Phonological Theory and Phonological Acquisition

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The purpose of this article is to trace the historical relationship between modern phonological theory and phonological acquisition theory in light of the concept of developmental continuity. Specifically, I intend to show how the question of continuity has provided a crucial link between developments in theoretical phonology and phonological acquisition theory. In order to illustrate this point, I focus on phonological acquisition models proposed within generative phonology – admittedly an arbitrary decision made at the cost of excluding contributions from other approaches to phonological acquisition (e.g., Jakobson 1941/1968, Locke 1983, Waterson 1987, MacNeilage and Davis 1990, Lindblom 1992).

After a brief introduction to the concept of continuity, I discuss its role behind models of phonological acquisition within the approaches of The Sound Pattern of English (Chomsky and Halle 1968), Natural Phonology (Stampe 1979), Principles and Parameters (Chomsky 1981) and Optimality Theory (Prince and Smolensky 1993). The general direction of the theory of phonological acquisition has been toward maximizing the underlying identity of the model of the developing phonological grammar of the child and that of the end-state adult grammar. In the last section of the article, however, I point to some conceptual and empirical issues that present potential problems for this meta-theoretical strategy and explore their implications for future research on phonological acquisition.

1. Continuity in phonological acquisition

Developmental continuity refers to the extent to which developing systems share the fundamental properties of the mature system. Identifying aspects of language that are held constant during acquisition is, of course, an empirical question. However, the concept of developmental continuity plays a role in constructing theories of language acquisition. Given several accounts of the same developmental data, theoretical parsi-
mony favors the one that assumes the most amount of continuity, since such a model requires the least amount of explanatory mechanisms. This consideration has motivated researchers in cognitive psychology and language acquisition to propose a meta-theoretical strategy by which full continuity between the child system and the adult system is assumed as the null hypothesis unless evidence indicates otherwise (The Continuity Hypothesis; Macnamara 1982, Pinker 1984; a similar idea has been expressed by Jakobson 1941/1968).

Crucially, the amount of continuity that can be subsumed in a model of language acquisition depends on the theory of the end-state (or the mature) system. Certain phonological models of adult language competence may provide mechanisms that can be used to explain development (or stages in child grammar), while others may not, and therefore require additional mechanisms to account for the same phenomena. From the perspective of developmental continuity, the former type of phonological theory is superior as a model of end-state grammar. As I demonstrate below, new models in generative phonology have almost always led to improvement in this respect. There are two important factors that contributed to these advances. One is the drive in phonological theory to develop a model that can systematically incorporate cross-linguistic differences. This has allowed to treat developing systems as possible variations of adult(like) phonological grammar. The second factor is the concept of markedness, which captures the fundamental properties that are held constant across languages. The crucial link between phonological theory and acquisition theory here is that the same general tendencies found across and within mature phonological systems also underlie the course of development.

Before examining the role of developmental continuity in models of phonological acquisition, it is useful to identify three different dimensions of the grammar that can be held constant. The first dimension concerns the representation of linguistic structures (representational continuity). Models of mature phonological grammars postulate structural elements, such as syllables and segments, which are seen as universal units of phonological representations. Child phonology can be assumed fully continuous with the end state if there is evidence that these categories exist from the onset of language acquisition. On the other hand, representations of phonological entities in developing systems may be qualitatively different from those of mature systems and become analyzable in terms of adultlike phonological units only later.

The second aspect of continuity is the architecture of the grammar, or the way in which phonological forms are 'computed' by the system of the speaker (architectural continuity). A theory of (mature) phonology defines a computational procedure – be it evaluative or derivational – by which the language-specific pattern of contrasts and distribution is generated. A developing phonological system may have a grammatical architecture that is essentially identical to that of an adult system. Conversely, such architectural continuity may not be justified. A scenario at the extreme opposite end is the possibility that children’s phonological behavior is not governed at all by a system that operates in the manner of a mature grammar.

