

ACQUISITION OF PHONOLOGY

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A diversity of issues informs work in the field of phonological acquisition, as it encompasses both first (L1) and second (L2) language acquisition examined by researchers in linguistics, psychology, speech-language pathology and language education. In L1, there are questions such as how the acquisition of phonology interfaces with perceptual and motor development (Locke 1993); and how an examination of disordered development can illuminate the normally-developing grammar (Bernhardt and Stemberger 1998, Dinnsen 1999). In L2, there are questions as to whether the acquisition process is fundamentally like L1 acquisition (Flege 1995), or whether L2 grammars are in some sense impaired due to, for example, L1 constraints which impede native-like attainment (see Brown 1998 on perception).

Due to space constraints, this chapter will focus on L1, although many of the same issues arise for L2. The acquisition of phonology will be examined from the perspective of *Generative Grammar*; thus, a principal theme will be to examine how acquisition research has used linguistic theory to inform development. This theme considers the starting hypothesis to be that children's productions are largely system-driven: acquisition research strives to understand the system that relates children's stored representations to their productions, and to formalize the developmental paths that children follow.

Children's Grammars as "Possible" Grammars

The focus of research on phonological acquisition is on the shapes of early grammars in the segmental and prosodic domains; thus, it parallels research on end-state (adult) grammars. (Segmental phonology is concerned with individual speech sounds; prosodic phonology, with larger units including syllables and feet (see below).) There is typically a comparison drawn between the shapes of developing grammars and some end-state grammar. Order of emergence of segmental (Dinnsen 1992) and prosodic complexity (Fikkert 1994, Levelt et al. 1999/2000), and error patterns observed in the segmental and prosodic domains, whether these patterns are expressed through rules (Smith 1973, Ingram 1974), templates (Macken 1992, Fikkert 1994) or constraints (Pater and Barlow 2003, Goad and Rose 2004), are all considered in relation to some adult grammar.

One exception is a body of research which views children's grammars as self-contained systems subject to their own constraints (Stoel-Gammon and Cooper 1984, Vihman 1996). This research program developed in response to the observation that children's grammars are not simply "reduced" versions of the target grammar; indeed, variation across learners is rampant (Ferguson and Farwell 1975).

While children's grammars may be self-organizing in that they contain processes not present in the target language, they can still be viewed as "possible" grammars (White 1982, Pinker 1984) if these processes have correlates in other adult languages. The notion "possible" grammar thus requires that, at each stage, children's grammars respect the constraints of adult grammars, even if they bear little resemblance to the target system. In *Optimality Theory* (OT) (Prince and Smolensky 1993/2004), for example, alternate routes observed across learners, as well as stages in the development of a single learner, are

viewed from the perspective of the typological options that adult languages display: both are accounted for by different rankings of the same constraints.

Markedness

Although children take different paths to the adult grammar, early phonologies are also strikingly similar (Jakobson 1941/68). As Jakobson emphasizes, these similarities reflect cross-linguistically unmarked properties. *Markedness* constrains the shapes of linguistic systems such that less complex properties are favored. For example, there is a well-documented preference for CV syllables among children (Ingram 1978; cf. Grijzenhout and Joppen-Hellwig 2002); this is also a syllable shape that no end-state grammar forbids (Jakobson 1962). Since unmarked patterns are systematically observed across learners, one might reasonably infer that they reflect early grammatical organization. However, markedness has not always been well-integrated into the theory of grammar (as part of the theory of representations or formulation of rules/constraints). This begs the question of whether markedness should instead be part of the theory of acquisition, which interfaces with but is independent of the theory of grammar.

An advantage of OT is that the formal devices for expressing phonological generalizations include a set of markedness constraints. Most researchers have proposed that learners begin acquisition with a ranking where markedness constraints dominate faithfulness (which favor identity between inputs (stored representations) and outputs) (e.g., Demuth 1995, Gnanadesikan 1995/2004, Smolensky 1996, Pater 1997, Ota 2003; cf. Hale and Reiss 1998). Throughout development, constraints are reranked to yield more marked outputs. However, many paths can be followed, as there are many options for what to rerank. Thus, the idea that grammars are initially unmarked is not inconsistent with their being self-organizing.

Perception versus Production

Most work in phonological acquisition has focused on production; indeed, researchers typically assume that children accurately perceive the ambient input. This is due, in part, to the observation that pre-linguistic infants can perceptually discriminate perhaps all contrasts exploited by the world's languages (Eimas et al. 1971, Werker et al. 1981). This ability largely declines by age one (cf. Best et al. 1988), coinciding with a reorganization of perceptual categories according to what is contrastive in the target language (Werker and Tees 1984). As children start to speak around age one, it would appear that perception is complete by the onset of production.

