl corrects herself, but the corrected form is not always closer to the target, e.g. [ʼanəθɔŋt] corrected to [ʼanəθɔŋ], correct *angezogen* 'dressed' (2;0,15), *aufgestunden* corrected to *aufgestunken*, correct *aufgestanden* 'stood up' (2;6,6). Double markings appear, for example [lönt], correct *verloren* 'lost' (1;6,2), *fallent*, correct *gefallen* 'fallen' (for several days at the beginning of 1;6, along with *fallt*), *geziehten*, correct *gezogen* 'pulled' (2;4,19).

However, some new observations are made which are underestimated or which have not yet been reported in the literature. For the formation of a participle, the choice of stem may vary, e.g., *gegangen* (*gegangen* 'gone') at 2;8.25, *gingt* (preterite stem), *gegangen* at 2;8.28, *gegeht* (infinitive stem) at 2;9.7, *gegangen* at 2;9.13. *-(e)n* and *-(e)t* may be added to irregular stems other than infinitive or participle, e.g. *gerunterfällt* correct *runtergefallen* 'fallen down'

Fig.1 Number of A.'s new words



(2;1,19), *weggeläufen* correct *weggelaufen* 'run away' (2;4,2). Irregulars and regulars may have stem vowels which do not appear in the target stems at all, for example [foŋ], correct *gefunden* 'found' (1;5,24), [ʔapəzuŋkt], correct *abgezogen* 'drawn off' (2;1,4), *geschmocht*, correct *geschmeckt* 'tasted' (2;5,0) (for more examples see Elsen 1997).³ Several forms co-exist, partly for months. A. applies regular and different irregular patterns to regular and irregular verbs. The examples show that inflection patterns are obviously less homogeneous than generally assumed and that the difference between regular and irregular formations are less clear cut than postulated by symbolists, which makes a rote/rule distinction less probable.

There are several sudden non-linear increases ('spurts') in the rate of vocabulary growth (Fig. 1), when the acquisition of new words nearly doubles (at the end of 1;2, at the end of 1;5, at the beginning of 1;9, and at the beginning of 2;3) or at least clearly rises (at the beginning of 2;0). Looking at the rate of verb growth, we also see that there is a sudden non-linear increase in the acquisition of verbs. For few irregulars, the first usage is overregularized (see appendix II), e.g., *lont* 'losted', for which only overregularized forms are noted at the first day of appearance. When examining the spontaneously produced verbs we notice that the rate of acquisition of regulars differs from that of irregulars. In Figure 2 the accumulation of A.'s regular and irregular verbs is documented. At the end of 1;5, there is a point in time when the gap between regular and irregular verbs widens in favour of the regulars and an increase in new verbs is noted: after learning around one, two or three new verbs every ten days, the child acquires seven new verbs at the end of 1;5, 18 verbs at the beginning of 1;6, then 14 verbs at the middle of 1;6. Figure 3 presents the proportion of regular and irregular verb types in relation to the total verb vocabulary level.⁴ Irregulars initially predominate. After some time, the proportion of regulars increases continuously.

The graphs are clear evidence that verb vocabulary composition is undergoing substantial change. When the rate of vocabulary rises at the end of 1;5, the rate of regular verbs rises, too. All verbs which were produced spontaneously up to this point of time are listed in appendix I. There are thirty verbs in the child's lexicon at 1;5,27, 15 regulars and 15 irregulars. If verbs with different prefixes are counted once and the irregular verb *haben* 'to have' is treated as weak according to the dental suffix of the past participle (*haben - ge-hab-t*), 13 irregulars and 15 regulars are recorded by the end of 1;5. These differences in ratings do not seem to be crucial. The assignment to the part of speech 'verb' might be questioned, especially for the first verbs. But their use as verbs soon becomes plain either because of their inflectional behaviour or use in correct situations.