The third aspect of continuity that must be considered is the composition of grammatical laws – the set of grammatical restrictions and operations that participate in the linguistic computation, variously called ‘principles,’ ‘rules,’ or ‘constraints’ depending on the model (compositional continuity). It is the membership rather than the type of such formal devices that is of the question here (the latter belongs to the domain of architectural continuity). In a fully continuous model of language acquisition, the child and the adult have exactly the same set of such grammatical laws. In a less continuous model, some of them are postulated to emerge or disappear during the development such that learners either lack some crucial phonological principles at the beginning or are in possession of child-specific principles that do not belong to mature phonological systems.
2. The SPE and Smith’s (1973) model

One of the most influential models of phonological acquisition that presupposes the framework of *The Sound Pattern of English* (SPE; Chomsky and Halle 1968) is the work of Smith (1973). Following the SPE, Smith assumes that a complete phonological system (of an adult speaker) consists of a phoneme inventory, a set of morpheme structure conditions and a list of phonetic rules, which together account for the phonological pattern of the language. Smith then asks the question of whether the phonological forms produced by a 2 to 4 year-old child are better explained with an adultlike model that has all such properties, or alternatively, with a system that simply maps the adult form to the child output. Smith argues for the latter view, based on the regularities seen in the way the child form deviates from its adult model, and also in the way diachronic changes in the child’s developing phonology take place across-the-board. These regularities are captured in a model schematized in Figure 1.

The child’s lexical form is equated with the input, or the surface form of the adult model.\(^1\) The synchronic regularity – i.e., the systematic relationship between the child form and the adult target – is attributed to realization rules which operate on distinctive features and other formal SPE devices. The diachronic regularity follows from the reorganization of these rules, which can disappear, emerge or become more complex. Crucially, such changes in the rules should uniformly affect the child outputs of target adult forms that satisfy the context of rule application. The example in (1) is a formal statement of one such rule.

(1) A realization rule in child phonology

\[ [+ \text{sonorant}] \rightarrow \emptyset / [+ \text{consonantal}] \]

Since the model assumes that the child’s lexical form is equivalent to the surface of the adult target, in principle all adult words that match the structural description of (1) undergo the change; hence the attested child forms in Smith’s subject Amahl: *brush* [bAT], *play* [be:] and *crumb* [gAm]. The rule persists unchanged until Amahl’s stage 12 (2 years and 219–227 days), after which it changes its form, systematically allowing different sonorant types to escape the deletion. Finally, the rule disappears in stage 29 (3 years and 286–355 days), when all adult targets with a stop-sonorant cluster are produced without reduction.

By favoring the mapping model illustrated in Figure 1 over the analysis that credits the child with a phonemic inventory and morpheme structure conditions, Smith essentially rejects full architectural continuity between the developing system and the mature system. This generalization, however, must be qualified for the realization rules which have the same formal properties as the re-write rules in mature grammar, including such notions as rule ordering and alpha variables. Moreover, as can be seen in (1), these rules presuppose representations of the

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![Figure 1. Smith's (1973) model of child phonology](image-url)
child's phonological forms in terms of distinctive features, which were regarded as the primary representational units on which SPE rules operate. Thus, Smith's model assumes both representational continuity and architectural continuity, although the latter is limited to the presence of rules.

But the discontinuity is instantly recognizable in the composition of the grammatical computational elements (i.e., the rules). Realization rules such as (1) have no place in adult English. While they receive adequate justification as descriptive devices, their presence in child phonology and eventual disappearance raise serious questions about their validity. At best, this conceptualization of phonological acquisition is counter-intuitive in that the child system is in some sense more complex than the adult system for containing many intricate rules whose connection to the end-state grammar is not apparent. Smith is aware of this problem and suggests that realization rules are manifestations of children's hypotheses, which are constrained by 'universal tendencies' such as vowel and consonant harmonization, cluster reduction and simplification of contrasts. The fact that these had to remain comments external to the model is ultimately due to the formalist orientation of SPE-style phonology which attempts to reduce the role of phonetics in phonology to purely mathematical notations in rules. While this approach gives the machinery to distinguish a natural rule from a less natural one, it does not in itself explain why realization rules in child phonology should be there in the first place.

