ACQUISITION OF PHONOLOGY

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Introduction

The limited length of this article and the generative scope of this journal will be primarily concerned with issues regarding the acquisition of phonology, also called child phonology. The latter term is often used to describe phonological phenomena found in child language, without consideration of theoretical linguistic issues of acquisition. Although good descriptions of phenomena and developmental patterns occur in child language are an absolute necessity for developing a theory of acquisition of phonology, they are not always sufficient. We also need to explain the attested phenomena and patterns of development, both to gain a better understanding of what happens during acquisition, why certain patterns occur and not others, and to be able to test current theories of grammar with respect to their learnability properties. These issues are investigated in the field of acquisition of phonology. However, work in this field is relatively sparse. Moreover, research in the context is strictly limited to the logical problem of acquisition and often ignores child language data as such. Of course, the two are closely related. They should be investigated in the framework of child language acquisition (cf. Ingram 1989). Perhaps optimistically, I detect a trend in current research in this direction: i.e. the consideration of theoretical issues on the basis of extensive child language data collections. The last decade has seen an upsurge in the number of research papers on child phonology. Preyer (1889), Stern & Stern (1907), Grégoire and early speech, or language disorders. Needless to say, this survey is far from complete, and inevitably reflects my own interests in the field.

2. A Brief History

The first studies of child language took the form of parental diaries. Some of the best known are Prayor (1889), Stern & Stern (1907), Grégoire (1937), Velten (1943) and Leopold’s four-volume work (1959-1947). The goal of these works was mostly descriptive and often had a larger focus than just language, because little was known about children’s behaviour in general. Diary studies focus on the development of one or two children: they are not very systematic, and do not provide norms for acquisition. Under the influence of behaviourism, researchers became interested in systematic measurements of language development and in norms for acquisition, which resulted in large sample studies such as Templin (1967), in which 430 subjects participated. Of course, one could only look at certain aspects, e.g. what kind of sounds could be articulated by three-year old children. However, norms do not tell us much about how the individual child goes about acquiring the phonology of a language.

In reaction to this, new research started to look for the emergence of rules and to describe the developing grammar. The goal was to explain language acquisition and to investigate how learning is accomplished in the presence of incomplete and often contradictory input. For this reason such questions are linguists formulated by Chomsky. Related to this is the question of how much of grammar is innate and how much is learned. In the last decades several different theoretical frameworks have been used: natural phonology (Stampe 1973), Firthian prosodic phonology (Waterston 1971, 1987), while Smith’s (1973) work used the framework developed in SPE (Chomsky & Halle 1968). The main reason for this, the methodology also changed. Large sample studies were replaced by longitudinal language sampling, where a number of children are visited at regular intervals over a period of time, to gain representative samples of the language development of more than one child. Longitudinal language sampling studies focusing on phonological development are not abundant and, partly because it is very time-consuming and partly because existing data bases are not (easily) accessible. This will hopefully soon change: currently, discussions on how to make phonological databases accessible through CHILDES are taking place (see CHILDES (e-mail) network).

In addition to longitudinal studies, experiments can be conducted to find answers to specific questions. Although this potentially a very fruitful method to gain insight into questions such as how lexical items are stored in the mind, very few experiments have been successfully carried out using young children as subjects: young children have a very short attention span and are often not able to carry out the tasks set.

3. Acquisition of Segmental Phonology

In the area of segmental phonology two basic approaches have been followed: a first one based on extensive longitudinal databases, its very thorough analysis of the data in a now somewhat out-of-date SPE framework, and its discussion of many issues that are still subject to debate, as for instance, the relationship between the child’s form and the adult’s. Although, these works undoubtedly remain very valuable, the field has undergone considerable changes since their appearance. This article provides an overview and update of the field.

1. Contrast between consonants and vowels, resulting in a CV syllable. The optimal contrast is between maximal closure — a labial step — and, and a maximally open vowel: /pa/.
2. Contrast between nasal and oral stops: /p/ versus /m/.
3. Contrast between labials and non-labials (dental): /p/ versus /t/.
4. Contrast between wide (low) and narrow (high) vowels: /i/ versus /æ/.
5. A contrast between front and back vowels: /i/ versus /u/.
6. A contrast between high and mid vowels: /i/ versus /u/.
7. A contrast between wide (low) and narrow (high) vowels: /i/ versus /æ/.

Both the first two steps make clear why papa and mama — the title of Jakobson’s 1939/1962 article — are among the first words in every language. Jakobson further claimed that there is a relationship between the order of acquisition and the distribution of sounds in the languages of the world. These features or contrasts that figure in all languages are acquired first. Furthermore, he claimed that there are laws of contrast and that there is a solidarity, i.e. claims about the distribution of phonological features among the world’s languages, that not only determine inventories but also dictate what kind of rules are to be expected in acquisition. For example, front consonants presuppose back consonants, and are therefore acquired earlier. Front consonants are also more likely to substitute for back consonants. Similarly, stops are acquired before vowels before voiced stops, and fricatives before affricates.

