Variation and Emerging Faithfulness in Phonological Acquisition

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1. Introduction

Variation is acknowledged to be a hallmark of developing systems and thus remains one of the central concerns of theories of phonology and acquisition. Many different types of variation have been identified, being attributed to a wide variety of factors and theoretical constructs, including (but not limited to) phonological context (Dinnsen 1999), task demands (Leonard, Rowan, Morris & Fey 1982), underspecification (Rice 1996), optional rules (Braine 1976), and stratified domination hierarchies (Demuth 1997). A further type of intra-word variation seems to have been overlooked or ignored. In particular, children often substitute [θ] for /s/ ([θup] *soup*), but these same children may realize target /s/'s correctly in the same position within a morphologically related word ([supi] *soupy*). Other children do just the reverse ([sup] but [θupi]). Such variation is theoretically problematic for several reasons. First, the presence versus absence of an affix appears to condition the alternation, even though the affected segments are not adjacent to the putative trigger. Also, given that the trigger has the reverse effect for different children, there can be no inherent relationship between the affix and the error pattern. To claim that such variation is 'optional' only denies the systematic character of the alternation within a given child's system. Optimality theory with its different types of correspondence relations (e.g. McCarthy & Prince 1995; Benua 1997) offers some insight to this problem and a possible solution.

The purpose of this paper is two-fold: (a) to document this sort of variation within and across children, and (b) to formulate an optimality theoretic account and typological characterization of the variation. Representative case studies illustrating different instances of the typology are presented from a larger archival investigation of children with phonological delays (ages 3;4 – 6;8). For more details about the individual cases considered here, see Dinnsen & Barlow (1998). The paper is organized as follows: In §2, data are presented from one child who produced /s/ and /z/ correctly in base words but substituted [θ] and [ð] in derived words. It will be argued that such a case constitutes 'emergence of the unmarked' in that an IO (input/output) faithfulness constraint must outrank an antagonistic well-formedness constraint which in turn must outrank an OO (output/output) faithfulness constraint. An important element of the account is

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that morphologically complex words are formed from a 'base' plus an affix. An alternative development is illustrated by another child in §3 where /s/ and /z/ were also produced correctly, but under different circumstances ([θup] and [supi]). Such cases are theoretically more challenging but are argued to require an exploded IO faithfulness constraint which competes with well-formedness. Importantly, a different morphological account is also shown to be implicated. The typology is further exemplified in §4 by considering data from these same children at an earlier stage of development where /s/ and /z/ were consistently replaced by [θ] and [ð] without variation ([θup] and [θupi]). It will be argued that this is consistent with general characterizations of early stages of development where well-formedness constraints outrank faithfulness. In §5, adult English with intact /s/'s and /z/'s in both base and derived words is argued to represent a further instance of the typology with the faithfulness constraints outranking well-formedness. In the concluding section, this typology is argued to be suggestive of a developmental progression involving an interplay of morphology and constraint rankings. Intra-word variation of this sort is thus shown to be the predicted result of morphological development and the differential ranking and promotion of independent faithfulness constraints.

2. Variation attributable to emergence of the unmarked

The data in (1) are from Subject 15 (age 5;1) and illustrate one instance of the typology. It can be observed that target /s, z/ are produced correctly in simple, nonderived base forms of nouns and verbs. In the morphologically more complex derived forms of the same words, however, /s/ and /z/ are replaced by [θ] and [ð], respectively. The occurrence of different suffixes (including diminutive, adjectival and progressive morphemes) appears to trigger the substitution error. This might seem surprising since the presumed trigger is not always immediately adjacent to the substitute. That is, the variation is evident even in nonlocal word-initial contexts (1A). Of course, the alternation also occurs at the more conventional juncture of morphemes (1B).

(1) Subject 15 (5;1)

A. Base:	Derived:	Gloss:	B. Base:	Derived:	Gloss:
s̪ʌn	θʌni	sun	dwɛs̪	dwɛθi	dress
sup	θupi	soup	aɪs̪	aɪθi	ice
s̪op	θopi	soap	dʒus	dʒuθi	juice
s̪ak	θaki	sock	woz	woði	rose
stov	θtovi	stove	noz̪	noði	nose
s̪wip	θwipiŋ	sweep	tʃiz̪	tʃiði	cheese
swɪm	θwɪmɪn	swim	bʌz	bʌðɪŋ	buzz

A functional account might simply attribute the variation to the relative difficulty of producing a late-acquired (hard) sound in simple versus complex words. Thus, errors are to be expected in more complex words. In lexical phonology terms, it might be suggested that the presumed neutralization rule is not permitted to apply in base words because of nonderived environment blocking but is applicable in more complex words because a derived environment has been created through the morphology. This would, however, entail a rather different interpretation of what constitutes a derived environment. While these approaches might seem plausible (even attractive), any such account must be reconciled against other cases showing the opposite effect as will be seen later in this paper.