When the increase of new verbs is noted, the first overregularized form is found: [dəfält], correct *gefallen* 'fallen' (1;5.30). Further overregularizations appear at 1;6.2 [lönt], correct

³ Even errors with *ge*-placement were found, e.g. *gerunterfällt*, correct *runtergefallen* 'fallen down' (2;1,19), *schubstgehat*, correct *hat geschubst* 'has pushed' (2;8,8).

⁴ For the proportion of A.'s regular and irregular verbs as a function of age see Elsen (1997).

Fig.2 A.'s regular/irregular verbs, cum.

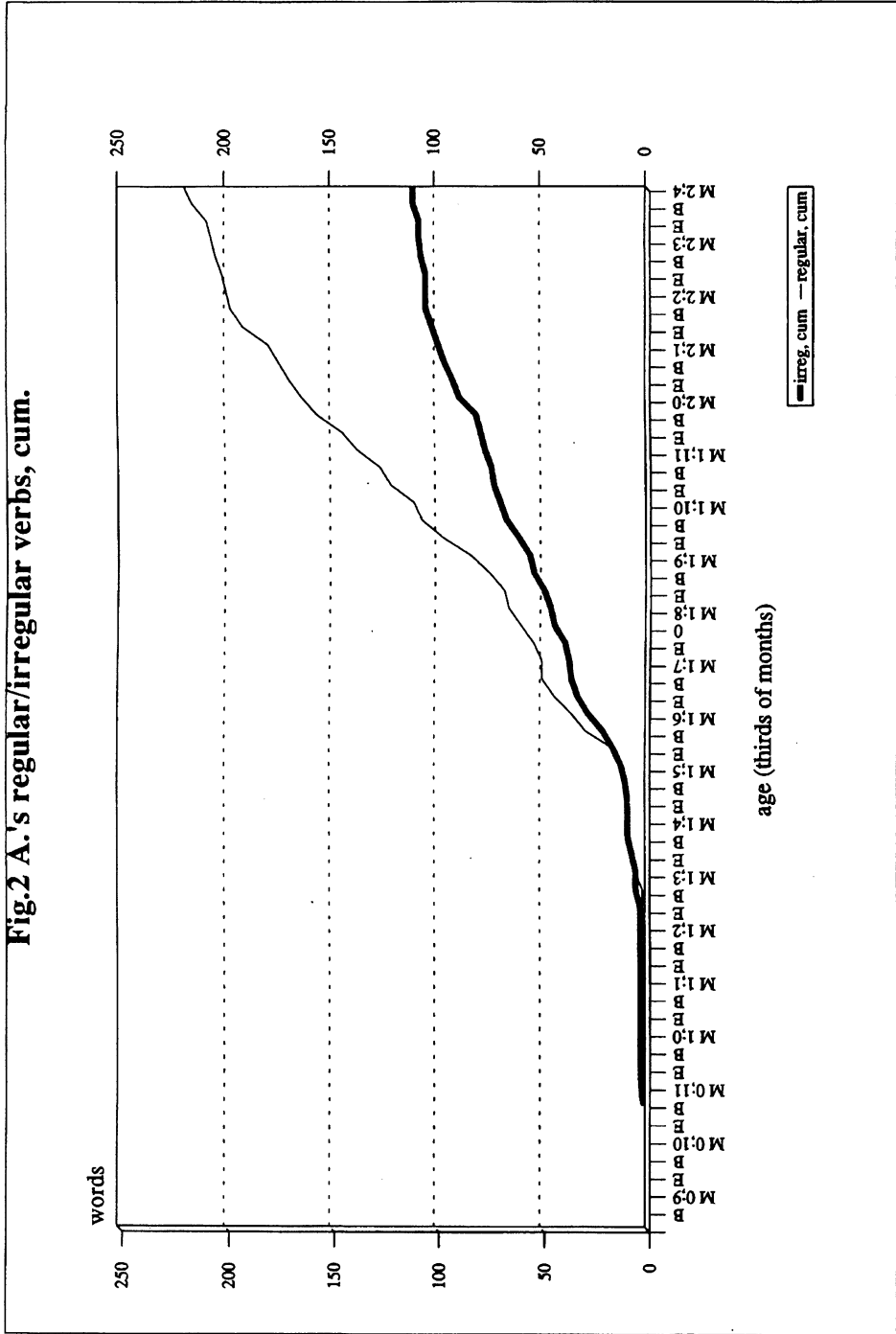
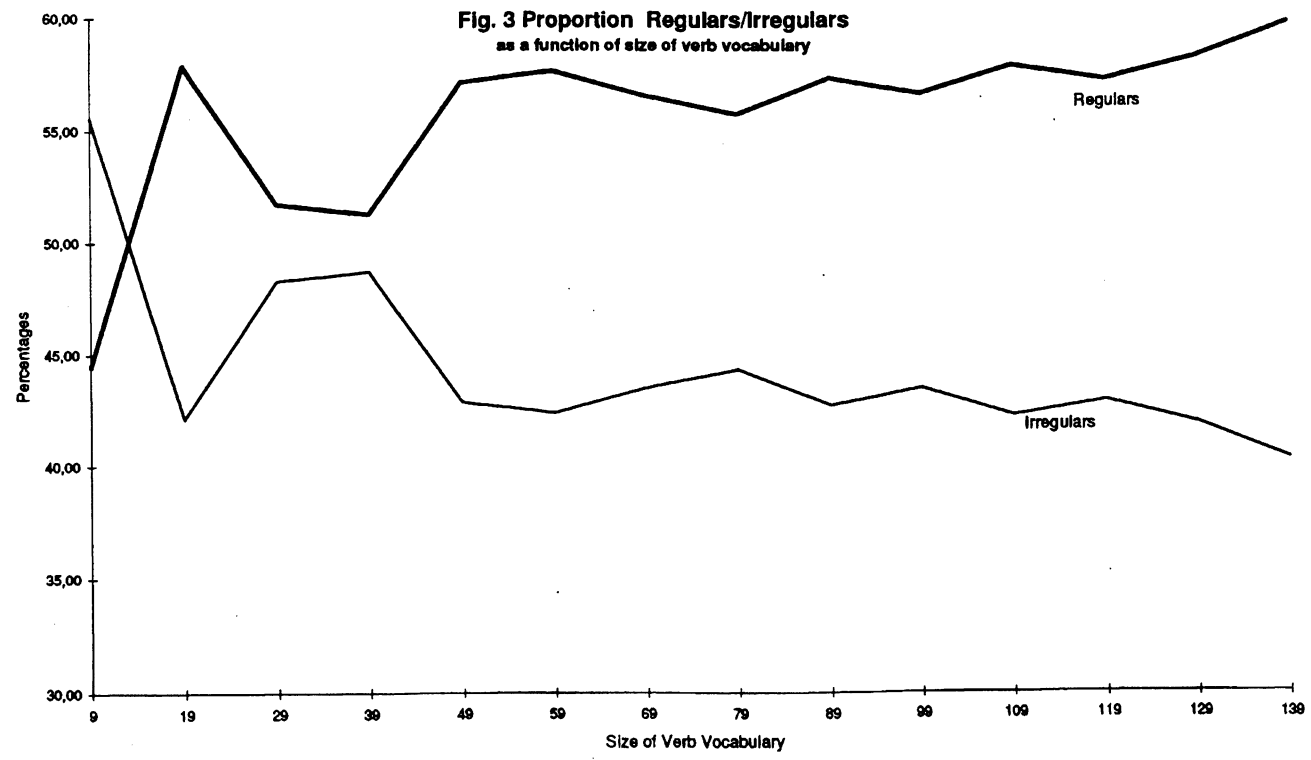