An important feature of Jakobson’s theory is the clear relationship between children’s phonological systems and those of adults. A child’s system will be similar (having fewer contrasts), but not fundamentally different. In other words, the child’s initial phonological structure is relatively impoverished. If positive evidence for a particular contrast has been encountered by the child, he or she is forced to add structure. This assumption is shared by most researchers, although not by all. Smith (1973), for example, views acquisition as an unfolding of rules, i.e. the supressing of natural rules. In their view the child’s system becomes simpler as the acquisition process goes along. On this view we might also assume that a child’s system is fundamentally different from that of adults with maturation being the key factor. On this assumption, however, the study of acquisition is however not particularly interesting or enlightening for linguists.

Jakobson’s work has been widely criticised, mainly because it predicts a universal order of development, whereas the study of acquisition data has revealed a great deal of both inter- and intra-linguistic variation. According to Jakobson, phonological development is not based on extensive longitudinal databases, he was probably not unaware of different kinds of variation in child language data. His work was based on phonological, and not on a clear view of the relationship between linguistic universals and languages acquisition. Even though there might be some variation, this variation is by no means random. Certain segmental inventories are
more likely than others, while others simply never occur.

Several researchers have attempted to improve Jakobson's theory by taking variation and variability into account. To gain insight into the amount of inter- and intra-child variation in the development of segmental inventories Ferguson & Farwell (1975), Shbatamo & Obsted (1978). Several researchers have also made use of phone classes and constructed phone trees: for each target phoneme a child's corresponding productions, forming a phone class, are noted; by connecting phone classes of a longitudinal series of language samples a phone tree is constructed. This method emphasizes the range of variation rather than the uniformity. The child was seen as a "little linguist," an active hypothesis tester, each child can therefore in principle come up with different hypotheses. Acquisition in this view is thus more probabilistic rather than deterministic (as in Jakobson's theory). This theory does not make any prediction about acquisition, moreover, it does not account for the large amount of uniformity that is found in children's developmental patterns. Ingram (1981, 1988) criticizes Jakobson's theory of acquisition, because it is not falsifiable, in that no criteria for acquisition are given. This criticism can hardly be taken seriously, especially since he proposes to amend this by merely stipulating Ingram (1988) criticizes Jakobson's work because of its sensitivity to all kinds of variability, not only due to competence factors, but also to performance factors. Criticism of Jakobson's work was also implicit in Jacobson's work. What Ingram proposes is in fact only a method for analysing children's data, not a theory of acquisition, let alone an improvement of theory. Another model that takes both uniformity and variability into account is that of Rice & Avery (1995). They hypothesize that inventories expand gradually, but systematically. Structure is built up one feature at a time, by increasing the number of contrasts in the inventory. Furthermore, elaboration must follow a predetermined path within any particular organizing node, in the Jacobsonian sense (cf. Demuth & Fee 1995). A well-known example is presented in Menn (1978): 

3.2. Segmental processes in child language

Many articles on child phonology provide lists of segmental processes in child language (cf. Ingram 1976, 1988, Stampe 1973, Smith 1973, Menn 1971, 1977, Iverson & Wheeler 1987). Processes or rules are often formulated in such a way that the child has to choose between more or less critical to the adult target form, and perform changes to this form so that they deliver an output, the child's production form. In other words, these processes describe the relationship between the adult and the child's production forms. The cases of such processes are given in (2), from Ingram (1976), who divides processes into three types: assimilation, substitution and syllable structure simplification processes. The latter are discussed in section 4.

3.3 for segmental processes and in 4 for suprasegmental processes.

To summarist, all approaches assume an input form that is more or less identical to the adult target form, and an output form — the child's production. They differ, however, in the way they formulate the relationship between input and output forms. In recent work attention has been shifted to explaining this relationship on the basis of a child's developing phonological system, rather than merely describing it by formulating a rule or process. One segmental rule that has been described is much debated lately in consonant harmony (cf. Levelt 1994).

3.2.1, 'Consonant harmony'

Consonant harmony (CH) is the process by which consonants in the word become more similar. This usually only affects primary place of articulation features. The process is relatively often attested in child language, but is hardly found in adult languages, where it always involves secondary place of articulation features, never primary. CH is usually defined as an assimilation-at-a-distance process (Vihman 1978). Features from one consonant spread to a non-adjacent consonant. A well-known example is presented in Menn (1978): [g:p] for duck.