Typical characterizations of children's error patterns within optimality theory have assumed adult-like representations with well-formedness constraints ranked above faithfulness (e.g. Gnanadesikan 1996; Barlow 1997). Correct realizations, on the other hand, are attributed to the opposite ranking. The co-existence of correct and incorrect realizations, as in this case, would seem to require something from each such characterization. A constraint-ranking paradox can be avoided with the constraints and ranking in (2).

(2) Constraints

IO FAITH:	Every segment and every feature in the input must have a correspondent in the output.
*S:	Avoid strident coronal fricatives.
OO FAITH:	Every segment and every feature of the base must have a correspondent in the output.
Ranking:	IO FAITH >> *S >> OO FAITH

IO FAITH is a generalized family of faithfulness constraints which demands that input segments and features be preserved in corresponding outputs. *S is a specific well-formedness constraint which disfavors the occurrence of the relatively marked, late-acquired strident coronal fricatives /s, z/ for many children. The interdental substitutes are also acknowledged to be late-acquired for many children, but their occurrence for these children is apparently preferred over their strident counterparts (cf. Dinnsen & Barlow 1998). OO FAITH differs from IO faithfulness constraints by focusing on the correspondence relation between output candidates, as has been employed, for example, in the characterization of various reduplication and truncation phenomena (Benua 1997; McCarthy & Prince 1995). The difference between these two types of faithfulness constraints is revealed in this instance through their interaction with the well-formedness constraint in different word formation processes.

The tableau in (3) illustrates the undominated effect of IO FAITH in the formation of morphologically simple base words such as *soup*. Candidate (b) with an initial /θ/ complies with the well-formedness constraint *S but fatally violates the undominated faithfulness constraint demanding that input /s/ be realized in the output. The faithful candidate (a) is thus optimal.

(3) Base words formed from input representation

/sup/	IO FAITH	*S	OO FAITH
a. ☞ sup		*	
b. θup	*!		

On the other hand, the tableau in (4) illustrates the dominance of a well-formedness constraint in the formation of morphologically related but more complex derived words such as *soupy*. An important element of our account is the claim that such words are formed from a 'base' plus an input affix rather than from a string of conventional input segments or morphemes. What serves as the base is an occurring output candidate (not an input), which is independently determined from the interaction of constraints as in (3). It happens in this instance that the base and its corresponding input are segmentally identical. However, since the input of a base is not directly relevant to the formation of derived words, neither of the two likely candidates incurs a violation of undominated IO FAITH. Both are equally good, passing the choice down to the lower ranked well-formedness constraint militating against /s/. Candidate (a) with target appropriate /s/ incurs a fatal violation of *S and is thus eliminated in favor of candidate (b) with [θ]. We know in this instance that *S must be ranked above OO FAITH because if they were unranked relative to one another, derived words would be predicted to freely vary between correct and incorrect realizations. Base words would occur correctly without variation. It is thus more important in this case to avoid /s/ in derived words than it is to preserve the correspondence between outputs. Put another way, while /s/ is disfavored as an output correspondent of a base, it is preferred as an output correspondent of an input. Such cases constitute a classic example of 'emergence of the unmarked' (McCarthy & Prince 1995). That is, an otherwise dominated well-formedness constraint emerges as decisive in selecting a candidate under certain circumstances.

(4) Derived words formed from /Base + affix/

Base: [sup] Input: /Base + i/	IO FAITH	*S	OO FAITH
a. supi		*!	
b. ☞ θupi			*

3. Variation attributable to exploded faithfulness

A rather different situation is illustrated by the data in (5) from Subject 33 (age 6;6). It can be observed that /s/ and /z/ are produced correctly only in the more complex derived forms of words. Since it is the morphologically simple

base words that are produced in error, it does not appear that derived words can be formed from a base plus an affix, as was the case for Subject 15 above. No ranking of the constraints as formulated above could achieve the observed effects in this case with the same morphological assumptions.

