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Mary Hughes, and Annabel Greenhill

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A Note from the Editors

We are delighted to present the Proceedings of the 21st annual Boston University Conference on Language Development. The publication of these proceedings continues our efforts to bring the research and ideas presented at our conference each year to a worldwide audience.

Included in these volumes are 65 of the 90 papers selected for presentation at the November 1996 conference. We are grateful to all of the contributors who took the extra step of turning their conference presentations into written papers.

There are many people who helped to make the 1996 conference, and these volumes, a success, and we would like to thank some of them here. We are very grateful to our reviewers, many of whom have supported the conference for many years. We would also like to thank the many students and faculty of the Boston University Program in Applied Linguistics who contributed their time to the conference. Finally, special gratitude is owed to Professors Cathy O'Connor and Marco Haverkort, faculty advisors to the conference.

We are pleased to continue the tradition of Proceedings of the Boston University Conference on Language Development, and hope you enjoy these volumes.

Elizabeth Hughes
Mary Hughes
Annabel Greenhill

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Acquiring verb morphology: German past participles

Hilke Elsen
Universität München

1. Symbolist and connectionist approaches to the acquisition of morphology

The acquisition of regular and irregular morphology, especially past tense formation, is the subject of several recent investigations. Symbolists and connectionists agree that children acquiring past tense and present perfect show U-shaped behaviour. In the beginning, they use irregular as well as regular forms correctly. Then comes a period of overregularization and variation until the correct forms prevail. Researchers, however, do not agree on the explanation of the development. Symbolists interpret overregularizations, forms like *goed, comed*, as evidence for the application of a rule or the insight into the idea of 'obligatory marking'. They are due to retrieval error. Connectionists hold that overregularizations appear because of quantitative and structural changes in children's verb vocabulary.

According to symbolists, a dual mechanism exists: rote, or more recently, associative and rule learning (e.g. Pinker & Prince 1988, Pinker 1991, Marcus, Pinker, Ullman, Hollander, Rosen & Xu 1992, Marcus 1995). They argue that irrregular items are lexically represented and learned associatively or by rote. Regular inflection is reached with the help of a rule, represented symbolically. 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 irregular forms are used often, the application of the rule is blocked. Insufficient use of a form results in failure of the blocking device. Hence, overregularizations occur. 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.

Recently, connectionists offered an alternative account for the acquisition of inflection (e.g. Rumelhart & McClelland 1986, Plunkett & Marchman 1993, Marchman & Bates 1994). They 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 showed a U-shaped behaviour pattern comparable to children's output (cf. Plunkett & Marchman 1993). Though only one associative mechanism was used, non-linear behaviour resulted. The onset of overregularizations was said to be triggered by a sufficient number of regulars in the lexicon which allowed for the abstraction of general patterns. Thus, a relationship between lexical and morphosyntactic acquisition was assumed. It was suggested that the

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development in both domains was governed by the same learning mechanism (*'critical-mass' hypothesis*, cf. Plunkett & Marchman 1993, Marchman & Bates 1994).

The first overregularizations may be related to growth in vocabulary size, as incremental increases in new regular verbs result in qualitative shifts in the way forms are treated. They may also be related to the proportion of regular and irregular verbs in the lexicon. Generalization of simulations was virtually absent as long as the percentage of regulars remained below 50%. 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. Quantitative increments in the size and structure of the training set triggered a shift in strategy: after a time of stem - past tense mapping by rote, the lexicon was organized in terms of general patterns (system building). This reorganization was generated internally (Plunkett & Marchman 1993, Marchman & Bates 1994).

Interestingly, relations between lexical and morphological development were not found in Marcus et al.'s (1992) investigation of the spontaneous speech of 83 children. Furthermore, evidence of a sudden non-linear increase of new verbs (a 'spurt') or changes in the proportion of regulars has not yet been found in naturalistic studies of individual children (Pinker & Prince 1988: 140, Marcus et al. 1992, Plunkett in press).

