

Context effects in the acquisition of fricatives

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1 Introduction

The acquisition literature has amply documented the emergence of many different new sounds and contrasts into the inventories of children as they are acquiring their phonology. In some (but not all) of these reports, the new sounds are added with contextual restrictions that are not evident in the target system. Ultimately, the contextual restrictions give way to allow a fuller distribution of the relevant sounds. In some of these cases (as well as in others lacking context effects), there is evidence that the new contrast diffuses gradually through the lexicon. Despite the general availability of these facts, the theoretical implications have not been fully appreciated. It will be argued here that the transition from early stages of development (with and without context effects) to later stages offers a unique window on the nature of grammar and the evaluation of theoretical claims. This argument can be made with various classes of sounds but will be illustrated through a consideration of the acquisition of fricatives and is especially relevant to theoretical proposals for the (under)specification of phonological representations.

In early stages of development where fricatives may not occur or occur in complementary distribution with stops, all theories of (under)specification would concur in the claim that the feature [continuant] is noncontrastive and thus underspecified at the underlying level of representation. These theories do, however, make different claims about the specification of [continuant] in the subsequent stage where the feature becomes contrastive. The different claims have further consequences for the characterization of individual differences and the nature of grammar change. When the plausibility of the presumed changes in grammar is considered against the observed individual differences and phonetic changes, it must be concluded that children's underlying representations are radically underspecified in a context-sensitive fashion. This characterization of the acquisition of a contrast parallels the facts of effecting a phonemic split in second-language acquisition and is just the reverse of what is required in the loss of a contrast in historical sound change.

The organization of this paper is as follows: In section 2, we first consider the acquisition of fricatives with context effects. In section 3, the acquisition of fricatives without context effects is considered. The implications of these two different situations is then related to the characterization of individual differences in section 4. Parallels in second language acquisition and historical sound change are sketched in sections 5 and 6, respectively. The paper concludes with a brief summary.

2 The emergence of fricatives with context effects

The acquisition of fricatives has been a focal point of many studies. It is well established that fricatives are acquired relatively late with some systems exhibiting no fricatives in early stages. Additionally, it has been claimed that, for at least some children, word-final position is a favored context for the acquisition of fricatives (Ferguson 1978; Farwell 1976). In some cases, this favored context for the occurrence of fricatives has given rise to the complementary distribution of stops and fricatives such that fricatives occur word-finally and stops occur elsewhere. Some representative cases are cited in (1).

- (1) Representative cases of stops and fricatives occurring in complementary distribution in an early stage, i.e. fricatives finally and stops elsewhere.
- a. Will, Sarah and Daniel from Stoel-Gammon & Cooper 1984
 - b. Subject CI from Stoel-Gammon 1985
 - c. Subject JB from Farwell 1976

Even though both stops and fricatives co-occurred in these systems, their complementary distribution suggests that manner was noncontrastive at that stage and fully predictable based on context. Within general underspecification theory, this early stage of development and the absence of the manner contrast would be accounted for by underspecifying the feature [continuant] in obstruents in all contexts as shown in Table 1 and filling in the default values by a context-sensitive structure-building rule like that in (2).

Table 1
Underlying specification of [continuant] for obstruents by context in an early stage

	Prevocalic	Final
Stops	[0 cont]	**
Fricatives	**	[0 cont]

'**' = nonoccurring

- (2) Context-sensitive structure-building fill-in rule

Given an obstruent that is underspecified for manner, the default value to be filled in word-finally is [+continuant]; elsewhere the default is [-continuant].

At the point that a few stops in final position and/or a few fricatives in initial position emerge, a manner contrast would be introduced. The characterization of this change is problematic for contrastive specification (e.g. Steriade 1987) and for context-free radical underspecification (e.g. Archangeli 1988). First, within the framework of contrastive specification, both values of a contrastive feature must be specified underlyingly. To account then for the introduction of the contrast within such a framework would require an underlying change in all obstruents from being underspecified for manner to being specified as either [-continuant] or [+continuant], despite the absence of a phonetic change in many words. The required changes in underlying representations are shown in Table 2 and should be compared with the specifications required for the earlier stage as in Table 1. It is important to note that the many obstruents in final position that remained as fricatives and the many others in initial position that remained as stops would have had to change underlyingly from being underspecified to being specified.

