ACQUISITION OF PHONOLOGY

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1. Introduction

Given the limited length of this article and the generative scope of this journal I will be primarily concerned with issues regarding the acquisition of phonology, examining 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 no means 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 into the basis is stric ted to the logical problem of acquisition and often ignores child language data as such. Of course, the two are closely related. They should be matched by the two-stage 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 study of acquisition of child phonology has been studied from at least this century, but it can hardly be said that there is a consensus about what the main issues are. The field is very interdisciplinary, and approaches differ drastically. The approach taken in Phonological Development, Models, Research, Implications edited by Ferguson, Menn and Sael-Gannon (1992) differs fundamentally from that in that in Archi field (ed.) (1996): Phonological Acquisition and Phonological Theory. The latter addresses acquisition from a theoretical phonological perspective and focuses mainly on production, whereas the former approaches acquisition from a wide range of perspectives — although not including a formal theoretical one — and addresses, as well as production, perception, vocalisation, child development in general, and other topics. As noted above, I give here an overview of the theoretical aspects of acquisition of phonology, focusing on production. I will not address the relationship between perception and production, although this is a very interesting and important topic (Macken 1980; Smith 1973; Spencer 1988; among others). Nor will I discuss acquisition of phonology above the word, tone, babbling, the difference between babbling and other speech, on 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 (1939-1947). 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 norm for acquisition, which was and is very interdisciplinary, and approaches differ strictly to the logical problem of acquisition and often ignores child language data as such. Of course, the two are closely related. They should be matched by the two-stage 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 study of acquisition of child phonology has been studied from at least this century, but it can hardly be said that there is a consensus about what the main issues are. The field is very interdisciplinary, and approaches differ drastically. The approach taken in Phonological Development, Models, Research, Implications edited by Ferguson, Menn and Sael-Gannon (1992) differs fundamentally from that in that in Archi field (ed.) (1996): Phonological Acquisition and Phonological Theory. The latter addresses acquisition from a theoretical phonological perspective and focuses mainly on production, whereas the former approaches acquisition from a wide range of perspectives — although not including a formal theoretical one — and addresses, as well as production, perception, vocalisation, child development in general, and other topics. As noted above, I give here an overview of the theoretical aspects of acquisition of phonology, focusing on production. I will not address the relationship between perception and production, although this is a very interesting and important topic (Macken 1980; Smith 1973; Spencer 1988; among others). Nor will I discuss acquisition of phonology above the word, tone, babbling, the difference between babbling and other speech, on language disorders. Needless to say, this survey is far from complete, and inevitably reflects my own interests in the field.

3. Acquisition of Segmental Phonology

The area of segmental phonology two basic approaches have been developed. The first is to conduct a detailed description of the phonology of a language based on extensive longitudinal databases, the second investigates the acquisition of segmental rules or processes (3.2). Surprisingly, hardly any work has been done on the acquisition of the segmental rules that play a role in the acquisition of phonology. The focus has largely been on rules typ­

1. Contrast between front and back vowels: /i/ versus /u/.
2. Contrast between nasal and oral stops: /p/ versus /b/.
3. Contrast between labials and non-labials (dental): /p/ versus /t/.
4. Contrast between wide (eye) and narrow (high) vowels: /i/ versus /u/.
5. Contrast between high and mid vowels: /i/ versus /a/.

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, but this has not always been funda­

cially 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 the suppressing of natural rules. In their view, the child's system is simplified so that adults with matu­
ed by longitudinal language sampling, where a number of children are visited at regular inter­
vals 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, 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 (n) databases accessible through e-mail networks are taking place in the CHILDES network.

In addition to longitudinal studies, experi­
ment can be conducted to find answers to specific questions. Although this is potentially a very fruitful method, it is difficult 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 very short attention spans and are often not able to carry out the tasks set.

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3. Acquisition of Segmental Phonology

Jakobson's theory is the clear relationship between children's phonological systems and those of adults. A child's sys­
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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), Shibamoto & Ohmeda (1976). Sonesson (1976, 1978) and others have observed that children use the same phoneme classes and structured phonological trees; for each target phoneme a child’s corresponding productions, forming a phone class, are noted; by comparing these 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 predictions, however, and it does not account for the large amount of uniformity that is found in children’s developmental patterns.

