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On the organization and specification of manner features[1]

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Within feature geometry, different claims have been made about the range, unity and location of manner features with little support for a Manner node as a unit of subsegmental structure. The issue is reconsidered, drawing on evidence of interacting error patterns in the developing systems of three young children acquiring English. The results reveal that obstruent stops and glides can serve as targets of assimilation when the triggering features are [continuant], [nasal], or [approximant], but also block as targets under superficially similar circumstances. It is argued that these three features are dependents of the same node, namely Manner, and that default features must be permitted to be both specified and underspecified underlyingly.

1. Introduction

The various conceptions of feature geometry have all made different substantive claims about the range, unity and location of manner (or stricture) features in the internal structure of segments. For an overview, see McCarthy (1988), Kenstowicz (1994), Keyser & Stevens (1994) and Clements & Hume (1995). A number of different features potentially relates to manner of articulation, but the focus here will be on the three candidate features [continuant], [nasal] and [approximant]. These features correspond with different degrees of sonority or stricture and serve to distinguish stops from fricatives, nasals from nonnasals, and liquids and glides from other segments. Despite their ubiquitous character, the relation of these features to one another and to other features in the geometry has remained unclear. While some have postulated a Manner node as a subsegmental organizing unit that might group these features together (for example, Clements 1985, Cho 1988), it is generally acknowledged that the empirical evidence for such a claim has been weak, especially relative to other geometric structures (see McCarthy 1988, Shaw 1991). Evidence for an organizing node has usually required a set

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of features to act together in the same way by either triggering or blocking some phonological rule. For example, in a typical case of nasal place assimilation, different articulator features such as [labial] or [dorsal] might both trigger place assimilation, motivating a higher order Place node that can be spread along with all of its dependent features. Likewise, an organizing Place node might also be motivated if some segment specified for [dorsal] blocked the spreading of some other articulator feature such as [labial], which presumably is on a different tier. An interaction of this sort would not be expected unless the features were on the same tier at some level of structure. Blocking effects can obtain in either of two ways. In one case, a feature or node is prevented from spreading to some target because a line-crossing violation would be incurred with an intervening specified structure on the same tier. In the other case, a feature or node is prevented from spreading to some target because of a feature licensing or feature co-occurrence constraint (see Goldsmith 1990, Itô et al. 1995). For example, many languages disallow complex (branching) segments such as labio-velars. The exclusion of branching structures is instantiated by a constraint on the organizing Place node such that no more than one articulator feature can be associated with Place. Such a constraint has the further consequence of blocking place assimilation if the target would result in a complex segment. Either blocking effect reveals relationships between features and limits what is a possible target of an assimilatory spreading process.

Assimilatory phenomena are also revealing because of their characteristic asymmetries in terms of what can be a trigger/blocker and target. That is, triggers and blockers of assimilation tend to be limited to marked features, whereas targets of assimilation tend to be restricted to segments that are unmarked with respect to the assimilating feature. The framework of radical underspecification theory (Archangeli 1988) accounts for these asymmetries by specifying underlyingly some features (usually marked features) and underspecifying others (usually unmarked features). In this way, underspecified features are not available to be spread and thus cannot trigger or block assimilation. The underlying underspecification of a feature does, however, render a segment vulnerable as a potential target of spreading. On the other hand, the presence of a specified feature on some segment makes that segment a possible trigger or blocker of spreading but an unlikely target, especially if the language disallows complex segments.

By extending such considerations to assimilatory phenomena involving putative manner features, it should be possible to determine how these features are organized in the geometry and how they are specified underlyingly. The developing sound systems of young children (normal or speech disordered) provide a rich source for assimilatory phenomena, including manner assimilation (Smith 1973, Vihman 1978, Chin 1993, Stoel-Gammon & Stemberger 1994). It is not uncommon to find, for example, some children replacing stops by nasals when a nasal occurs elsewhere in the

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word, for example, [winɪn] 'reading'. Also, while fricatives are often replaced by stops, stops can be replaced by fricatives under conditions of assimilation with another fricative in the word, for example, [soʊz] 'toes'. In yet other cases, glides can assimilate to a following liquid consonant, for example, [lɛlo] 'yellow'. Such errors appear to be the result of an assimilatory process that spreads some manner feature to a stop or glide that might not always be string-adjacent. Several questions are raised by these phenomena. For one, how must stops and glides be represented to be vulnerable as targets of such assimilations? Also, what segments can block as targets of these assimilations, and how must they be represented to resist assimilation? These and related questions about the nature of such assimilations will be considered in detail, drawing on interacting error patterns in the developing systems of three young children acquiring English. The intent will be twofold: (a) to establish some facts about what is a possible trigger/blocker and target of assimilation, and (b) to motivate a geometry and theory of (under)-specification that is capable of accounting for these facts. In sections 2–4, it will be argued that the features [continuant], [nasal] and [approximant] must be grouped together as dependents of the same node, namely Manner. The argument is first developed under the widely held assumption that children's underlying representations are essentially adult-like. In section 5, an alternative account is considered which further motivates an extension to radical underspecification theory allowing default features to be both specified and underspecified underlyingly. The final section concludes with a brief summary and a consideration of the implications of these phenomena for nonderivational constraint-based theories (Prince & Smolensky 1993).

The particular cases considered here have been selected from a larger archival study of the sound systems and learning patterns of young children with functional (nonorganic) speech disorders. Many aspects of the children's systems have been described elsewhere (see Dinnsen et al. 1990; Chin 1993; Dinnsen & Chin 1994, 1995). While these children's systems are classified as disordered, they do not seem to differ substantively from those of younger normally developing children (see Ingram 1989). Their systems would seem to more properly reflect a delay in the course of otherwise normal acquisition. It is thus expected that the results and conclusions should hold generally for first language acquisition. Finally, to the extent that each stage of a developing system is one in a series of viable linguistic systems, and a proper theory of language is a theory of acquisition, these results should contribute to general phonological theory.