Table 2
Contrastive specification account of stop/fricative contrast in a later stage

	Prevocalic	Final
Stops	[-cont]	[-cont]
Fricatives	[+cont]	[+cont]

The context-free radical underspecification account of the change in Table 3 is problematic on similar grounds. Given that only one value of the manner feature would need to be specified underlyingly, and given the marked character of fricatives (relative to stops), it would likely be the fricatives that would be specified for manner as [+continuant]. Stops would be underspecified in all contexts with the [-continuant] value being filled in by a context-free version of the rule in (2). Phonetic occurrences of all fricatives would have had to change underlyingly from being underspecified to being specified. For those fricatives in final position that remained unchanged phonetically, this would have entailed an underlying change with no phonetic change. Also, since stops would presumably be underspecified after the introduction of the manner contrast, and since all obstruents were underspecified for manner prior to the contrast, the emergence of stops in final position would have to be attributed to no change in underlying specification. That is, a phonetic change would have occurred without a change in underlying specification. These points are made clear by comparing the specifications in Table 3 with those in Table 1.

Table 3
Context-free radical underspecification account of stop/fricative contrast in a later stage

	Prevocalic	Final
Stops	[0 cont]	[0 cont]
Fricatives	[+cont]	[+cont]

An alternate version of radical underspecification theory, namely context-sensitive radical underspecification (e.g. Kiparsky 1993a), allows both values of a contrastive feature to be specified underlyingly, but never in the same context. In terms of such a framework, the introduction of the manner contrast would be characterized by the underlying specification of [-continuant] in final position and the underlying specification of [+continuant] in initial position in just those words exhibiting a phonetic change as shown in Table 4. The opposite values of these features would remain underspecified in their respective contexts and would continue to be filled in by the earlier rule in (2). Consequently, minimal change in the underlying specification of representations is postulated in accord with the minimal phonetic changes that occur.

Table 4
Context-sensitive radical underspecification account of stop/fricative contrast in a later stage

	Prevocalic	Final
Stops	[0 cont]	[-cont]
Fricatives	[+cont]	[0 cont]

To the extent, then, that the manner contrast emerges from the complementary distribution of stops and fricatives, the framework of context-sensitive radical underspecification can be judged superior as an account of the observed change. That account requires only minimal grammar change in accord with the minimal phonetic changes that occur. In the following section, these frameworks will be evaluated based on the emergence of the manner contrast when context is not an issue.

3 The emergence of fricatives without context effects

A number of studies have reported cases of children who at an early stage of development produce obstruent stops in a variety of contexts but exclude fricatives (and affricates) in all contexts. Some representative studies are cited in (3).

(3) Representative cases of stops occurring to the exclusion of fricatives in an early stage

- a. Amahl from Smith 1973
- b. JJ, JV, KW, NC, MC, LH, AH, JK, EM, TN, CA, NB, JH and JL from Stoel-Gammon 1985
- c. Subject KL from Farwell 1976
- d. Phonologically disordered subjects, S4 and S26, from Dinnsen, Chin, Elbert & Powell 1990.

In these cases, manner is noncontrastive within obstruents at the early stage with no variation attributable to context. To account for the absence of fricatives and the absence of a manner contrast, the feature [continuant] would be underspecified for obstruents in all contexts as in Table 5 and would be filled in by default as [-continuant] by a context-free rule like that in (4).

Table 5
Underlying specification of [continuant] for obstruents in an early stage

	Prevocalic	Final
Stops	[0 cont]	[0 cont]
Fricatives	**	**

*** = nonoccurring

(4) Context-free structure-building fill-in rule

Given an obstruent that is underspecified for manner, the default feature to be filled in is [-continuant].

At a subsequent stage, a manner contrast would be introduced by the occurrence of a fricative in one or more of the contexts where stops can also occur. Additionally, if the occurrence of this new class of fricative sounds diffused gradually through the lexicon, not all words would be affected phonetically in the early stages of the contrast. For example, Smith (1973:124) reports that Amahl added coronal fricative phonemes in all contexts at Stage 21 (age 2 years;359 days to 3 years;10 days). The data in (5a) and (5b) are drawn from Stage 21 to illustrate the contrastive status of stops and fricatives in initial, medial and final contexts. The forms in (5c), however, represent the continuation of the earlier error pattern in all contexts into Stage 21 and

subsequent stages, establishing (contrary to Smith's claim) that the phonemicization did not occur across-the-board.