2. Aims and method

In this paper some predictions of connectionist models are investigated using data from one German girl. One purpose is to present data from this continuous observation of the acquisition of verb morphology. A further aim is to compare results obtained from different data samplings: continuous longitudinal data (Elsen 1991), longitudinal data from sporadically collected recordings (e.g. Marcus et al. 1992, Clahsen & Rothweiler 1993, Weyerts & Clahsen 1994) and parental report information on a large population (Marchman & Bates 1994). The results reported here are very similar to those predicted by the network models: The composition of the verbal lexicon changes. When quantitative and structural changes in the verb vocabulary appear, the first overregularizations are produced. The formation of past participles shows various error types. Furthermore, the acquisition of verbs shows a sudden non-linear increase. For the production of overregularizations a wave-like development occurs, that is, times of high and low production of overregularized forms alternate. These findings shed new light on the relevance of network simulations. They illuminate possible limits of fragmentary data samples.

The discussion of learning mechanisms has centred around the English past tense. In spoken German the past tense of the verb is rare and the present perfect is used instead, so we will focus on the acquisition of past participles. A

rough sketch of German participle formation: Among other things, regulars form participles by adding *-t* to the stem, this is called weak inflection. Most irregulars may show a vowel change and the suffix *-n*, this is strong inflection. Then we have a few irregulars which form participles with the help of vowel change and the suffix *-t*, they are called mixed verbs. Some verbs show still different patterns (for more detail see Elsen in prep.).

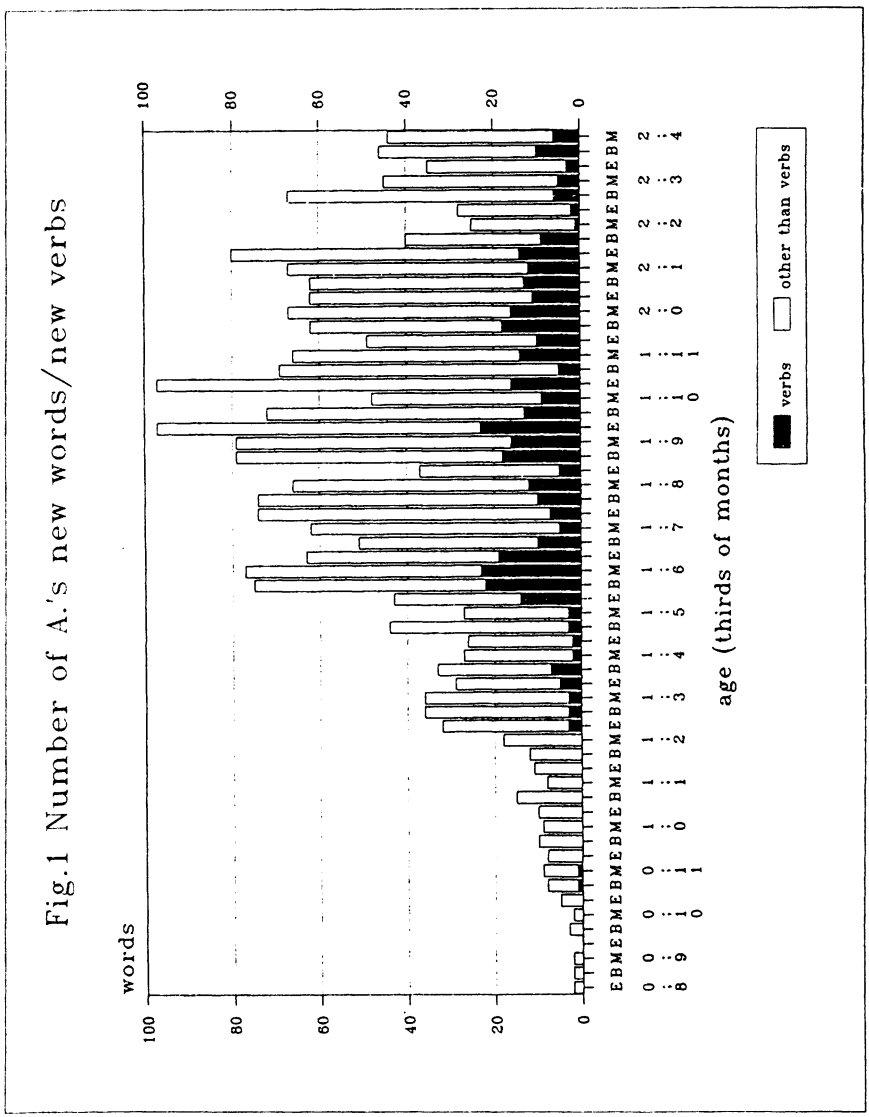
The findings reported in this paper are based on diary data of a German speaking girl A., (cf. Elsen 1991), collected continuously during the whole waking time up to an age of 2 years and 5 months. All new words, word forms and novel pronunciations of established items were documented in IPA phonetic transcription together with essential linguistic and non-linguistic information. Afterwards, notes were taken first daily, than in greater intervals. The method is described in more detail in, e.g., Elsen (1996a).