Research on phonemic perception, which requires the ability to form sound-meaning pairings, has challenged this view (Shvachkin 1948/73, Edwards 1974, Brown and Matthews 1993). Although experiments examining minimal contrasts between native-language sounds have revealed that perceptual development is mostly complete by age two, some contrasts develop as late as three. Even age three is probably conservative because, for consonant perception, this research has focused almost exclusively on word-initial position. Since contrasts in other positions are harder to discriminate, many non-target patterns that children's productions display could reflect perceptual miscoding, rather than production constraints (Macken 1980).

If perception and production both reflect aspects of children's *Competence*, both must be included in the grammar (cf. Hale and Reiss 1998). However, the time lag observed (production trails perception) has suggested to some researchers that they form independent (interacting) grammatical modules (see Menn and Matthei 1992). This approach, though, cannot predict that perception and production abilities develop in a similar order. The latter favors the postulation of a single grammar *if* the time lag can be built in. In Pater (2004), this is accomplished by introducing perception-specific faithfulness constraints into OT.

As shown in (1), at Stage 1, both perception-specific faithfulness (F-perc) and general faithfulness (F) are outranked by markedness (M). The result is unmarked forms stored in perception and uttered in production. In the example provided, the ambient form [əwei] ‘away’ undergoes truncation of the “pre-tonic” syllable (an unstressed syllable immediately preceding a stressed syllable) in both components of the child’s grammar; accordingly, words of this shape are perceived and produced without this syllable.

Ambient Form:	Stage	Grammar:	Stored Form:	Grammar:	Produced Form:
[əwei]	1	M >> F-perc, F	/wei/	M >> F-perc, F	[wei]
	2	F-perc >> M >> F	/əwei/	F-perc >> M >> F	[wei]
	3	F-perc, F >> M	/əwei/	F-perc, F >> M	[əwei]

At Stage 2, the child’s perceptual abilities become more target-like (i.e., he/she learns to correctly identify information in the ambient language); this indicates that the relevant markedness constraints have been demoted below perception-specific faithfulness. General faithfulness is still outranked, yielding a mis-match between what the child perceives and what he/she produces. At Stage 3, markedness is demoted below general faithfulness, and the form is correctly produced. The perception-production time lag results because forms that are correctly perceived at Stage 2 are not correctly produced until Stage 3.

Phonological Theory and Phonological Acquisition

As the preceding discussions reveal, research in phonological acquisition has been directly impacted by thinking in generative phonology. Modern generative phonology began with Chomsky and Halle’s (1968) *Sound Pattern of English* (SPE). Although more recent work has situated the shapes of developing grammars within the typological range manifested by adult systems, this was less the case in the SPE-based literature. Much of this work used SPE as a tool only, in part because, with the formal apparatus employed by the theory, it was difficult to constrain what a possible grammar is, developing or end-state. And although the theory contained an evaluation metric to guide learners in selecting the most highly valued among descriptively-adequate grammars, rules for unattested processes were as easy to formalize as rules for commonly-attested processes. Finally, SPE contained no workable theory of markedness and, thus, children’s grammars could not be considered relative to some notion of optimal.

To facilitate a comparison between SPE and later theories, we draw on truncation, further exemplified in (2) from Amahl (age 2.60) (Smith 1973) ([B,G] are voiceless unaspirated lenis stops). (The discussion focuses on the stage when perception is target-like and truncation is restricted to production.)

- (2) [ɛ:p] ‘escape’
[bɑ:nə] ‘banana’

In SPE, every deviation from adult forms required one or more rules, so there was little in common between the rule sets for developing and target systems. To capture truncation, Smith (1973) provides the rules below, neither of which operates in the adult grammar.

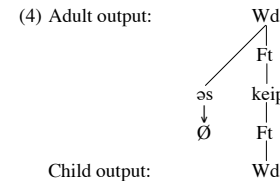
(3) R14: $V \rightarrow \emptyset / \# (C) \begin{matrix} \text{_____} & C & V \\ [-\text{stress}] & [+ \text{stress}] \end{matrix}$

R16: $[+\text{sonorant}] \rightarrow \emptyset / [+ \text{consonantal}] \text{_____}$

R14 deletes initial vowels in words like ‘escape’. For consonant-initial forms like ‘banana’, the result is [bɑ:nə] which then undergoes R16, yielding [bɑ:nə].