Ingram (1981, 1985) 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 a new criterion for the evaluation of processes. He also criticizes Ferguson & Farwell’s work because of its sensitivity to all kinds of variability, not only due to competence factors, but also to performance factors. Criticism of this latter work was also implicit in Jakobson’s work. What Ingram proposes is in fact only a method for analyzing children’s data, not a theory of acquisition, at least an im­probable theory of acquisition. 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 rule per inventory, by increasing the number of distinct forms in the inventory. Furthermore, elabora­tion must follow a predetermined path within any particular organizing node, in the Jakobsonian sense. Usually this work is said to be implicit in Jakobson’s work. What Ingram proposes is in fact only a method for analyzing children’s data, not a theory of acquisition, at least an imp­probable theory of acquisition.

K. Many articles on child phonology provide lists of processes that are crucial in acquisition. For example, Ingram reanalyzes Smith’s data in a non-linear phonological framework. Inverse & Wheeler (1987) analyze a number of assimilation processes using non-linear phonological tools. A non-linear framework allows us to formulate the rules much more elegantly. However, even in a non-linear phonological framework, the represent­ations are enriched and the number of rules severely limited — only spreading (assimilation) and deletion (deletion) rules are allowed — the problem mentioned above remains. Although, for in­stance, stopping can now be elegantly described as the deleting of the feature (continuant), and con­sonant harmony as the spreading of one or more features from one consonant to another (as we will see in 2.1.2), in the formulation of the rule refer­ence still has to be made to an underlying repre­sentation that resembles the adult target form. These works have characterized because the rules do not seem psychologically real: it is hard to believe that a child, having an underlying rep­resentation, can no longer be assumed. Second, if spreading is intimately unlearned in the course of development; and resembles the adult target form we have to conclude that the rules are performance rules and do not reflect competence.

In this view, assimilation is an inter-child and cross-linguistic variatio­n. With respect to intra-child variability they argue that in the absence of cross-linguistic patterns, some can be found, while in the presence of contrast the amount of variation decreases.

All the works mentioned above have in common that they deal with individual vari­ances and/or phonemes. Although they may take different positions in the word into consideration, they fail to explain why differences between differ­ent positions exist. Some recent work shows that it is useful to look at whole words (Macken 1979, Stool-Gammon 1983, Levelt 1994, Vellman 1995), and to consider a child’s whole vocabulary as some point in time (Levelt 1994). I will return to this in 3.3.

3.2. Segmental processes in child language

Many articles on child phonology provide lists of processes that are crucial in acquisition. (cf. Ingram 1976, 1985, Stampe 1973, Smith 1973, Macken 1992, Levelt 1994, Fikkert 1994a,b, Demuth 1995a,b, Demuth & Fewell 1995); it is now often assumed that children have certain canonical forms or templates onto which the adult forms are projected. In some cases, the canonical forms or templates are constrained in certain ways, the child’s production form often differs from the adult target form. Development means getting rid of constraints on elaborating templates so that the child forms resemble the adult target more and more. How this may proceed will be shown in 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 is an example of much debate lately is 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-a­distance process (Vihman 1978). Features from one consonant spread to a non-adjacent con­sonant. A well-known example is presented in Menn (1978): [g]k] for duck.

In non-linear phonology CH is accounted for by assuming feature spreading of one consonant to a consonant not specified for place of articulation (Stemberger & Stool-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 problem arises, however, when the vowel is also specified for place, since now the spreading results in crossing 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 & Stool-Gammon 1991). How­ever, evidence from consonant-vowel interactions points towards a shared set of features for conso­nants and vowels (cf. Lahiri & Evers, 1991). Mc­Dowall & Myers (1990) present a different solu­tion to the problem in (3b) by assuming that vowels and consonants are on different planes (planar segregation), a view shared by, for in­stance, Macken (1992, 1995), Lieo (1995), Stoel­Gammon (1995). In this view vowels and consonants are adjacent and there is no intervening vowel that causes association lines to cross. This account is schematized in (3c):

(a) CH as feature spreading from a specified to an unspecified segment:

(b) CH as feature spreading from a specified to an unspecified segment:

(c) CH as feature spreading assuming planar segregation:

Although this seems an elegant account of the process, examination of the full vowel sets in child language reveals certain problems, as argued by Lev­elt (1994). First, planar segregation 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 segregation can no longer be assumed. Second, if spreading is
Vallman (1998). Thus, as 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 phonology develop, as they change processes such as those mentioned in 3.2 take place. This shows once more the importance of longitudinal databases.

