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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, labeling the section 'Acquisition of 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 examples of phonological phenomena and developmental patterns occur in child language, it is an area needing further work in this field. The two are closely related. They should be considered - and addressed, as well as proposed solutions - in a network.

2. A Brief History

The first studies of child language took the form of resemblance to the adult system. The latter term is often used to describe phonological phenomena found in child language, without consideration of theoretical linguistic issues of acquisition. Although good examples of phonological phenomena and developmental patterns occur in child language, it is an area needing further work in this field. The two are closely related. They should be considered - and addressed, as well as proposed solutions - in a network.

3. Acquisition of Segmental Phonology

The acquisition of phonology is a critical aspect of language development, and understanding the process is essential for the development of effective education and intervention strategies. The acquisition of phonology involves the development of the ability to produce and perceive speech sounds in a language. This process is complex and involves multiple stages.

3.1. Segmental Inventories

One of the questions that constantly recurs is whether there is a universal order in which segments and/or features are acquired. Jakobson (1931/1968) and his followers have proposed that the order of acquisition of phonological units is based on phonological features. The order of acquisition is as follows:

1. Contrast between consonants and vowels, resulting in a CV syllable. The optimal contrast is between minimal pairs — a labial stop, and a maximally open vowel /a/.
2. Contrast between nasal and oral stops /p/ versus /m/.
3. Contrast between labials and non-labials (dental) /p/ versus /t/.
4. Contrast between voiced /l/ and voiceless (high) vowels /u/ versus /i/.
5. Contrast between high and mid vowels /u/ versus /i/.

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.

An important feature of Jakobson’s theory is the clear relationship between children’s phonological systems and those of adults. A child’s system may be simpler (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. Smith (1973), for example, views acquisition as the matching or simplifying of rules. Stampe (1973) and Halle (1973) support this view of the relationship between linguistic universals and language 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), Shibamoto & Ohrström (1978). Stemberger & Stoel-Gammon (1991) and others found 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 them to 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 about acquisition, moreover, 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 set of predictions. 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 Stemberger's work was also implicit in Jakobson'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.

A new model that takes both uniformity and variability into account is that of Rice & Avery (1995). They hypothesise that inventories expand gradually, but systematically. Structure is built up over time, by increasing the number of contrasts in the inventory. Furthermore, elaboration must follow a predetermined path within any particular organising node, in the Jakobsonian sense of an underlying representation that resembles the adult target form. Although, for instance, stopping can now be elegantly described as the spreading 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 3.2.1.), in the formulation of the rule reference still has to be made to an underlying representation that resembles the adult target form. The rules that are being added because the rules do not seem psychologically real: it is hard to believe that a child, having an underlying representation which resembles the adult form based on phonological knowledge, can produce forms that are far more advanced than his or her production—subsequently changes it to create a new impoverished form. Nevertheless, this is often implicitly assumed. If the input form is the underlying form and resembles the adult target form we have to conclude that the rules are performance rules and do not reflect competence.

Another problem with formulating rules to express the relationship between adult and child forms is that rules can only operate on input or adult forms, while many phenomena seem to be better accounted for by assuming constraints on the output, the child's forms. For example, in a particular position not only fricatives are changed into stops, but also other types of consonants, such as liquids and nasals, we could still try to formulate a rule in the adult inventory and generalise to the child's forms. This violates the uniformity assumption of Jakobson and is in fact often more advanced than his or her production—subsequently changes it to create a new impoverished form. Nevertheless, this is often implicitly assumed. If the input form is the underlying form and resembles the adult target form we have to conclude that the rules are performance rules and do not reflect competence.

3.2. Segmental processes in child language

Many articles on child phonology provide lists of segmental processes in child language (cf. Ingram 1976, 1985). In non-linear phonology CH is accounted for by spreading features of one consonant to a non-consonant not specified for place of articulation (Stemberger & Stoel-Gammon, 1991). Coronals 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 & Stoel-Gammon (1991)). However, evidence from consonant-vowel interactions points towards a shared set of features for consonants and vowels (cf. Lambrich & Evers, 1991). McConnell & Myers (1999) have shown that this is not the case and that feature association lines cross. This account is schematised in (3c):
Feature-filling, that is, if a feature is spreading always from a specified source, and if spreading is blocked by a dis­favored (i.e. coronal) consonant, the forms in (4a) are expected, but not those in (4b):

(4) Apparent cases of CI (from Levelt 1994)

a. brood /bRoit/ ‘bread’ Lbopjpoes /pus/ ‘cat’ [puf]
b. bed /bet/ ‘bed’ vis /vLs/ ‘fish’ [dLs]

Further evidence against the account presented by McDonald and Meyers (1991) comes from other apparent cases of consonant harmony. As Levelt pointed out, words like Zijm (5) are often produced as [pir], which appears to involve (labial) spreading. However, the only labial ele­ment in the target word is the vowel. These cases can thus be assumed to be caused by vowel spreading its place features to the consonants. Levelt therefore investigated all cases of conso­nant harmony and discovered that most of them could be reanalysed as consonant-vowel inter­actions. The forms in (4a) have a labial vowel and lab­ial consonants, the forms in (4b) have a coronal vowel and coronal consonants. In other words, the whole place specification is specified in the vowel. Menn (1978) and Iverson & Wheeler (1987) also propose accounts in which features are specified for whole words, but they implicitly assume either planar segregation or different features for vowels and consonants.