Tabelle1 Diagramm 6



verloren 'lost', at the end of 1;6 [mitnēm̄t], correct *mitgenommen* 'taken along with', and at 1;7.24 [vest], correct *gewesen* 'been'. According to Marcus et al. (1992), low-frequency irregular verbs are inherently prone to overregularization. Note that these are not low-frequency verbs, especially not in talking to children. To what extent frequency is the decisive factor for overregularizations is discussed in detail in Lindner (this volume). Furthermore, some show overregularizations from their very first usage. At 1;6.2 only overregularized tokens are recorded for *lont*. These examples mark the beginning of overregularizations at a point of compositional change and abrupt increase of new regular verbs at the end of 1;5. Interestingly, at this time further productive verb inflection is recorded such as 3rd sg. present tense for e.g., *schlafen* 'to sleep', *essen* 'to eat', *sitzen* 'to sit', *wischen* 'to wipe'. However, overregularizations do not appear at a constant rate. There are three new overregularization types at the end of 1;5/1;6. The first two are used several times for a few days. Then all three forms disappear. Only one new type with one token is produced at 1;7. The same holds for 1;8. Then there are three new overregularization types at 1;9, but nothing new during 1;10/1;11. At 2;0 seven new types are recorded. At 2;1 eight new types are noted. At 2;2 one new type appears. At 2;3, three new overregularization types are found. At 2;4 it's only one. Though most of them only appear once initially, for *runterfällt* 'fallen down' frequent use is noted at 1;11/2;0, for *getrinkt* 'drunk' during 2;0/2;1, for *geschmeißt* 'thrown' during 2;0/2;1, for *weggetunt* 'put away' during 2;1, for *reingetunt* 'put in' during 2;1. After daily note taking ceased, observations show that times of high and low production of overregularized forms still alternate. That is, we can see waves of development. It is interesting to note that a further increase in the acquisition of regular verbs is found at 1;9 when we find an increase in new overregularization types. The same happens at 2;0, when types and tokens of overregularizations increase. Overregularizations and sudden accelerations in verb growth show a correlation, as overregularizations show the same pattern of development as verb vocabulary development itself. These waves are investigated in more detail by Lindner (this volume) who found systematicity in the way different patterns of erroneous participle formation were used over time.

Taken together the data is in line with the findings of the acquisition of the English past tense as shown by Marchman & Bates (1994): The acquisition of verbs shows a sudden non-linear increase. The composition of the verbal lexicon undergoes changes. When structural and quantitative changes in the verb vocabulary appear, that is, when regulars exceed the 50% mark, the first overregularizations are found. Furthermore, for the production of overregularizations a wave-like development is noted which correlates with non-linear increases in the verb lexicon. Moreover, the formation of incorrect past participles shows various patterns which may coexist. Overregularizations as well as irregularizations, though less frequently, are found. Regulars and irregulars have double-markings, stems other than infinitive or participle or non-existing stems, both with *-(e)t* or *-(e)n* suffixes.

4. Discussion

The data shows that the child produces her first overregularizations when the composition of the verb vocabulary changes and the proportion of regulars exceeds 50%, as predicted by the network. If the surge of morphological errors was simply due to more opportunities for errors because of more new verbs, then the number of overregularizations should increase in the course of development as numbers of new verbs (and, thus, numbers of opportunities) rise, too. The numbers of verbs increase throughout the study, but the use of overregularizations sometimes rises (at the end of 1;5/1;6, at 1;9, at 2;0/2;1), then again drops (at 1;7, 1;10, 2;2). Another possible explanation is that the increase of overregularizations might be due to more talking in general. However, the investigation of noun plurals, which is currently under way, shows that overregularization rates of nouns do not correlate with those of verbs, which should be expected if such errors were simply the result of more talking. So it is highly probable that the onset of overregularizations was triggered by quantitative and structural changes in the verb vocabulary.