3. Natural phonology

The observation that some phonological rules are more natural, or less marked, in the sense that they are more likely to occur, lies at the center of the theory of Natural Phonology (Stampe 1979, Donegan and Stampe 1979). In fact, in Natural Phonology, a clear line is drawn between 'natural processes' such as place assimilation and final devoicing, which are phonetically motivated, and 'rules' such as velar softening and trisyllabic laxing in English, which are language specific, arbitrary, and lack synchronic phonetic motivation. 'Rules' in this sense are considered purely conventional properties that fall outside the explanatory scope of a phonological theory.

Grounded in innate phonetic capacity, natural processes potentially govern all languages, but their realizations are limited or suppressed according to the specification of the language. For example, final devoicing is suppressed in English, which has a voice contrast in the final position, while its force is apparent in German. On the other hand, nasalization of prevocalic vowels is a general process in English, but it is limited in French, which contrasts nasal and oral vowels. The intuition the theory captures is that overriding the phonetically natural state in order to create a contrast is a marked option in human phonological systems.

The implications of this approach for phonological acquisition are explicitly discussed and treated as important motivations for the theory. All natural processes are credited to the child at the initial state, and the task the child faces is one of suppressing those processes that play only limited roles in the adult language (Stampe 1979). A child exposed to English, for example, must learn to suppress final devoicing and cluster reduction. On the other hand, there is nothing that children exposed to German need to learn about devoicing final obstruents or children exposed to Japanese about the lack of onset or coda clusters in the language. These processes are there from the initial state.

Thus Natural Phonology provides an explanation as to why a mapping relation between the adult target form and the child form such as (1) should exist. While Smith had to conclude that (1) is specific to child phonology and subsequently disappears, a Natural Phonological model would state that (1) is part of the child's innate capacity, which may or may not have to be controlled during the course of language acquisition. The increased compositional continuity in the developmental account is brought about by the quest for "essential" universals – universals "which we can show to follow necessarily from the essence of things" (Donegan and Stampe
For Natural Phonology, implicit phonetic forces are the essence of general tendencies found across languages, and also the source of continuity in phonological acquisition. On the other hand, proponents of Natural Phonology, such as Stampe (1979), concur with Smith in viewing the architecture of the child's system as a mapping between the adult form and the child form. Therefore, while the processes are seen to be shared throughout different stages in the development, the child system is not credited with a self-contained system which completely defines its set of well-formed phonological structures. Moreover, the exclusion of 'rules' from the scope of the model means that the theory has nothing to say about how phenomena such as trisyllabic laxing and velar softening develop.

4. Principles-and-Parameters model

The impact of the Principles-and-Parameters approach (Chomsky 1981) on phonological theory was considerable, if not as profound as that on syntactic theory, and gave rise to a new approach to phonological acquisition. The theory states that universal grammar consists of principles that apply to all languages and parameters that allow crosslinguistic variation within defined limits. A parametric approach to phonological analysis has been successfully applied to certain domains of phonology, in particular stress and syllable structure, where languages vary in clearly identifiable dimensions of options (e.g., Halle and Vergnaud 1987, Hayes 1985, 1995). Some metrical parameters for stress are shown below.

(2) Parameters of metrical theory

(Dresher and Kaye 1990: 142)

P1: The word-tree is strong on the [Left/Right]
P2: Feet are [Binary/Unbounded]
P3: Feet are built from the [Left/Right]
P4: Feet are strong on the [Left/Right]
P5: Feet are quantity sensitive (QS) [Yes/No] […]

The process of learning in a Principles-and-Parameters model comprises setting parameters such as those in (2) to the adult value using the linguistic data children are exposed to (Wexler and Manzini 1987, Dresher and Kaye 1990). For certain parameters the child begins the learning process with a 'default' setting. For instance, two parameters related to the onset of the syllable are argued to have the following default settings indicated by the underlining:

(3) Onset parameters (Fikkert 1994: 41)

a. Minimal onset parameter: are onsets obligatory? (Yes/No)
b. Maximal onset parameter: can onsets be branching (Yes/No)