In non-linear phonology CH is accounted for by postulating features of one consonant to an consonant not specified for place of articulation (Stemberger & Stoel-Gammon 1991). Coronal features are usually assumed to be underspecified for place and are therefore prone to adopt features spreading from other consonants. This feature-filling process can be represented as in (3a). A process arises, however, when the vowel is also specified for place, since now the spreading results in cross-association lines, as shown in (3b). Of course, this problem does not arise if we assume that consonants and vowels have different sets of place features (cf. Stemberger & Stoel-Gammon 1991). However, evidence from consonant-vowel interactions points towards a shared set of features for consonant and vowels (cf. Lahiri & Evers, 1991). McDavid & Myers (1991) have tried to solve the problem in (3b) by assuming that vowels and consonants are on different planes (planar segmentation), a view shared by, for instance, Macken (1990b), Vihman (1978), and Stoel-Gammon (1995). In this view consonant and vowel are adjacent and there is no intervening vowel that causes association lines to cross. This account is schematized in (3c):

3.1 for segmental processes and in 4 for suprasegmental processes.

Although this seems an elegant account of the process, examination of the full variation in a child who reveals certain problems, as argued by Levelt (1994). First, planar segmentation presupposes that the order of consonants and vowels is entirely predictable. As long as the child only has CV syllables, this is the case. When the child has VC, CV and CVC words this statement is no longer valid. At this point the order of consonants and vowels in a word has to be learned and planar segmentation can no longer be assumed. Second, if spreading is
be readily understood by taking into consideration that what is perceived best is not only whole words, but also whole vocabularies and different features for vowels and consonants. CV-interaction does not explain all consonant harmony cases. Words like zee 'zoo' and poot 'poot', produced as [pe:p], are not accounted for. Although taken as individual words may be odd, they can be readily understood by taking into consideration not only whole words, but also whole vocabularies at certain points in time, as we will now see.

3.3. Considering the whole lexicon

Waterston (1971) observed that all early production forms of her son fitted into one of five basic word structures, also called prosodies or canonical forms. Furthermore, she noted that these early production forms often did not have a straightforward relationship with the adult forms: the relationship could not be expressed by any of the rules or processes described in 3.2. Nevertheless, on closer inspection, adult and child forms had certain features in common, although the distribution of these features in the word might be complicated different. She noted for these phenomena by assuming that what is perceived best is produced earliest, and that the schemata of these early production forms or prosodies facilitate both the production of other forms and the acquisition of new forms, through pattern recognition. Development takes place when the child perceives more phonetic detail, which differentiates new prosodies, until the final state is reached in which every word has its own prosody. Although Waterston's account may account for the initial stages, it has been convincingly shown that incomplete perception at best accounts for a small subset of the production data, and that in most cases the child can perceive differences that he or she cannot produce. The child's phonological system develops, features are first aligned to word edges, rather then to the whole word. Later, these alignment constraints are gradually relaxed, so that features can be attached to any segment in the word. As a result the child is able to expand the set of word forms, until each word has its own form. Work like this shows that it is not sufficient to look at features or segments in isolation, but that one needs to take whole words into account. Furthermore, it is also important to consider a child's whole vocabulary at certain stages, to gain a deeper understanding of how segment inventories and vocabularies develop, and by processes such as those mentioned in 3.2. Table shows this place once more the importance of longitudinal databases. Work from a holistic point of view has only just begun, and much more research is needed.

4. Acquisition of suprasegmental phonology

Although research on the acquisition of suprasegmental phonology is not abundant, its development has been similar to research on the acquisition of segmental phonology. In the seventies, a major goal was the explanation of the main differences between adult forms and child forms, by formulating a set of rules or processes such as those given in (5):

(5)

<table>
<thead>
<tr>
<th>Rule</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule 1</td>
<td>Final consonant deletion</td>
</tr>
<tr>
<td>Rule 2</td>
<td>Cluster reduction</td>
</tr>
<tr>
<td>Rule 3</td>
<td>Unassimilation</td>
</tr>
</tbody>
</table>

Again, these processes or rules are at best a description of the relationship between adult target forms and children's production forms, and provide no insight into why children's productions differ from adult forms. With the emergence of non-linear phonology these were subsequently reanalysed in a non-linear framework. The relationship between input (adult) and output (child) forms was often described as the result of mapping the adult target onto the child's template (cf. Iverson & Wheleer 1987, Fikkert 1994). If the child's template cannot contain the whole segmental structure of the adult target, this results in simplifications, as illustrated in (6):

(6)

<table>
<thead>
<tr>
<th>Rule</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule A</td>
<td>Mapping of adult target onto universal word template</td>
</tr>
<tr>
<td>Rule B</td>
<td>Final consonant deletion</td>
</tr>
<tr>
<td>Rule C</td>
<td>Cluster reduction</td>
</tr>
</tbody>
</table>

(6a) and (6b) depict final consonant deletion; (6b) shows in addition cluster simplification; and (6c) illustrates universal word template. The representation in (6) provides a graphic description of the processes, but still leaves many questions unanswered. For example, what determines the shape of the template's target word and why is mapping the way it is? Why is the [b] cluster reduced to [b] when the initial unstressed syllable in [6c] deleted and not the unstressed final syllable [6f]?