These findings contrast with those of Pinker & Prince (1988) or Marcus et al. (1992). Marcus et al. (1992) report data on children that show no sudden non-linear increase in new verbs. Furthermore, the 'onset' of overregularizations does not correlate with compositional changes in the lexicon (cf. Marcus et al. 1992: 86-88, 99). The same holds for Weyerts & Clahsen's (1994) data on Simone. Again, there is no sudden non-linear increase of new verbs. Simone's first overregularizations are noted before changes in the composition of the verbal lexicon appear, which may be due to an underestimation of the number of regular verbs in the Weyerts & Clahsen data. In non-continuous samples only higher frequency items can be noted. Rare tokens will be missed. Consequently, the degree of variation as well as the actual amount of types will be underestimated. The present data shows that several verbs are initially produced with very low frequency, in part less than once a week (considering only spontaneous productions). *Essen* 'to eat' is said once at 0;11.3, once at 1;3.4, at 1;3.7 and then daily. *Lassen* 'to let' is produced once at 1;6.10. The next productions are noted at 1;7.0. *Singen* 'to sing' is recorded once at 1;3.22, once at 1;6.11 and at 1;6.20. Then it appears more often. Some verbs are produced daily from the start, e.g., *anziehen* 'to dress', though most early verbs are produced only occasionally during several days. The same holds for irregularizations and overregularizations. Especially the first overregularized forms are quite infrequent. *Wes* (*gewesen* 'been'), for example was recorded only once (1;7.24). Low frequency items like those mentioned will only be noted in data with high recording density. Thus, differences in results might be due to the method of data collection. Token frequency of many regular verbs is initially extremely low, in German as well as in English, whereas frequencies for many irregulars tend to

be higher.⁵ Thus, numbers of types in a continuous sample will be very different from those in non-continuous samples. There the rise of new verbs depends upon an increase of token numbers. A related problem arises for sudden non-linearities. According to connectionists, and in contrast to symbolists's assumptions (e.g. Marcus 1995), non-linearities in vocabulary growth are a contributing factor to the onset of overregularizations, not a necessary or sufficient condition (Marchman & Bates 1994, Plunkett & Marchman in press). Nevertheless, although the relation to morphological development is not clear, it should be stressed that for A. a sudden spurt-like increase in verb vocabulary exists. Again, such non-linearities in Marcus et al.'s and Clahsen's data may have been missed. However, careful investigation of weekly recordings do show non-linear verb acquisition and changes in the composition of the verbal lexicon in relation to early overregularizations, as Champaud (1996) demonstrated with data on a French child.

The same problem arises for early overregularizations, which might be, initially, also quite infrequent. We cannot rule out the possibility that the child's second or third wave of overregularizations, when type and token numbers increase, is equivalent to the first overregularizations found in other children. In other words, investigations such as that of Marcus et al. (1992) are very likely to miss early regulars, which tend to have low frequencies, as well as relationships between vocabulary and 'onset' of overregularizations. Furthermore, as pointed out by Plunkett & Marchman (1993: 63), Marcus et al.'s recordings probably occurred during a later period of verb acquisition when a regularization process had already set in. Thus they do not necessarily contradict network results. What is more, as most rare tokens will be missed in periodic recordings, the actual amount of variation will be underestimated. Lindner (this volume) analyzed A.'s overregularized forms from particular verbs and found systematic variation. Variety of error types and variability across children cannot be explained by symbolists, but is in line with a one-mechanism approach (cf. Plunkett & Marchman in press).