The motivation for these default settings comes from learnability consideration. Under the assumption that only positive evidence is used to set parameters, learners have to adopt the smallest grammar (i.e., one that generates the least number of structures) that is consistent with the input data, or else they may erroneously adopt an overgeneralized grammar from which they will not be able to retreat (Wexler and Manzini 1987). This Subset Principle states that the default setting for (3a) must be 'Yes', the setting that gives a smaller grammar which allows only syllables with an onset. If the target language happens to allow syllables both with and without an onset, exposure to an onsetless syllable gives sufficient positive evidence to reset the parameter to the 'No' setting. Suppose, conversely, that the child starts off with a 'No' setting for (3a), which allows the developing grammar to generate syllables with or without an onset, but the target language happens not to allow onsetless syllables. In this case, the syllables in the input data (all with an onset) do not contradict the current setting of the parameter, and therefore, never induce a reset of the parameter to the correct 'Yes' value. The same argument motivates the default setting of (3b) to 'No' (which bans consonant clusters in the onset), rather than 'Yes' (which permits onset clusters).

The default setting hypothesis receives sup-
port from empirical data. Fikkert (1994) provides evidence for an initial stage in child Dutch during which children disallow onsetless syllables, e.g., /o:to/ ('car') [ta:to:], /a:pi:/ ('monkey') [ta:pi:]. The non-branching default for onset is consistent with the widely attested reduction of onset clusters children exhibit when learning a language that contains clusters.

There is a noticeable increase of continuity assumed in the development in this approach compared to the models reviewed in the previous sections. In particular, this model tacitly assumes that the architecture of a mature grammar is present from the onset of the acquisition for all intents and purposes. The same computational devices (principles and parameters) that make up a mature grammar are credited to the child. More importantly, the grammar is seen to be complete in the sense that the pattern observed in the child’s output is the product of the well-formedness criteria of the developing system, rather than just a mapping from the adult forms.

Since principles and parameters operate on structural units, this approach also assumes representational continuity. Many advances have been made in theories of phonological representation since the 1970s when Smith’s (1973) and Stampe’s (1979) models were proposed, and the set of phonological units credited to child systems has expanded to include prosodic categories such as syllables and feet.

An interesting comparison can be made between Principles-and-Parameters and Natural Phonology with respect to compositional continuity. In a parametric approach, the full set of parameters is hypothesized to be present throughout development, and changes only occur in their settings. In that sense, this model is more continuous than Natural Phonology. However, what is gained in continuity in the Principles-and-Parameters approach is lost in the encoding of markedness in the developmental account. In Natural Phonology, a grammar that suppresses a process is intrinsically marked in the sense that it allows a state that goes against phonetic naturalness. Thus, the model captures the course of phonological acquisition as a process of overcoming the physical or cognitive forces that define the unmarked state of human phonological systems. In a parametric approach, however, a non-default option is marked only in the sense that it generates more structures, but the unnaturalness of the added structure does not directly follow from the inherent properties of parameters. In that sense, the motivation behind markedness is less visible in the parametric approach.

5. Optimality Theory

In Optimality Theory (OT; Prince and Smolensky 1993), all phonological systems consist of a universal set of violable constraints. Some of these constraints demand certain structural configurations in the output form, effectively making them statements of markedness. For example, the markedness constraint *COMPLEX bans onset or coda clusters. Other constraints ensure identical mapping between two representations. Examples of such faithfulness constraints include MAX-IO, which requires that every segment in the input correspond to some segment in the output, thus banning segment deletion; and DEP-IO, which requires that every segment in the output correspond to some segment in the input, thus mitigating against epenthesis. There is much conflict in the demands of these constraints, which is resolved by the prioritization of the constraints specified in each language. The grammar evaluates an infinite number of output candidates, and selects as the actual output the most harmonic candidate with respect to the language-specific ranking of constraints.

In OT-based models of phonological acquisition, just as end-state grammars share the same set of constraints, developing grammars are also hypothesized to contain all the same constraints. Most researchers subscribe to the position that the child starts off with a constraint hierarchy that ranks all markedness constraints above faithfulness constraints (Gnanadesikan 1995, Smolensky 1996a, Pater 1997). The reasoning behind this initial-state hypothesis is similar to the learnability consideration discussed in rela-
tion to the default setting of parameters. Re-ranking a markedness constraint below a relevant faithfulness constraint is possible with positive evidence but re-ranking a faithfulness constraint below a relevant markedness constraint is not (Smolensky 1996a). According to this view, the markedness constraints and two faithfulness constraints mentioned above are ranked as *COMPLEX > MAX-IO, DEP-IO in early child grammar. As (4) illustrates, this ranking maps an input form with an onset cluster to a clusterless structure either by deletion or epenthesis, depending on the relative ranking of MAX-IO and DEP-IO.