(5) Subject 33 (6;6)

A. Base:	Derived:	Gloss:	B. Base:	Derived:	Gloss:
θʌn	sʌnɪ	sun	dreθ	dresɪ	dress
θup	supɪ	soup	aɪθ	aɪsɪ	ice
θoup	soupɪ	soap	bʌθ	bʌsɪ	bus
θtouv	stouvɪ	stove	nouθ	nouzɪ	nose
θtar	starɪ	star	nɔɪð	nɔɪzɪ	noise
θnou	snouwɪŋ	snow	tʃiθ	tʃizɪ	cheese
θwip	swipiŋ	sleep			

The solution appears to require both a reconsideration of IO FAITH and a different assumption about the morphology of derived words. On the first point, if IO FAITH were exploded to expose different instances of the constraint, a well-formedness constraint could be interwoven into the ranking to account for the differential behavior of base and derived words. Such an account is sketched in (6). The generalization appears to be that /s/ and /z/ are produced correctly only in stems of morphologically complex words; the same stems of morphologically simple words are produced in error. This sensitivity to morphological structure shows at least that words are analyzable as a string of morphemes. The existence of morphological structure allows the generalization here to be expressed directly by a specific instance of IO FAITH, namely IO FAITH[M-C], which is understood to define a subset of all input strings. This more specific instance of IO FAITH would preserve properties only of *morphologically complex* input strings, namely those composed of a stem plus an affix. The substance of this constraint is in line with other proposed morphological and contextual restrictions found in faithfulness constraints (e.g. Beckman 1997; Benua 1997) and avoids appeal to certain other types of correspondence relations, e.g. sympathy (McCarthy 1997) or Input/Reduplicant correspondence (McCarthy & Prince 1995). The more general IO FAITH would remain operative as the 'elsewhere' case of faithfulness and is naturally ranked below the more specific case. This ranking achieves the desired result by claiming that it is more important to preserve input properties of morphologically complex words than it is to preserve the same properties in morphologically simple words. The crucial morphological assumption here is that base and derived words are both formed directly from one and the same input stem. In the concluding section, we will suggest that these effects are a

natural consequence of newly evolved morphological structure which developed from words as unanalyzable wholes.

(6) Constraints

IO FAITH[M-C]:	Every segment and every feature of a morphologically complex input must have a correspondent in the output.
*S:	Avoid strident coronal fricatives.
IO FAITH:	Every segment and every feature in the input must have a correspondent in the output.
Ranking:	IO FAITH[M-C], *S >> IO FAITH

The tableau in (7) illustrates how these constraints interact with our assumption about the morphology to yield simple base words. Since an affix is not included in the input string, IO FAITH[M-C] is rendered irrelevant to the evaluation of these candidates. The faithful candidate (a) does, however, incur a fatal violation of *S and is eliminated in favor of candidate (b) with the substitute [θ]. The winning candidate does violate the general IO FAITH constraint, but the lower ranking of that constraint renders the violation less serious.

(7) Base words formed from input representation

/sup/	IO FAITH[M-C]	*S	IO FAITH
a. sup		*!	
b. ☞ θup			*

The tableau in (8) illustrates how target appropriate realizations are achieved in morphologically complex words where IO FAITH[M-C] can play a crucial role. Notice that candidate (b) with [θ] does violate IO FAITH[M-C], but the faithful candidate violates *S, resulting in a tie. The choice is passed on to the lower ranked faithfulness constraint which selects the faithful candidate (a) as optimal.

(8) Derived words formed from concatenation of input morphemes

/sup + i/	IO FAITH[M-C]	*S	IO FAITH
a. ☞ supi		*	
b. θupi	*		*!

Our account of Subject 33 here might reasonably raise a question about why the facts of derived words are not the same for Subject 15, where IO FAITH was undominated. That is, if IO FAITH[M-C] is indeed a specific instance of undominated IO FAITH, it might be expected that /s/ would be realized correctly for Subject 15 at least in derived words. One of the crucial differences is,

however, that Subject 15 forms derived words from a base plus an affix rather than from input strings. Aside from differences in morphology, these two children are also claimed to differ in their constraint rankings. While we have not discussed the ranking of OO FAITH for Subject 33, it can nonetheless be assumed to be present but ranked below IO FAITH.