To gain quantitative results on type numbers in a child's actual repertoire from periodic recordings is not possible. Comparability with network results is questionable. To compare real-life information on type numbers with network observations, we have to rely on continuous samples from single children. On the other hand, there is still a further method of data collection: the parental report technique (see Marchman & Bates, 1994). When parents are asked about their children's linguistic abilities with the help of checklists, data on the development of a great many children can be obtained, though only for those aspects which are explicitly requested in the list. Facts not mentioned will be missed. However, Figure 3 is quite similar to Marchman & Bates' (1994) results. They collected data on 1130 children between 1;4 and 2;6 using the parental report technique and found that early in acquisition irregulars predominated before a shift in favour of the regular verbs was noted. These then predominated. Marchman &

⁵ Interestingly, irregulars and regulars seem to differ in lexical frequency effects. Large effects on language processing are found for irregulars, whereas hardly any effects are found for regulars (cf. Stemberger 1994). This emphasizes the relevance of type numbers as opposed to token numbers.

Bates stated that 'the shape of the relationship between verb learning and the productive use of past tense morphology [was] consistent with the non-linear 'critical mass' assumptions of the single-mechanism theory' (Marchman & Bates 1994: 360). Thus, results from continuous data collection match those from a different methodology.⁶ As all three sampling methods have their limits, their results should be considered together, though not without reservation.

In two investigations on the acquisition of German past participles, the network model is assumed to be able to generalize the regular pattern only because of high numbers of regular verbs in the input instead of reaching a critical mass (Clahsen & Rothweiler, 1993, Weyerts & Clahsen, 1994). In English, regular forms outnumber irregulars. In German, regulars and irregular forms are said to be found in equal numbers. Thus, Clahsen and colleagues conclude that learning of the regular pattern must be due to a symbolic inflectional rule. But the model does not need high frequencies of regular verbs to generalize the regular pattern. As already pointed out, a change in the proportion of regulars and irregulars together with a growth in vocabulary size triggered the formation of regular patterns in the model. It is exactly this relation between changes of quantitative and structural properties of the verb vocabulary and first overregularizations that is found in the present data. Regular forms are not more frequent than irregular forms, and nevertheless the child overregularizes. Therefore, though the idea of a rule is not explicitly excluded, it is *not necessary* to assume a symbolic rule for the formation of regular inflection.

Furthermore, Clahsen and colleagues found that *-n* was not overapplied in their corpora.⁷ „In all the data there are no participles in which an irregular stem pattern has been extended to a weak verb“ (Clahsen & Rothweiler 1993: 1) and the only kind of stem error they found were regular stems replacing irregular ones (ibid.: 1 and cf. ibid.: 20f., 31). For their 70 children, Weyerts and Clahsen (1994) found only three cases of irregular stems replacing regular stems, three cases of wrong marked stems of irregular verbs and only one example of a double marking (ibid.: 449). Thus, they conclude that a child can qualitatively distinguish between regular and irregular inflection.

However, A.'s data shows that inflection patterns are obviously less homogeneous than generally assumed and differences between regular and irregular patterns are less clear-cut than postulated by symbolists. This makes a rote/rule distinction less probable but is consistent with a one-mechanism approach. A. applies irregular patterns, vowel change or *-n* suffix or both, to regular and irregular verbs. Not only stem vowels from various verb forms are found (such as 2nd/3rd person singular present tense (*ge-nimm-t*, correct *genommen* 'taken'), past tense (*ge-*

⁶ In several previous investigations, A.'s phonological and lexico-semantic acquisition already yielded parallels to other children (Elsen, 1991, 1994, 1995, 1996a,b).

⁷ *Only* the participle affix *-t* is overregularized by the children, whereas the *-n* affix is *not* overextended“ (Clahsen & Rothweiler 1993:1). „it is *only* the regular *-t* suffix which is overregularized by children“ (Weyerts & Clahsen 1994: 430) (Emphasis mine), though actually *-n* errors were found to be 12,5% of suffix-errors in Weyerts & Clahsen's data. Irregularization errors did not occur in their data (Clahsen & Rothweiler 1993: 31).