CV-interaction does not explain all consonant harmony cases. Words like zeej ‘zeep’ (soap), produced as [zep], are not accounted for. Although taken as a whole, these 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. Since both for these phe­nomena by assuming that what is preserved 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 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.

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 to account for the main differ­ences between adult forms and child forms, by formulating a set of rules or processes such as those given in (5):

(5) List of syllable structure processes (Ingram 1976)

- Final consonant deletion
- Cluster reduction
- Unstressed syllable deletion
- Sudden vowel lengthening

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 insights into why children's forms 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, Fee 1995, Fikkert 1994). If the child's template cannot contain the whole seg­mental input, the input forms get simplified, as illustrated in (6):

(6) Mapping of adult target onto universal word template

Ft = Wd

a. [bәd] [bә] [d] [ә]
b. [pәd] [pә] [d] [ә]
c. [bә] [d] [ә]

(a) and (b) depict final consonant deletion; (b) shows in addition cluster simplification; and (c) illustrates unstressed syllable 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] and not the unstressed final syllable? As we will see, how the child develops the rules of adult tar­get forms.

Insight into these questions can be gained by carefully examining longitudinal acquisition data within Levelt's (1989) theoretical framework. 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. Children's 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 child's language).

4.1. Stateable structure

The acquisition of syllable structure 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 onset the following develop­ment has been found for Dutch children (Fikkert 1994a,b): after a stage in which children use uni­sonic clusters in the initial part of the word, the clusters are simplified to single consonants. This is a striking finding that, while most children start with obstruent-con­sonant clusters, some children first have obstruent clusters. Apparently, these involve 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 re­sembling the description of the adult forms and 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), branching models occur, consisting of a long vowel or a short vowel plus a sonorant consonant (ac­quiring more subtle contrasts). Fourth, extra­syllabic position is acquired, allowing syllables ending in a long vowel or consonant, or a short vowel plus a sonorant-obstruent cluster. Finally, syllables ending in two or more obstruents appear in the child's output forms (nucleus and on­set).

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 acquires new output forms and develops new 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: (i) whether children learn stress lex­i­cally, and if so, which types of words are con­sidered; and (ii) how and when stress markedness patterns are acquired, given the overall formal and phonetic characteristics of the syllable. Until recently, the literature on the acquisi­tion of stress mainly focused on the following two questions: (i) whether children learn stress lex­i­cally, and if so, which types of words are con­sidered; and (ii) how and when stress markedness patterns are acquired, given the overall formal and phonetic characteristics of the syllable. Until recently, the literature on the acquisi­tion of stress mainly focused on the following two questions: (i) whether children learn stress lex­i­cally, and if so, which types of words are con­sidered; and (ii) how and when stress markedness patterns are acquired, given the overall formal and phonetic characteristics of the syllable. Until recently, the literature on the acquisi­tion of stress mainly focused on the following two questions: (i) whether children learn stress lex­i­cally, and if so, which types of words are con­sidered; and (ii) how and when stress markedness patterns are acquired, given the overall formal and phonetic characteristics of the syllable. Until recently, the literature on the acquisi­tion of stress mainly focused on the following two questions: (i) whether children learn stress lex­i­cally, and if so, which types of words are con­sidered; and (ii) how and when stress markedness patterns are acquired, given the overall formal and phonetic characteristics of the syllable. Until recently, the literature on the acquisi­tion of stress mainly focused on the following two questions: (i) whether children learn stress lex­i­cally, and if so, which types of words are con­sidered; and (ii) how and when stress markedness patterns are acquired, given the overall formal and phonetic characteristics of the syllable. Until recently, the literature on the acquisi­tion of stress mainly focused on the following two questions: (i) whether children learn stress lex­i­cally, and if so, which types of words are con­sidered; and (ii) how and when stress markedness patterns are acquired, given the overall formal and phonetic characteristics of the syllable. Until recently, the literature on the acquisi­tion of stress mainly focused on the following two questions: (i) whether children learn stress lex­i­cally, and if so, which types of words are con­sidered; and (ii) how and when stress markedness patterns are acquired, given the overall formal and phonetic characteristics of the syllable. Until recently, the literature on the acquisi­tion of stress mainly focused on the following two questions: (i) whether children learn stress lex­i­cally, and if so, which types of words are con­sidered; and (ii) how and when stress markedness patterns are acquired, given the overall formal and phonetic characteristics of the syllable. Until recently, the literature on the acquisi­tion of stress mainly focused on the following two questions: (i) whether children learn stress lex­i­cally, and if so, which types of words are con­sidered; and (ii) how and when stress markedness patterns are acquired, given the overall formal and phonetic characteristics of the syllable.
The child's feet at stage 2 still contain exactly one foot, but the monosyllabic stages of form 1 are now disyllabic. The transition from stage 1 to stage 2 may be triggered by the fact that the child's output in (7) 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 not (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 di-syllabic, 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 close 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 not relevant: 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 notice that not all feet in the language have the same number of strong stresses, which means that 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 principle 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 attestations stages can reliably be accounted for within the theory. It might be the case that the study of the acquisition of other stress systems will reveal different patterns, but the theory severely reduces the number of possible intermediate grammars. Also, it predicts 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 detailed longitudinal databases is required.

5. Concluding remarks

The question of how learning is accomplished in the presence of incomplete and contradictory input cannot be ruled out from a formal a priori point of view, without looking at actual data. This is often referred to as the logical problem of acquisition. 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. I have shown 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 child 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 the field is interdisciplinary 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.