(5) Amahl, Stage 21 (age 2;359-3;10)

a. Coronal stops corresponding to target stops

[tait]	'tight'	[tʊmɔrəu]	'tomorrow'
[fi:tiz]	'sweeties'	[hudən]	'hidden'
[rut]	'wrote'	[ɔ:kwɔ:d]	'awkward'

b. Coronal fricatives corresponding to target fricatives

[sɔ:pən]	'saucepan'	[sə:kəlz]	'circles'
[geimz]	'games'	[kisin]	'kissing'
[haus]	'house'	[zu]	'zoo'

c. Stops (or affricates) corresponding to target fricatives

[gʊ:ts]	'goose'	[hɔ:pikəl]	'hospital'
[tsend]	'send'	[kɑ:dz]	'cars'
[ʌdə]/[ʌdzə]	'other'	[wi:dzəl]	'weasel'
[fɑ:dzə]	'father'	[kləutsə]	'closer'

A contrastive specification framework finds this sort of lexical diffusion to be problematic. That is, the account of the change requires widespread restructuring of lexical representations, despite the more limited phonetic changes. All obstruents must change from being underspecified for [continuant] to being specified as either [-continuant] or [+continuant]. In the case of all phonetically occurring stops (5a) and (5c), an underlying change must be postulated despite the absence of a phonetic change. Additionally, any phonetically unchanged stop that corresponds with a target fricative (5c) would have to be specified as [-continuant] in contradiction to the target facts.

Table 6

Contrastive specification account of Amahl's stop/fricative contrast at Stage 21 and later

	Prevocalic	Final
Stops	[-cont]	[-cont]
Fricatives	[+cont]	[+cont]

Cases of phonemic acquisition lacking these context effects do not contribute to a further differentiation among the two different versions of radical underspecification. Both context-free and context-sensitive radical underspecification are equally compatible with the facts of phonemic acquisition when context is not an issue. A radical underspecification account of the change is given in Table 7. Specifically in this case of the acquisition of a manner contrast, both frameworks would directly relate changes in the underlying representations of particular words with phonetic changes in those words. The emergence of fricatives in any or all contexts (5b) would be characterized by a change in underlying specification for particular words from being underspecified to being specified as [+continuant]. Also, all stops that remain unchanged phonetically, (5a) and (5c), would remain underspecified underlyingly with the default [-continuant] feature being filled in by the context-free rule in (4). Furthermore, no underlying specifications before or after the introduction of the contrast would contradict target specifications. That is, even though some stops may correspond with target fricatives (5c), they would not constitute a contradiction to target specifications because they would remain underspecified underlyingly. Also, the preservation of underspecified representations and of the rule that supplied [-continuant] as the default throughout the development of this contrast preserves continuity across the grammars of the individual stages and explains why stops might predominate.

Table 7

Radical underspecification account of Amahl's stop/fricative contrast at Stage 21

	Prevocalic	Final
Stops	[0 cont]	[0 cont]
Fricatives	[+cont]	[+cont]

4 Implications for the characterization of individual differences

If the above arguments are correct, it should be possible for two children to both exhibit a stop/fricative contrast in word-final position but to do so with different features specified underlyingly in that context. For example, [-continuant] would be the specified feature in word-final position for children like those in (1) who had acquired fricatives prior to stops in that context. On the other hand, [+continuant] would be the specified feature in final position (and elsewhere) for children like those in (3) who acquired stops in all contexts prior to any fricative. These different claims about which features are specified have further consequences for the features that are available to trigger rules. For example, in cases where word-final fricatives are underspecified and stops are specified, stops should be able to trigger a rule such as word-final reduction, which is evident in many varieties of English (e.g. Harris 1994). This process

can be understood in some cases as the loss of place features. The data in (6) are drawn from a phonologically disordered child, S17, who replaces final stops (but not fricatives) with a glottal stop. It must be assumed that final stops are specified as [-continuant] in order for the glottal replacement rule to apply exclusively to stops.