ging-t, correct *gegangen* 'gone'), conjunctive (*ge-läg-en*, correct *gelegen* 'lain')) but various examples of past participles with stems that do not appear in the target stems at all (e.g. *get-rogen*, correct *getragen* 'carried', *gewoppt*, correct *gewippt* 'balanced'). Both *-n* and *-t* are applied to wrong stems. There was only one child in Clahsen & Rothweiler (1993) who had comparable results: Peter, an SLI child. His inflectional system was treated as a special case. Furthermore, some of A.'s erroneous forms were used often during several months and were more frequently applied than the correct participles (e.g. *ausgezungen*, correct *ausgezogen* 'taken off') or showed both *-t* and *-n* interchangeably (e.g. *trunken*, *trunkt*, correct *getrunken*, *getan*, *getanen*, *getant*, correct *getan*). In contrast to Clahsen & Rothweiler's results (1993: 23), A.'s incorrect forms cannot be called 'occasional'. Her data calls into question the claim that the child qualitatively distinguishes between regular and irregular verb inflection because marked as well as unmarked stems and regular as well as irregular suffixes were overapplied, partly for several months. Thus, we suggest that both irregular and regular inflection are based on one associative learning mechanism.

The present data is consistent with the current connectionists' position. As already noted by Marchman & Bates (1994), the beginning of overregularizations should be triggered by the composition of the verbal lexicon. This contradicts Marcus et al.'s (1992) claims of independent development of the lexicon and verb morphology. But it is in line with the 'critical mass' hypothesis. However, the present results are not entirely inconsistent with a symbolic approach as long as one accepts the existence of an input trigger for the appearance of overregularizations. Some further facts are consistent with a connectionist framework. There are irregularized regular verbs which, according to symbolists, should not be produced, at least not in higher numbers and certainly not several times per token. They cannot be explained by symbolic approaches. The same holds for the variation found for A.'s patterns of incorrect participle formation which should not appear according to symbolists. Thus, a qualitative distinction between regular and irregular verbs should be questioned. The production of the first overregularizations at a time of change in verb vocabulary composition is not predicted by a symbolic account, nor are further correlations between verb lexicon and overregularization patterns.

5. Concluding Remarks

After presenting data of the acquisition of German verbs, the observations were compared to findings from different data samples. Several results were quite similar to those found in Marchman & Bates (1994) for the acquisition of the English past tense. The acquisition of verbs shows a sudden non-linear increase. The composition of the verbal lexicon undergoes changes. The first overregularizations are found when structural and quantitative changes in the verb vocabulary appear. These and further observations were found to contrast with recent

symbolists' investigations of periodically recorded samples. It was argued that differences are due to the method of data collection.

Though A.'s data does not rule out a symbolic account entirely, some findings are more in line with a single-mechanism approach. Changes in the rate of verb vocabulary acquisition coincide with overregularization patterns, resulting in a wave-like development. The onset of overregularizations appears when the proportion of regulars exceeds the 50% mark. The formation of past participles shows various patterns: overregularizations, irregularizations, double-markings, stems other than infinitive or participle or non-existing stems, both with *-(e)t* or *-(e)n* suffixes. Different forms may coexist. Consequently, the assumption of a qualitative distinction between regular and irregular inflection and the existence of a symbolic rule is questioned. Instead, the data suggests a relationship between lexical and morphosyntactic development and the use of one associative learning mechanism for both irregular and regular inflection.

Further detailed investigations are needed to see whether the present findings are due to idiosyncrasy or whether current theories must be refined so that, one day, more of the developmental facts can be explained. It is to be hoped that the dawning of the new millenium will see the divergent attitudes converge.