(4) A partial initial state hierarchy of constraints

<table>
<thead>
<tr>
<th>Input: trai</th>
<th>*COMPLEX</th>
<th>MAX-IO</th>
<th>DEP-IO</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. trai</td>
<td>!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. tai</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. tVrai</td>
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</tbody>
</table>

This analysis predicts that in early child phonology, complex onsets do not surface and at least two different types of strategy should be adopted in order to avoid clusters. The prediction is supported in child English and child Dutch where we see both deletion and epenthesis applied to target words with a cluster, as illustrated by the examples in (5).

(5) Epenthesis and deletion in clusters

a. Child English: ‘snow’ [so], ‘dwarf’ [dɔːwarf] (Gnanadesikan 1995);
b. Child Dutch: /bru:k/ (‘trowsers’) [buːk]; /kloːk/ (‘clock’) [koːk], [koːlkoː]; /trap/ (‘stairs’) [tɔːrap] (Fikkert 1994)

Development in this model is the process of re-ranking the constraints toward the target hierarchy. Children acquiring languages such as English and Dutch, which allow clusters, demote *COMPLEX below MAX-IO and DEP-IO. Children acquiring languages such as Japanese and Korean, which disallow clusters, do not change the ranking between *COMPLEX and the faithfulness constraints, although the ranking MAX-IO > DEP-IO will be established, arriving at a grammar that avoids clusters through epenthesis, as seen in the adaptation pattern of loanwords. The results of these re-ranking processes are illustrated in (6) and (7).

(6) Constraints ranked to English-type hierarchy

<table>
<thead>
<tr>
<th>Input: trai</th>
<th>MAX-IO</th>
<th>DEP-IO</th>
<th>*COMPLEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. trai</td>
<td></td>
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<td>*</td>
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<tr>
<td>b. tai</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>c. tVrai</td>
<td></td>
<td>*</td>
<td></td>
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</tbody>
</table>
(7) Constraints ranked to Japanese-type hierarchy

<table>
<thead>
<tr>
<th>Input: trai</th>
<th>*COMPLEX</th>
<th>MAX-IO</th>
<th>DEP-IO</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. trai</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. tai</td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>c. tVrai</td>
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</tbody>
</table>

OT allows modeling of phonological acquisition as a fully continuous process in all aspects. The representational units can be assumed to be present from the beginning so that constraints such as ONSET, which presume the relevant structure, are applicable even at the initial stages of acquisition. The learning process is seen to begin with a fully mature architecture of the grammar and a complete set of universal constraints, whose ranking is the only locus of changes that occur during the development. We note that the constraint ranking in (4), or more specifically, *COMPLEX » DEP-IO » MAX-IO, essentially gives rise to the same effect that is captured in Smith’s (1973) rule in (1). But while Smith had to stipulate a complex rule that is unique to child phonology, there is nothing child-specific about (4) in the sense that the constraints and mechanisms of well-formedness evaluation are exactly the same as in any adult grammar, some of which in fact would even have the same constraint ranking as (4).

The idea that markedness constraints are demoted in the process of phonological acquisition formally reinstates the claim of Natural Phonology that processes are ‘suppressed’ in some adult systems. However, OT-based models of acquisition push the full continuity assumption a step further in maintaining that markedness constraints are always present in the hierarchy even if their effects become non-apparent due to demotion. To illustrate this point using (6) as an example, consider the question of whether *COMPLEX plays any role in a grammar that allows onset clusters. The outcome of ranking *COMPLEX below MAX-IO and DEP-IO does not seem to be different from removing it from the hierarchy in (6) altogether. However, there are arguments in support of the analysis that *COMPLEX should remain in the hierarchy even when children stop to reduce target clusters. One such argument comes from languages such as Sanskrit in which onset clusters are admitted generally, but banned in cases of reduplication: e.g., sna: → sa-sna; prach → pa-prach (Gnanadesikan 1995). As the reduplicant is related to the base, the constraint that ensures that all segments in the base be mapped onto the reduplicant (MAX-BR) must be outranked by *COMPLEX. At the same time, *COMPLEX must be ranked below MAX-IO and DEP-IO, as the language does allow onset clusters otherwise. The effects of this ranking are demonstrated in (8) and (9).