Fikkert (1994a,b) distinguishes five stages in the development of rhymes in Dutch children's speech. First, only open syllables are allowed, where vowel length is non-distinctive, again resulting in the deletion of the stress and the development of single vowels. Second, branching rhymes, i.e. rhymes consisting of a nucleus and a coda (an obstruent), appear (maximal contrast between the vowel and the coda), and branching nuclei occur, consisting of a long vowel or a short vowel plus a sonorant consonant (acquiring more subtle contrasts). Fourth, extrasyllabic positions are acquired, allowing syllables ending in a long vowel or a consonant, or a short vowel plus a sonorant consonant (acquiring more subtle contrasts). Finally, syllables ending in two or more obstruents appear in the child's output, after onset and nucleus.

Fikkert (1994a) argues that each stage in the development is marked by the setting of a syllable parameter (see also Glot International 4), thereby extending the child's template. As a result, the child's input forms are different from the adult forms. It is an empirical question whether these developments can also be found in other languages than Dutch.

4.2. Word stress

Until recently, the literature on the acquisition of stress mainly focused on the following two questions: (1) whether children learn stress lexically or whether it is acquired through general learning procedures, and (2) whether children use stress to an extent that deviates from a pattern of stress that has been acquired through general learning procedures. These two questions are closely related, as stress is an important property that influences word segmentation. Stress patterns in Dutch are complex, and much more research is needed.
The child's forms at stage 2 still contain exactly one foot, but the monosyllabic forms of stage 1 are now disyllabic. The transition from stage 1 to stage 2 may be triggered by the fact that the child's output in (7b) and the adult input forms display a mismatch in the number of syllables. None of the stress parameters is changed; since there are no stress mismatches the child has (yet) encountered evidence that triggers the setting of a stress parameter from the default to the marked value. As a result the child forms are disyllabic, with initial stress for both initial and final-stressed target words at stage 2.

Comparing these new output forms with the input forms, the mismatch in the number of syllables is solved; however, now a stress mismatch exists. The existence of words with the same number of syllables but different stress patterns may trigger the setting of the quantity-sensitivity parameter to the marked value quantity-sensitive, since in a quantity-insensitive system words with the same number of syllables have the same stress pattern. At stage 3 very closed syllable is considered heavy and forms a foot on its own. Moreover, the data show that the string of segments is fully parsed into feet, and, that the main stress parameter is still irrelevant: the child produces both feet with the same degree of stress. When comparing his or her output forms with the input forms the child may detect that not all feet in the language have the same amount of stress, which triggers the setting of the main stress parameter at stage 4. Now, the child's representation of the target words in (7) is adult-like. This account demonstrates that a close study of child data reveals the principled and systematic nature of development. The child builds up his or her grammar step by step. The transitions from one stage to the next can be understood as (i) the setting of one or more parameters from the default (unmarked) value to the marked, and/or (ii) the extension of the child's template.

Although metrical theory might not predict exactly what the intermediate stages are, the intermediate stages can explain different parameters. However, it is likely that the initial stages are contextually restricted and fewer than the contextually unrestricted model. It seems likely that the initial stages are more or less equivalent and, independent of the language being acquired. Again, it is an empirical question whether this is true, and more research based on longitudinal data is required.

5. Concluding remarks

The question of how learning is accomplished is a problem of high importance. It has been discussed in the presence of incomplete and contradictory input and output data from the acquisition of phonology. An important characteristic of any theory of grammar should be that it is learnable and, therefore, any theory should also provide an account of the acquisition process. We have discussed in this article that research into the acquisition of phonology is not only based on formal theories of phonology, but also on analyses of longitudinal data from children in language, in which the complete set of data at different stages of development is taken into account.

Different phonological theories of course make different predictions concerning the specific details of acquisition. Acquisition studies should help decide on which theory is better suited to account for the attested variation and uniformity in children's grammars.

To conclude, although the first studies of acquisition of phonology date from some time ago, progress has been very slow, both because of methodological problems and because the study of the actual acquisition process very time consuming. Nevertheless, by combining the efforts of theoretical phonologists, psycholinguists and researchers studying child language, we may hope to find an answer to the question of how phonology is acquired, which part of phonology is innate and which part has to be learned.

An Acquisition of Phonology Bibliography