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APPENDIX I

A. 's first 30 verbs (spontaneously produced, regulars underlined)

No.	age	verb	gloss
1	beg. 0;11	essen	to eat
2	0;11.18	trinken	to drink
3	1;2.30	<u>kleckern</u>	to spill
4	1;3.5	anziehen	to dress
5	1;3.8	stehen	to stand
6	1;3.13	<u>gucken</u>	to look
7	1;3.15	<u>wickeln</u>	to swaddle (a baby)
8	1;3.16	<u>wischen</u>	to wipe
9	1;3.22	singen	to sing
10	1;3.25	<u>rutschen</u>	to slide (e.g., on a slide)
11	1;3.28	ausziehen	to take off
12	1;4.4	schlafen	to sleep
13	1;4.8	<u>aufmachen</u>	to open
14	1;4.8	sitzen	to sit
15	1;4.9	<u>aufräumen</u>	to tidy up
16	1;4.11	<u>putzen</u>	to clean
17	1;4.28	<u>klingeln</u>	to ring
18	1;5.2	<u>drücken</u>	to press, to excrete (euphemism)
19	1;5.3	gehen	to go
20	1;5.11	<u>drehen</u>	to turn
21	1;5.16	<u>tanzen</u>	to dance
22	1;5.16	sehen	to see
23	1;5.18	haben	to have
24	1;5.24	finden	to find
25	1;5.25	<u>kaputtmachen</u>	to destroy, to spoil, to ruin
26	1;5.26	<u>regnen</u>	to rain
27	1;5.26	<u>warten</u>	to wait
28	1;5.26	helfen	to help
29	1;5.26	fallen	to fall
30	1;5.27	geben	to give

APPENDIX II

A. 's first overregularized verbs

age	child's form	target	gloss	further deviant participles
1;5.30	defallt [dɛfɔ̃lt]	gefallen	fallen	fallt, fallnt
1;6.2	lont* [lɔ̃nt]	verloren	lost	
end 1;6	mitgenehmt* [mɪtɛnɛ̃mt]	mitgenommen	taken along with	
1;7.24	west* [vɛst]	gewesen	been	
1;8.21	runterfallt* [xʉntɛfɔ̃lt]	runtergefallen	fallen down	
1;9.3	gehaut*	gehauen+	beaten	
1;9.23	trunkt	getrunken	drunk	getrinkt
1;9.26	wehgetant	wehgetan	hurt	wehtanen (1;7,3), wehd/getanen, wehgetunt, -getut
2;0	getrinkt	getrunken	drunk	trunkt
2;0.10	eingereibt* [aɪnɛʁaɪpt]	ingerieben	rubbed in	
2;0.14	abgebeißt [ʔapɛbaɪs ^ɪ t] [#]	abgebissen	bitten off	
2;0.15	annesongt [ʔanɛθɔ̃ŋt]	angezogen	dressed	annesoggen
2;0.16	reinetunt	reingetan	put in	reingetut
2;0.17	genehmt	genommen	taken	
2;0/2;1	geschmeißt	geschmissen	thrown	
2;1	wehgetunt	wehgetan	hurt	(see above)
2;1	weggetunt	weggetan	put away	weggetant
2;1.3	weggenimmt	weggenommen	take away	weggenehmt
2;1.4	abbesunkt [ʔapɛzʉŋkt]	abgezogen	drawn off	
2;1.5	hinneschmeißt*	-geschmissen	chucked	
2;1.9	weggenehmt	weggenommen	taken away	weggenimmt
2;1.15	gelauft	gelaufen	run	
	geschlafft	geschlafen	slept	
2;1.22	gegeht	gegangen	gone	
2;2.14	ausesieht [ʔaus ^ɛ ɛs ^ɪ ɪnt]	ausgezogen	taken off	aus(e)d/s/zungen, auseziehne
2;3.21	gekommt	gekommen	come	
2;3.25	weggetant	weggetan	put away	weggetunt
2;3.28	gehelft	geholfen	help	
2;4.19	geziehten	gezogen	pull	
2;5.0	gekannt	gekonnt	been able to	

* the first participle token was overregularized

+ for this verb regular participles exist although they are not used by the mother (prime caretaker)

the notation [s^ɪ] refers to a slightly [j]-like pronunciation of [s]