(8) Non-reduplicated words in Sanskrit

<table>
<thead>
<tr>
<th>Input: sna:</th>
<th>MAX-IO</th>
<th>DEP-IO</th>
<th>*COMPLEX</th>
<th>MAX-BR</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. sna:</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
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<tr>
<td>b. sna:</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
<tr>
<td>c. sana:</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

— 42 —
The ranking in (8) shows how an underlying CCV form normally surfaces with a cluster in this language. The effects of *COMPLEX are invisible because the markedness constraint is outranked by MAX-IO and DEP-IO. In (9), however, *COMPLEX incurs its effects on the output form of the reduplicant by virtue of being ranked above MAX-BR. This analysis incorporates the continuous role of markedness throughout language development more effectively than does the Principles-and-Parameter type approach, in which restrictions on phonological forms are essentially ‘turned off’ in an all-or-nothing fashion during the course of acquisition (Pater 1997).

Moreover, this general approach allows to relate some seemingly unrelated properties in child and adult phonology through the effects of general markedness constraints shared between the systems. Thus Pater (1997) demonstrates that three basic markedness constraints (PARSE-SYLLABLE, FOOT BINARITY and ALL-FEET-LEFT) that are responsible for the basic stress pattern in adult English also give rise to the frequently attested disyllabic upper size limit of early word production (e.g., banana [bana]) if ranked above relevant faithfulness constraints. Similarly, Ota (2001, in press) argues that the same three markedness constraints not only underlie prosodic morphological operations in adult Japanese, such as hypocoristics and renyouokei reduplication, but also explain Japanese-speaking children’s tendency to lengthen monomoraic words (e.g., /me/ ‘eye’ [me:]) and truncate multisyllabic words (e.g., atama ‘head’ [a:pa]). As these examples show, the view that the same markedness constraints (and their interaction with faithfulness constraints) govern any developing or mature phonological system provides a principled account of the connection between child phonology phenomena (which seem to deviate from the target adult phonology though in a systematic way) and the acquisition of the target adult phonology (which differs from language to language, though again in a systematic way).

6. Issues and future directions

The historical overview presented above shows that theories of phonological acquisition developed within generative phonology have integrated many mechanisms to implement full continuity in their models. This has been achieved mainly by incorporating the results of theoretical research exploring more principled ways to account for language variation (e.g., parameters, constraint ranking) and the role of markedness (e.g., processes, markedness constraints). In the recent OT-based model, this possibility seems to be pushed to its conceptual limit, allowing full continuity to be assumed in the architecture, representation and composition of the grammar through the re-ranking of universal constraints that operate on adultlike representations. That this is theoretically possible is by no means tantamount to saying that such an approach is correct, and we are reminded that the question of developmental continuity cannot after all be answered without investigating the relevant empirical issues. Keeping this point in mind, I would like to discuss several unresolved issues which are important keys to our further understanding of developmental continuity.

The first question relates to the characterization of phonological patterns observed in
child language. The assumption that has driven much of the phonological acquisition research in the past few decades is that analogues of child-like process are to be found in mature phonological systems, and therefore related in some crucial ways. For example, in almost all theories, developmental phenomena such as cluster reduction and the loss of voicing in final consonants are associated, respectively, with the ban of clusters and final devoicing in certain adult languages. Natural Phonology and OT explicitly link both phenomena to the same ‘(natural) processes’ or markedness constraints. However, this putative comparability between child and adult patterns does not extend to all phenomena. Some of the exceptions are only a matter of tendency. Thus, Drachmann (1976) points out that ‘stopping’ or the fortification of target fricatives is more common than spirantization of stops in child language, while the reverse is true for adult language. In other cases, however, a common child language phenomenon seems to lack a clear adult analogue. The most well-known case is consonant harmony of the type illustrated in (10), a process frequently observed in the speech of 2-year-old children, in which non-adjacent consonants assimilate in place.