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 of research was to describe main differences between adult forms and child forms, by formulating a set of rules or processes such as given in (5):

- Initial consonant deletion $\text{cat} \rightarrow \text{km}$
- Cluster reduction $\text{blanket} \rightarrow \text{bakle}$
- Unrounded syllable deletion banana $\rightarrow \text{ban}$

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 rules 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 & Wheeler 1987, Fikkert 1994). If the child's template cannot contain the whole segmental template of the adult target, the results are simplifications, as illustrated in (6):

- Mapping of adult target onto unrounded word template $P \leftrightarrow Wd$

(6a) and (6b) depict final consonant deletion; (6b) shows in addition cluster simplification; and (6c) illustrates unroundedness deletion. 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 child's template and why is the mapping the way it is? Why is the (b) cluster reduced to (b)? Why is the initial unstressed syllable in (6c) deleted and not the unstressed final syllable? Moreover, (6d) does not tell us anything about the child's developmental stage. Therefore, these differences between adult target forms.

Insight into these questions can be gained by carefully examining longitudinal acquisition data within lexical phonology, rather than with a theory of acquisition. If there is an innate Universal Grammar (UG) which contains universal principles and parameters, with default values for each parameter, then UG predicts the initial stage in acquisition: all parameters have the default value.

The language learner has to look for evidence in the input data (the language of the environment) to change a parameter from the unmarked default value to the marked value. If such evidence is encountered, the parameter is set to the marked value; if not, it remains in the default value. The acquisition process continues until all parameters have the setting required for the language that the child is learning. Formal linguistic theory tells us something about the initial state (all parameters have the default value) and the final state of acquisition (all parameters are fixed as required for the target language). It also makes specific predictions about the intermediate stages, although it drastically reduces the number of possible grammars a child can come up with.

Within the acquisition process and the intermediate stages one needs a careful study of longitudinal acquisition data.

4.1. Symbolic structure

The symbolic structure of a syllable has hardly been studied. Although the statements that children (i) start with CV syllables, (ii) reduce consonant clusters, and (iii) often delete final consonants are commonplace in the literature, claims on further development are hard to find.

With respect to onsets the following development has been found for Dutch children (Fikkert 1994a,b): after a stage of non-obstruent onset clusters present in the child's production forms, resulting in CV syllables, even when the target syllable is onsetless — onsetless output forms appear, and finally, complex onsets are produced. Characterization of children's first complex onsets is that the two members of the onset differ maximally in sonority: preferably a stop plus a glide (Jakobson's principle of maximal contrast).

Moreover, the three stages can be distinguished in the acquisition of obstruent-sonorant clusters: (i) at the first stage obstruent-sonorant clusters are simplified to single obstruents (again creating a maximal contrast between the two members of the onset); (ii) at the next (optional) stage they are simplified to single sonorants (acquiring more subtle contrasts); and (iii) finally, they are produced as obstruent-sonorant clusters. A striking finding is that, while most children start with obstruent-sonorant clusters, some children first have /al/-obstruent clusters. Apparently, these involve two different, unrelated parameters.

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 onset and a simple rhyme. Second, branching rhymes, i.e. rhymes consisting of a nucleus and a coda (an obstruent), appear (maximal contrast between the vowel and the coda), through pattern recognition. Development takes place when the child perceives more phonetic detail, which differentiates new prosodies, until the final stage is reached in which each 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 (Smith 1973, Macken 1980).

Recently, the focus of explanation has shifted towards output constraints. Macken (1992) noticed that, if child's productions are consistent with the same recipe: labial consonant - vowel - coronal consonant - vowel, so that a Spanish word like sopa 'soup' is parsed as [sop,a], Leeveld (1996) makes the same observation for Dutch at a particular stage in the development. Usually, this stage is preceded by one in which children only have words that are either completely labial or completely coronal, and that, since the child has not acquired the ability to produce the right edge of words, explaining why a Dutch word like kip 'chicken' /kip/ is produced as [uk] or [p]. Alignment constraints are also proposed by
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