(6) Glottal replacement of stops: S17 (aged 4;3)

a. Stops are reduced

[iʔ]	'eat'	[kəjuʔ]	'cute'
[belʔ]	'belt'	[goʔ]	'goat'

b. Fricatives are not reduced

[dres]	'dress'	[feɪs]	'face'
[diz]	'these'	[ðerz]	'theirs'

In other cases where stops are underspecified and fricatives are specified, fricatives (but not stops) should be able to trigger a rule. In (7), a phonologically disordered child, S1, evidences a rule (Figure 1) that spreads the specified feature [+continuant] from a final fricative to an initial underspecified stop.

(7) Assimilatory spreading of feature [+continuant]: S1 (aged 3;4)

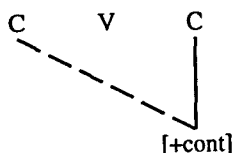
a. Spreading

[θiθ]	'teeth'	[θɔf]	'cough'
[θoð]	'toes'	[servz]	'caves'

b. Stops occur in final position and contrast with fricatives

[it]	'eat'	[fæt]	'fat'
[wid]	'read'	[wak]	'rock'

Figure 1
Spreading from a final fricative to an initial underspecified stop



It thus appears that children can differ in how they specify their underlying representations and that those differences may account for why different children exhibit different rule-governed error patterns. This account also has the consequence that different adult speakers of the same language may have arrived at the same contrasts by different paths and thus may represent those contrasts differently in terms of (under)specification. This is an important point because it means that not all speakers necessarily share the same feature specifications and thus may not share a rule that is dependent on one common feature specification. In other words, speakers of a language may not share the same grammar. Allophonic rules are, however, often believed to be shared by all speakers of a language and might be thought to challenge our proposal. It is noteworthy, however, that English has no allophonic rule that is dependent on the uniform availability of some specification for the feature [continuant].

5 Parallels in second-language acquisition

Many of the points noted above have parallels in second-language acquisition. For example, an acknowledged problem for a second-language learner is to effect a 'phonemic split'. This problem arises when two sounds in a learner's native language are allophones of the same phoneme but are separate phonemes in the target language. This is comparable to the situation that confronts first-language learners when, for example, stops and fricatives occur in complementary distribution in an early stage, as we saw for those children in (1). If these children are to acquire the ambient system, they too must effect a phonemic split.

Eckman and Iverson (1994) document a similar phonemic split between stops and fricatives for Spanish speakers learning English. In Spanish, [d] and [ð] occur in complementary distribution as a consequence of the feature [continuant] being noncontrastive for voiced obstruents. The result is for voiced spirants to occur in intervocalic (or possibly just postvocalic) position with stops occurring elsewhere. Since these two sounds are distinct phonemes in English, a phonemic split is required. Eckman and Iverson found that while some learners failed to show any evidence of a phonemic split, others effected the split in a well-defined set of contexts. That is, the split was effected more readily in nonderived contexts with the merger persisting in derived contexts. This means, for example, that the medial obstruent in *ladder* (a nonderived

context) would be produced target appropriately, but the medial obstruent of *redder* and *smoother* (a derived context) would be produced as a spirant. Their account is that the original allophonic spirantization rule persists but with a neutralizing effect. The spirantization rule is rendered neutralizing by the occurrence of some new spirant phonemes. The neutralizing status of the rule has the further consequence of restricting its application to derived contexts in conformity with requirements of structure preservation (Kiparsky 1993a).