4. Consistent substitutes attributable to undominated well-formedness

Another instance of the typology is exemplified by the above two children at an earlier stage of development. Since the facts are essentially the same for both children, we report as representative the data in (9) for Subject 33 (age 5;4). It can be observed that target /s/ and /z/ were systematically replaced by [θ] and [ð], respectively, without any variation.

(9) Subject 33 (5;4)

A. Base:	Derived:	Gloss:	B. Base:	Derived:	Gloss:
θʌn	θʌni	sun	dɛθ	dɛθi	dress
θup	θupi	soup	aɪθ	aɪθi	ice
θop	θopi	soap	bʌθ	bʌθi	bus
θaʔ	θati	sock	duθ	duθi	juice
θo	θowɪn	sew	maʊθ	maʊθi	mouse
θip	θipən	sleep	woð	woði	rose
θwɪm	θɪmɪn	swim	noð	noði	nose

An optimality theoretic account for this case is relatively straightforward and is consistent with standard characterizations of early stages of development where well-formedness outranks faithfulness. The constraints and their ranking are given in (10). The undominated character of *S prevents /s/ and /z/ from occurring in any output no matter what is assumed about the morphology or the different types of faithfulness.

(10) Constraints

*S: Avoid strident coronal fricatives.

FAITH: Every segment and every feature in S_1 must have a correspondent in S_2 (where S_1 = an input or an output)

Ranking: *S >> FAITH

The tableaux in (11) and (12) illustrate how /s/ is systematically replaced by [θ] in base and derived words, respectively. The result in (12) would be the same even if derived words were assumed to be analyzable as a string of input

morphemes. This early stage of development differs from the subsequent stages for these two children by at least the ranking of constraints.

(11) Base words formed from input representation

/sup/	*S	FAITH
a. sup	*!	
b. ☞ θup		*

(12) Derived words formed from (unanalyzable) input representations

/supi/	*S	FAITH
a. supi	*!	
b. ☞ θupi		*

5. Adult English attributed to undominated faithfulness

A further instance of the typology is exemplified by adult English where /s/ and /z/ are produced correctly in both base and derived forms of words. The undominated character of a generalized faithfulness constraint, FAITH, guarantees that /s/ and /z/ will be realized appropriately no matter what is assumed about the morphology of derived words. Adult English differs from the other instances of the typology at least in terms of the constraint ranking.

(13) Base words formed from input representations

/sup/	FAITH	*S
a. ☞ sup		*
b. θup	*!	

(14) Derived words formed from any type of morphology

/sup + i/	FAITH	*S
a. ☞ supi		*
b. θupi	*!	

6. Conclusion

The various instances of this typology are suggestive of a developmental progression in both morphology and constraint rankings. The table in (15) sketches the characteristics of each stage with an added focus on the morphology of derived words. The validity of this course of development is supported by the attested longitudinal evidence for each of these Subjects as well as by continuity considerations. Note, for example, that Subject 33 documents stages 1 (5;4), 2 (6;6), and 3 (6;8). The change from stage 2 to stage 3 is especially interesting because superficially it might appear that there was a regression back to stage 1, at least in terms of the pronunciation facts. A regression in pronunciation is, however, precisely what would be predicted if the

constraint ranking remained constant and only the morphology changed to form derived words from a base plus an affix. Under such an account, highly ranked IO FAITH[M-C] at stage 3 is rendered irrelevant by the change in morphology, and the dominance of *S over other faithfulness constraints results in a return to a consistent substitution pattern. This account thus has the advantage of providing for positive and unidirectional grammar change, despite apparent regressions in pronunciation.

(15) Stages of development

Stage	Ranking	Morphology of derived words	Example
1	*S >> FAITH	unanalyzable /supi/ or string of input morphemes /sup+i/	Ss 33 (5;4) and 15 (4;2) θup~θupi
2	IO FAITH[M-C], *S >> IO FAITH >> OO FAITH	string of input morphemes /sup+i/	Ss 33 (6;6) and 15 (4;7) θup~supi
3	IO FAITH[M-C], *S >> IO FAITH >> OO FAITH	/Base + i/	S 33 (6;8) θup~θupi
4	IO FAITH >> *S >> OO FAITH (emergence of the unmarked)	/Base + i/	S 15 (5;1) sup~θupi
5	FAITH >> *S	--	Adult English sup~supi