3. Predictions

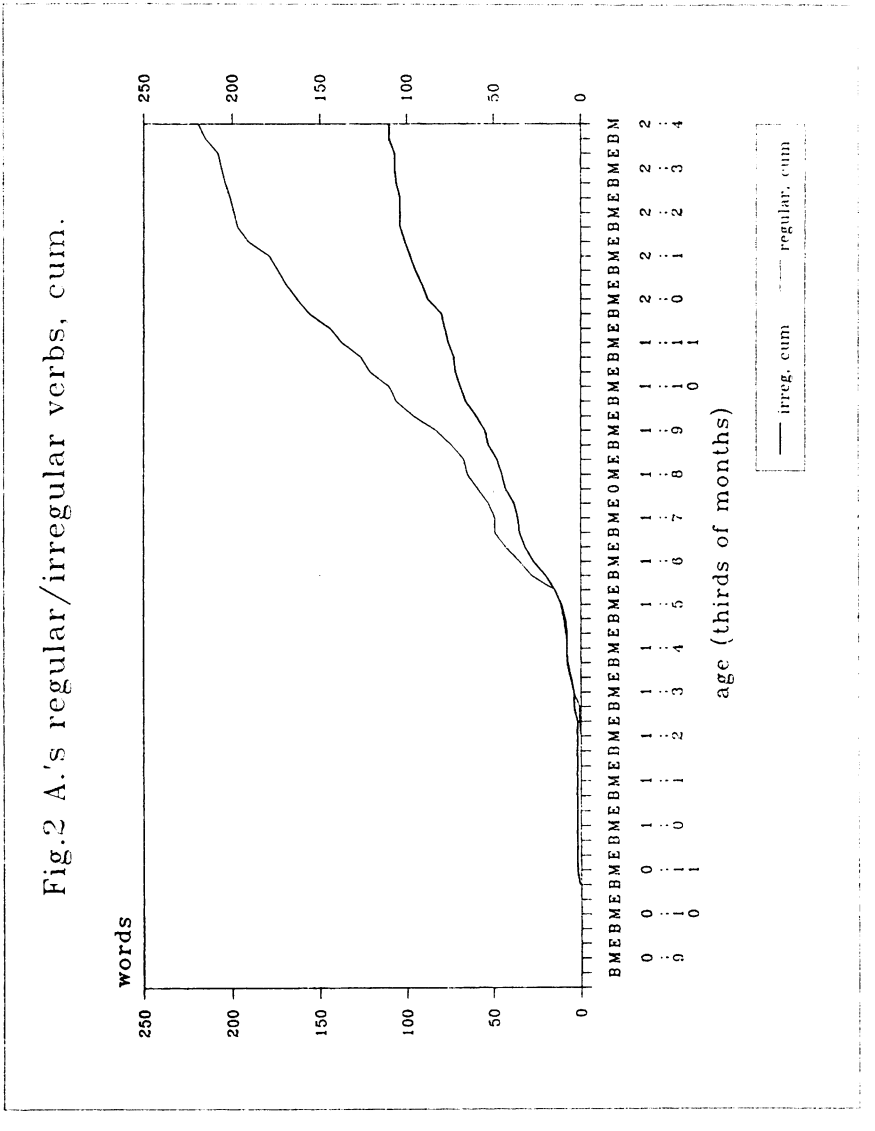
According to the dual mechanism approach, the onset of overregularizations should not be related to measurable increases in the number of regular verb types due to a clear dissociation between the mechansisms responsible for lexical and morphological acquisition. Due to the single-mechanism account a non-linear critical mass relationship between lexical and morphological development should be found. Only the acquisition of a vocabulary of a certain size should allow the abstraction of general patterns resulting in the production of the first overregularizations, that is, productive usage. According to the Plunkett/Marchman model, overregularizations should not appear in small vocabularies where irregular verbs outnumber regulars (Plunkett & Marchman in press).