Since SPE employed linear representations, the theory did not offer any insight into why pre-tonic rather than post-tonic syllables delete (‘escape’ → [ɛ:p], but ‘tiger’ → [gɑiɔ], *[gɑi(g)]). The development of non-linear phonology (see Goldsmith 1985 for an overview), notably the move to highly-articulated prosodic representations, led to significant breakthroughs in understanding this asymmetry. In trochaic languages, where the foot (the rhythmic unit in which stress is assigned) is left-headed (stress-initial), ‘escape’ cannot form a single foot, [əs(kéip)]_{Ft}Wd, whereas ‘tiger’ can, [(táigə)]_{Ft}Wd.

Much work in non-linear phonology has explored the idea that prosodically-defined templates constrain output shape (McCarthy and Prince 1995). Fikkert (1994) proposes that templates, which at early developmental stages reflect what is unmarked, are responsible for truncation. If the child’s productions are limited to one foot, circumscribed from the adult output, this template will determine which material is preserved from the adult form and which is deleted:



In contrast to SPE, non-linear phonology reveals the relationship between target and truncated forms, and the role that markedness plays in shaping outputs. The material inside the foot survives, as syllables organized by feet ([keip]) are less marked than those linking directly to the word ([əs]). One problem with the templatic approach, however, is that it is too rigid: if the segments predicted to survive are precisely those delimited by the constituent that serves to organize them in the adult form, it becomes difficult to capture the observation that material from the truncated syllable can also survive. For example, in Amahl’s pronunciation of ‘banana’ in (2), onset selection favors [b], replacing [n] from the stressed syllable; that is, his production is [bɑ:nə], not *[nɑ:nə] as expected from adult [bɑ:(nɑ:nə)]_{Ft}Wd (see Kehoe and Stoel-Gammon (1997) for other problems with the templatic approach).

This problem is rectified in OT. First, there are no templates; templatic effects arise from the interaction of markedness constraints. Second, segmental content (e.g., labial preservation) is the responsibility of faithfulness constraints. Finally, all constraints are inter-ranked; thus, the co-occurrence of truncation and onset selection is not unexpected (see Pater 1997).

To illustrate, concerning truncation, the constraint PARSESYLLABLE (syllables are parsed into feet), along with other markedness constraints, must be satisfied at the expense of the lower-ranked faithfulness constraint MAX-IO (every segment in the input has a correspondent in the output). Fully faithful (5a) is thus eliminated because the initial syllable is unfooted. Concerning onset selection, MAX[labial]-IO (every [labial] in the input has a correspondent in the output) must be ranked over I-CONTIGUITY (the portion of the input standing in correspondence forms a contiguous string). Preservation of [labial] in ‘banana’ will thus be favored, (5c), even though the result violates I-CONTIG through morpheme-internal deletion.

	PARSESYLL	MAX[lab]-IO	MAX-IO	I-CONTIG
a. [bə(na:nə) _{F1}] _{Wd}	*!			
b. [(na:nə) _{F1}] _{Wd}		*!	**	
c. [(ba:nə) _{F1}] _{Wd}			**	*

OT has had a major impact on acquisition research. Phonological processes are now generally expressed through constraints rather than rules as this provides a better conceptualization of the observation that markedness shapes early grammars. As discussed, children's productions become more target-like when markedness constraints are demoted below faithfulness. A similar idea, that development is best viewed as the gradual relaxing of constraints, had been proposed earlier (Stampe 1969, Menn 1980), but it was difficult to formally implement this in the rule-based frameworks of the time.

OT seems to provide an appealing view of the initial state and of development; researchers can address important questions such as how the theory may restrict what a possible developing grammar is and how, in turn, data from development may inform the theory. However, this is not to say that OT has solved all problems in phonological acquisition. One understudied problem is rogue behavior. We have been assuming that children's grammars are "possible" grammars, thereby ignoring the fact that some commonly-attested processes, notably consonant harmony (CH), have no adult analogs (Drachman 1978). In CH, consonants share place over vowels of any quality (Vihman 1978), as seen in (6) for Amahl (age 2.60) (Smith 1973).

(6) [gaigə]	'tiger'
[gɔ:k]	'stroke'

Some recent accounts of CH (Goat 1997, Rose 2000) incorrectly predict that the process should be attested in adult grammars; others (Pater 1997) appeal to child-specific constraints, thereby challenging the notion that children's grammars are "possible" grammars. Neither of these approaches questions whether CH is truly grammar-driven nor addresses, more generally, what criteria should factor into the determination of what is grammar-driven and what is not. I leave these questions to future work.

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