Subject 15 also documents a progression through several of these stages, namely stage 1 (4;2), 2 (4;7), and 4 (5;1). This course of development is especially interesting because stages 2 and 4 find the same child producing /s/ correctly under just the opposite circumstances at different points in time. Importantly, however, the target sound first emerges correctly in the morphologically complex words (stage 2). If our sampling procedures had permitted, we might have also expected to see Subject 15 exhibiting a superficial regression (stage 3) before going on to stage 4, where emergence of the unmarked obtained. Taken together, this allows for the claim that the morphology of derived words develops incrementally. That is, derived words begin as a morphologically simple unanalyzable string of input segments, becoming morphologically analyzable as an input string of morphemes, and finally becoming elaborated as a base plus an affix. The reranking of constraints also proceeds unidirectionally and incrementally from undominated well-formedness to undominated faithfulness. The promotion of faithfulness, or more properly, the demotion of well-formedness (Tesar & Smolensky 1998), begins in stage 2 with IO FAITH[M-C] becoming unranked relative to *S. The next change in ranking (stage 4) finds IO FAITH[M-C] and IO FAITH converging to dominate *S with OO FAITH remaining low ranked. Finally, adult English further demotes

*S below all faithfulness constraints (including OO FAITH). There may well be other stages intermediate to these where certain constraints become unranked relative to one another to yield some free variation for a period of time.

In conclusion, the seemingly odd and problematic sort of intra-word variation documented here has been shown within optimality theory to be the predicted result of plausible morphological developments and the differential ranking and promotion of independent faithfulness constraints. Our focus in this paper has been on one particular error pattern, but we want to emphasize that these same effects can be observed in other children with different error patterns. For example, our database includes other cases of intra-word variation involving alternations between affricates and non-branching singletons, between /r/ and /w/, and between onset clusters and singletons. The occurrence and observation of these effects is especially compelling given that the data were gathered with a very different purpose in mind. The validity of our account can be better assessed by future research which is specifically designed to sample a wider variety of base words and affixes in this and other populations, including younger normally developing children and second language learners. Of course, still to be resolved about our account (and other optimality accounts of acquisition) is the larger question of what triggers reranking of constraints and/or changes in morphology. A consideration of the development of prosodic structure and its correspondence to morphological structure as in Hannahs & Stotko (1997) may hold some promise.

Our account nevertheless has interesting clinical implications which are amenable to experimental tests. For example, one observation was that a systematic error pattern without variation ([θ] for /s/) could be indicative of two rather different stages of development, i.e. either stage 1 or stage 3. While it may not be possible to discern a child's stage of development from a nonvarying error pattern alone, it is predicted that the child's response to treatment should reveal something more about his or her stage of development. That is, different children who respond in the same way to a given treatment would likely be at the same stage of development. Perhaps even more informative would be the circumstance where different children respond differently to the same treatment. Individual differences of this sort could be ascribed to the children being at different stages. Consider, for example, a case where two different children with a nonvarying error pattern might have been taught /s/ in morphologically complex words. If the first child acquired /s/ only in the morphologically complex derived words, and the other child acquired the sound only in base words, then we might reasonably infer that the first child was at stage 1 pretreatment, and that the second child presented at stage 3.

This further overlays on examinations of treatment efficacy. In particular, besides the condition where some children with nonvarying error patterns receive treatment on /s/ only in derived words, we would want other such children to receive treatment on /s/ only in base words. One of the two treatment conditions would be expected to result in greater improvements, possibly also influenced by the child's presenting stage of development. Since by this

account, the occurrence of /s/ in base words reflects a more advanced stage treatment using base words with success in those words may ultimately be mor effective. Another related claim is that certain intra-word variation (stage 4) i better (further along the developmental track) than certain other intra-wor variation (stage 2). A possible test implication of this might be the relativ ease/difficulty of achieving conformity with adult English from either stag through clinical treatment. The prediction might be that it will be easier t eliminate those errors which are attributable to emergence of the unmarke (stage 4) than it will be to eliminate certain other errors. In fact, children wh present with intra-word variation which is characteristic of stage 4 may not eve require intervention. It is considerations of this sort along with the result reported here which we hope will bring more attention to this type of intra-wor variation and the insights it offers for acquisition and phonological theory.

Notes

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