4. Results

My data shows that total vocabulary in types does not increase at a constant rate. Figure 1 presents the number of new words, new verbs resp., that were acquired during each third of month. We can see several non-linear increases in Figure 1 (and cf. Elsen 1996b). Nouns dominate the lexicon. The growth of verb vocabulary is not steady. That is, there is a 'verb spurt' (at the end of 1;5). In general, early verb tokens are correctly inflected. In most cases, correct irregular forms precede overregularizations. Up to the end of the continuously collected data, about 25% of the irregular verbs show at least one token of overregularization (the first overregularized forms are given in Elsen, in prep.). Futhermore, the formation of incorrect past participles shows various patterns. We find overregularizations with different stems. They are irregular verbs with regular *-t*, e.g. *gehen - gegeht* (correct *gegangen*) 'to go', *nehmen - genehmt* (correct *genommen*) 'to take', *trinken - getrunkt* (correct *getrunken*) 'to drink'. There are irregularizations. These are regular verbs with irregular patterns, e.g. *schmecken - geschmockt* (correct *geschmeckt*) 'tasted', *aufkleben - aufgekleben*



(correct *aufgeklebt*) 'glued on'. There are stems other than infinitive or participle or non-existing stems, both with regular *-t* or irregular *-n*, e.g. *gehen - gegingt* (correct *gegangen*) 'to go', *wegnehmen - weggenimmt* (correct *weggenommen*) 'to take away', *lesen - gelosen* (correct *gelesen*), 'to read', *rausnehmen - rausnuhmen* (correct *rausgenommen*) 'to take out'. Furthermore, we find double-markings, *ziehen - geziehten* (correct *gezogen*) 'to pull', *ab-*



brechen - abgebrochnet (correct *abgebrochen*) 'to break off', *tun - getant, getanen* (correct *getan*) 'to do' (for more examples see Elsen, in prep.). What is more, different forms may coexist, partly for several months. Some erroneous forms are more frequently applied than the correct participle.

In Figure 2, the accumulation of the spontaneously produced regular and irregular verbs is documented. We see that the rate of acquisition of regulars

differs from that of irregulars. There is a point in time when regulars come to dominate: at the end of 1;5. In Fig. 3 you can see the proportion of regular and irregular verb types in the girl's verb vocabulary as a function of age (for the relative distribution of A.'s regular and irregular verbs as a function of verb vocabulary see Elsen in prep.). After a period of predominance of irregular verbs and a time of relative equal distribution, the proportion of the regulars rises at the end of 1;5. These findings are quite similar to those of Marchman and Bates (1994) (cf. their Figure 1, p 353). They investigated 1130 children between 1;4 and 2;6 with a parental report technique. Parents were asked to check verb lists. Marchman and Bates found 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). Note that the results from my continuous data collection match those from Marchman and Bates and thus support their findings with a different methodology.

The graphs show that there is clear evidence that verb vocabulary composition is undergoing substantial reorganization. There is a distinct change in the proportion between regulars and irregulars. From the end of 1;5, regulars contribute more than 50% of the verbs overall.

When the child's lexicon contains 15 irregulars and 15 regulars at 1;5,27 (these verbs are given in Elsen, in prep.), the first overregularized forms are found after some days of correct inflection at 1;5,30, [dəfal̈t], correct *gefallen* 'fallen'. The next ones appear at 1;6,2 [lōnt], correct *verloren* 'lost', at the end of 1;6 [mɪtənēmt], correct *mitgenommen* 'taken along with', and at 1;7,24 [vest], correct *gewesen*, 'been'. This happens at the time 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 rise in later development as numbers of new verbs rise, too. But this is not the case. If it was due to more talking in general, then rates of participle overregularizations should correlate to rates of plural overregularizations, but they don't. So it is highly probable that the onset of overregularizations was triggered by quantitative and structural changes in the verb vocabulary. Furthermore, after a time of few overregularizations they increase both in types and tokens by 1;9. Another peak is observed at 2;0/2;1. And looking beyond the time of continuous note taking, times of high and low production of overregularized forms alternate. Thus, overregularizations clearly come in waves. These waves are interesting in yet another respect - there seems to be systematicity in the way different patterns of erroneuos participle formation are used over time (cf. Lindner, in prep.). Note - at the age of 1;9 as well as at 2;0 there is a definite increase in new regular verbs, see Figure 1.