Eckman and Iverson's account does not explicitly take up the issue of how underlying representations are specified or how they might change (if at all) over time, but by adopting the framework of context-sensitive radical underspecification, precisely these results can be shown to follow. Given that the feature [continuant] is noncontrastive for Spanish, it would be underspecified in all contexts and filled in by default. The default value would be [+continuant] in intervocalic contexts and [-continuant] elsewhere. For those learners who do not effect the phonemic split in their rendition of English, their underlying representations would resemble those of Spanish by remaining underspecified for the feature [continuant]. Their original allophonic rule would continue to supply the values for [continuant] in conformity with Spanish. For those learners, all English words with a medial voiced obstruent would be produced with a spirant, including in nonderived contexts. On the other hand, the learners who evidenced the phonemic split, but only in nonderived contexts, would represent the contrast in just those words by specifying underlyingly the feature [-continuant] in intervocalic contexts (and [+continuant] elsewhere). The original structure-building rule would supply the default values as before to any form underspecified for the feature [continuant], but the rule would be blocked by other segments specified underlyingly for the feature. The medial obstruent in words like *lather* (nonderived) and *redder* (derived) would thus be realized as a spirant as a result of remaining underspecified and being subject to the original rule. The rule would be blocked from applying to the medial obstruent in *ladder* by virtue of its being specified as [-continuant] in that context.

This account of effecting a phonemic split preserves maximal continuity across the grammars that a learner is presumed to go through in arriving at the ambient system. The nature and specification of underlying representations is largely preserved along with the original structure-building rule. As the contrast is introduced, just those words evidencing a change in pronunciation change underlyingly to become specified in a context-sensitive fashion. The context-sensitive specification of more and more words over time should result in a reduction in errors attributable to the original rule. The other frameworks of contrastive specification and context-free radical underspecification run into all the same problems detailed above relating to the characterization of change.

6 Parallels in historical sound change

Gradual diffusion of a contrast through the lexicon of the sort described in section 3 has been documented in other cases of phonemic acquisition (e.g. Gierut 1985; Macken 1992; Tyler & Edwards 1993; Dinnsen 1996) and is similar to what has been observed in the historical development of languages

where a contrast is lost (e.g. Chen & Wang 1975; Kiparsky 1988, 1993b; Labov 1981; Wang 1969). More specifically, under Kiparsky's (1993b) characterization, lexical diffusion comes about from the extension of a structure-building rule to representations that have become simplified (underspecified) by the loss of a contrastive feature. This process is just the reverse in acquisition under our characterization; the applicability of the structure-building rule decreases due to the blocking effect of more and more words becoming specified for a contrastive feature.

7 Conclusion

The case studies considered here of the acquisition of fricatives present a unified picture relevant to the evaluation of different claims about the (under)specification of children's underlying representations. The early stage where the target contrast had not yet emerged was compatible with the various different theories of underspecification. Noncontrastive features in the child's system were simply underspecified. The apparent merger of a target contrast (or a substitution pattern) came about from a rule that supplied a default feature to undifferentiated and underspecified representations. The challenge for underspecification theory was revealed in the characterization of the subsequent stages and the transition to those stages. At the point a phonemic contrast was first introduced, a contrastive specification account and a context-free radical underspecification account require that many (if not all) words would change in terms of their underlying specifications without a corresponding phonetic change, and many others would change phonetically without an associated change in underlying specification. Also, many of the words that continue to be produced in error had to be specified underlyingly with feature values that contradicted target values. The required changes in underlying representations and in the rule that had supplied default feature values preserved little from the prior grammar and thus violated continuity and compatibility concerns.

The characterization of such change within a framework of context-sensitive radical underspecification ascribed minimal change to the system in accord with the minimal phonetic changes that occurred. What changed was only the specificity of a few lexical items in well-defined contexts in a way that preserved the radically underspecified character of representations. The specification of more and more words over time resulted in phonetic changes in just those words and brought them into conformity with the target.

Even if some phonemic contrasts for some children are introduced in an across-the-board fashion as some have claimed (e.g. Macken 1992; Smith 1973), many of the same problems confront the frameworks of contrastive specification and context-free radical underspecification. Consequently, whether phonemic contrasts are acquired with or without context effects, across-the-board, or by lexical diffusion, the only framework that appears to be able to account for all the facts is context-sensitive radical underspecification. This framework also receives independent support from its characterization of certain individual differences, of phonemic splits in second-language acquisition and of the loss of contrasts in historical sound change. Additionally, the evidence and arguments

presented here regarding the acquisition of a manner contrast are also reiterated by the acquisition of voice and place contrasts (Dinnsen & Chin 1995; Dinnsen 1996). As other cases of phonemic acquisition come to light, a fuller range of context effects should be revealed. At that point, it may be possible to define more precisely what constitutes a possible context for the (under)specification of particular features.

Notes

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