(10) Consonant harmony in child language
(Ingram 1974; Cruttenden 1978)

a. dog [gɔk]
b. take [kek]
c. spoon [bum]
d. birdie [bɔ:bi]

Non-local consonant harmony is extremely rare in adult language, and the known cases are quite restricted in their context (e.g., palatality agreement in Chumash; Poser 1982). Such a mismatch can be overcome within a partially continuous model, for example by appealing to a child-specific constraint that demands place agreement between consonants (Pater 1997) or even within a fully continuous model, for example by employing only general constraints motivated for adult phonology (Goad 1997). But besides such analytical exploration, the question that must be addressed is whether all child language patterns are to be considered objects of formal phonological study. It is very likely that apart from processes that are essentially comparable to adult phonological patterns, child language displays phenomena that are more suitably explained in terms of lack of motor control skills or perceptual abilities. Cases such as these, therefore, raise the question of what types of data are to be accounted for in a theory of phonological acquisition.

A second, somewhat related, issue concerns the status of different types of phonological generalizations found in adult language. Recall that Natural Phonology separated out patterns that lack synchronic phonetic motivations from patterns that are phonetically grounded. Such a distinction is not assumed in recent generative theories, including OT. Yet, just as the case of child language patterns that lack analogues in adult language, adult patterns that are language specific and arbitrary may need to be treated separately in investigating developmental continuity. Take for example the case of /b/ - /h/ alternation in modern Japanese that recurs in a variety of morphological contexts.

(11) /b/-/h/ alternation

a. reduplication:
   huka-buka (‘deeply’), hito-bito (‘people’)
b. rendaku (sequential voicing):
   se ‘back’ + hone (‘bone’)
      \rightarrow sebone (‘backbone’)

This is known to be the product of historical change that turned old Japanese /pl/, which alternated with /b/, to /h/ via /fl/ (Shibatani 1990). In the modern context, however, the alternation has lost its phonetic motivation and fails to receive a straightforward feature-based analysis. While one can presumably draw up a formal analysis of the data in (10) by ranking universal constraints, the lack of synchronic motivation in the alternation strongly cautions against relating the pattern with general child language phenomena through developmental constants.

Finally, one aspect of phonological acqui-
sition that has not yet been adequately addressed is the development of lexical representation. In models based on SPE and Natural Phonology, the child’s underlying form was derived from the adult surface form with the necessary conversion to feature-level representation. Although subsequent phonological acquisition models have a dramatically different look, this is an area that has not seen much change, with some recent OT analyses still making basically the same assumption (e.g., Smolensky 1996b, Pater 1997). However, it is not well understood how child lexical forms that mirror adult surface forms develop into more abstract underlying representations that are often assumed in generative analysis and whether a continuous model can be adopted to explain the transition. With the emergence of theories of lexico-phonological representation that do away with the notion of underlying representation (e.g., Burzio 2000, 2002, Bybee 2001), this may be another area in which advances in phonological theory bring about a paradigm shift in modeling phonological development.

These are some of the many questions that must be further investigated in order to better understand how to model phonological acquisition in relation to the properties of end-state grammar. Developments in phonological theory have provided acquisition theory with conceptual frameworks that allow construction of a fully continuous model, but to what extent those mechanisms should be exploited is a decision acquisition theorists must make based on future empirical research.

3) All the discussions of representation given so far are related to the surface representations.

References


Notes

1) Later, Smith (1978) concedes the possibility that the child’s perception is not always perfect and the adult surface form and the child lexical form may be mediated by a perceptual filter.

2) Parse-Syllable requires that all syllables be parsed into feet. Foot Binarity states that feet must be binary, i.e., either bimoraic or disyllabic. All-Foots-Left demands that all feet be located at the left edge of a prosodic word.

— 45 —


Smolensky, Paul (1996a) *The Initial State and 'Richness of the Base' in Optimality Theory*. Baltimore, Maryland: Johns Hopkins University. Ms.