Taken together, the present data supports the 'critical mass' hypothesis. The results are congruent with a connectionist account of learning verb inflection. There is a definite relation between this child's change in vocabulary

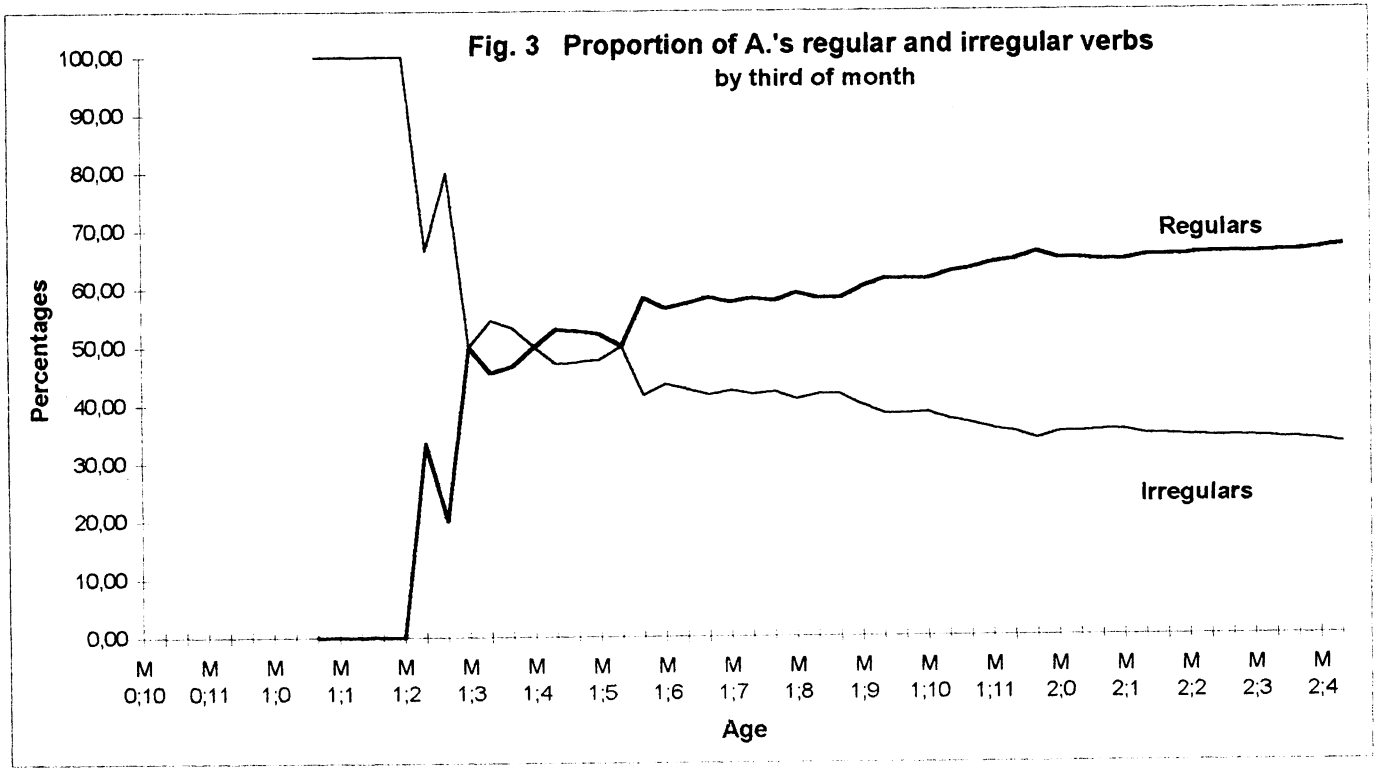


Fig. 3 Proportion of A.'s regular and irregular verbs
by third of month
Percentages
100,00
90,00
80,00
70,00
60,00
50,00
40,00
30,00
20,00
10,00
0,00
Regulars
Irregulars
M 0;10
M 0;11
M 1;0
M 1;1
M 1;2
M 1;3
M 1;4
M 1;5
M 1;6
M 1;7
M 1;8
M 1;9
M 1;10
M 1;11
M 2;0
M 2;1
M 2;2
M 2;3
M 2;4
Age

composition and the onset of overregularizations, as predicted by the single-mechanism approach. Furthermore, several patterns of over- and irregularization are found as well as a discontinuity in expansion rate. Note that 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 i. pr.).

5. The problem of non-continuous data sampling

This data is obviously not compatible with symbolists' results whose data on individual children does not show sudden increases in new verbs and no relation between compositional changes in the verbal lexicon and first overregularizations (eg. Marcus et al. 1992: 86-88, 99; Weyerts & Clahsen 1994: 442). The explanation may be found in the method of data collection, as A.'s data was compiled continuously as opposed to recordings of several children during one hour a week or a month. I assume that they missed the first overregularizations and many low-frequency items and, more importantly, crucial non-linear development between recording sessions. It is highly probable that non-linearities in verb acquisition are missed when recordings for a child are too rare. Token frequency of many verbs, especially regulars, is extremely low initially (cf. Elsen, in prep.) so that numbers of types in a continuous sample will be very different from those in sporadically compiled corpora. There, the rise of new verbs depends upon an increase of token numbers. Strictly speaking, statements about type numbers are not possible for sporadically recorded samples. The same problem arises for early overregularizations. We cannot rule out the possibility that this child's second wave of overregularizations, when type and token numbers rise, is equivalent to the first overegularizations found in other children. Thus, correlations between the onset of overregularizations and changes in vocabulary size and structure will hardly be found.

Non-continuous sampling might be the reason why other investigators of children's German past participles conclude that there is no irregularization of regular patterns. 'In all the data, there are no participles in which an irregular stem pattern has been extended to a weak verb. Rather, the only kind of stem error we found are regular stems replacing irregular ones.' (Clahsen & Rothweiler 1993: 1). 'Despite similar frequencies of regular and irregular participles in the input, it is only the regular -t suffix which is overregularized by children' (Weyerts & Clahsen 1994: 430). They interpret the networks' generalizing capacities as depending on high frequency numbers of regulars. As in German regular and irregular forms are said to be found in equal numbers and, according to Clahsen and colleagues, errors only affect irregulars, a qualitative distinction between regular and irregular inflection can be assumed. A symbolic inflectional rule must be responsible for the acquisition of regular patterns. But, 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. And 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. Therefore, the assumption of a symbolic rule is not necessary. Moreover, inflection patterns are less homogeneous and differences between regular and irregular patterns are less clear-cut than postulated by symbolists. The present data shows that several irregular patterns were applied to regular and irregular verbs. Stems other than infinitive or participle as well as non-existing stems were combined with the regular *-t* or irregular *-n* suffix. Different forms coexisted, partly for months. Thus, the claim that a child qualitatively distinguishes between regular and irregular inflection should be reconsidered. I suggest that both irregular and regular inflection is based on one associative mechanism - a lexical learning device.

6. Conclusion

Though the results presented here do not rule out a symbolic account entirely, the findings are more consistent with a single-mechansim approach. They are similar to those found in Marchman & Bates (1994) for the acquisition of the English past tense: there is a non-linear relationship between overregularizations to vocabulary size and structure. Some results cannot be explained by symbolic accounts, such as various patterns of incorrect participle formation. Variability, however, is in line with the connectionist approach (Plunkett & Marchman in press). Changes in the rate of verb vocabulary acquisition coincide with overregularization patterns, resulting in a wave-like development. Overregularizations appear when the proportion of regulars exceeds the 50% mark, as predicted by the networks. Thus, the data supports a one-mechanism approach which suggests a relationship between lexical and morphosyntactic development.

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