2. The features [nasal] and [continuant]

A relatively common error pattern in the course of phonological development (normal or disordered) replaces a stop with a nasal when another nasal

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occurs elsewhere in the word (see Chin 1993, Stoel-Gammon & Stemberger 1994). This error pattern was evident in the speech of one of our phonologically disordered children, Subject 29 (age 4;11), but with some crucial asymmetries as shown in (1). In (1a), the voiced coronal stop /d/ was replaced by a nasal when followed by a nasal later in the word, indicative of assimilation. Coronal stops did otherwise occur appropriately in word-medial contexts when there was no following nasal. Also, nasals did not target any other segments for assimilation, not even certain other voiced coronal stops. That is, the data in (1b) show that assimilation was blocked by some voiced coronal stops even when a nasal followed. Those stops that blocked as targets of assimilation were themselves the product of another common error pattern, namely stopping. More specifically, this child excluded many fricatives from his inventory, replacing them with stops. In fact, the only fricatives that occurred were [v] and [ð] and only in word-initial position. Thus, while some stops served as targets of nasal spreading, others that were the product of another error pattern (stopping) were never targets of this assimilation.

(1) Asymmetries in nasal harmony (Subject 29, age 4;11)
   (a) Voiced coronal stops assimilated to final nasal
   [winiŋ] 'reading' [waɪniŋ] 'riding'
   [haɪniŋ] 'hiding'
   (b) Voiced coronal stops corresponding to fricatives did not assimilate to nasals
   [bʌd] 'buzz' [bʌdiŋ] 'buzzing'

The interaction of these two error patterns argues for an intimate geometric relationship between the two features [nasal] and [continuant]. First, given that nasal consonants are generally produced with an oral closure and in the world's languages pattern phonologically with stops, it is perhaps not surprising that stops might be able to take on the feature [nasal] by assimilation. The feature [−continuant] is certainly compatible with nasals in a way that, for example, [+continuant] is not (see Henton et al. 1992, Mohanan 1993, Padgett 1994). Most conceptions of subsegmental structure do not, however, relate these features in a way that captures the affinity between stops and nasals along with the incompatibility of fricatives and nasals. The two features are typically placed on different tiers dominated by different organizing nodes or are associated (along with many other features and nodes) with the root node.

If, however, the two features [nasal] and [continuant] are each associated with a single organizing node limited to manner features, their relationship and behavior can be expressed directly. First, consistent with radical underspecification theory, the unmarked nature of stops would suggest that stops are underspecified for manner. The default value would be [−con-

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tinuant], being filled in automatically if no other rule applied. The underspecified character of a stop would furthermore render it vulnerable as a target of a process that spreads some specified feature of the same general type, namely a manner feature. If nasals are assumed to be specified for manner as [nasal], that feature would be available to spread by a process of nasal harmony to stops, which are underspecified for manner.[2] This is essentially the account of the forms in (1a) and is depicted in (2a).

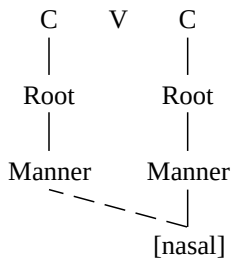
The account of forms like those in (1b) continues this line of reasoning, but bears on the nature of the child's underlying representations. The issue is how to block nasal harmony in (1b), yielding a voiced coronal stop. Because such stops correspond with fricatives in the ambient system, it might be assumed that the child represents these stops in an ambient-like fashion as fricatives underlyingly. The marked character of fricatives would suggest that they are specified underlyingly for manner as [+continuant]. As depicted in (2b), at the point nasal harmony would apply, spreading of the feature [nasal] would be blocked for any form like that in (1b) for lack of a target with an underspecified Manner node. The specified manner feature of fricatives and a general constraint prohibiting complex (branching) segments would prevent fricatives from serving as potential targets of [nasal] spreading. As shown in (2c), a subsequent rule (ordered in a counterfeeding relation) would then be necessary to delink the feature [+continuant] from all those underlying fricatives that are realized phonetically as stops. The default manner feature [−continuant] could then be filled in to yield a stop.

(2) Geometric account of nasal harmony
   (a) For forms in (1a), [nasal] spreads to underspecified Manner node of obstruent[3]

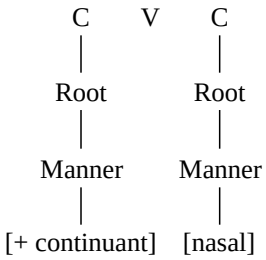
[2] As will be seen in subsequent sections, glides are also assumed to be underspecified for manner and thus might be expected to be possible targets of assimilation. The fact that nasal harmony is limited in this case to obstruents (and not glides) could be stipulated as a condition on the rule in this child's system. Alternatively, within a constraint-based framework, the restriction may be a consequence of a highly ranked constraint which licenses the feature [nasal] only for consonantal segments. This would account for the fact that nasalized glides do not occur in this child's system, and all nasals are consonants. The feature [nasal] would thus be prevented from associating with any but consonantal segments in this child's system. Since obstruent stops would be the only consonants that are underspecified for manner, they would be the only segments in this child's system that could serve as potential targets of assimilation. Such constraint-based alternatives are considered further in the concluding section. Additionally, while the assumption that nasals are specified for manner may be controversial, it must be acknowledged that nasals are marked relative to obstruents and act like other specified features in terms of both triggering assimilation and being resistant as a target of manner assimilation.

[3] The manner node need not be represented overtly if it supports no dependents, but well-formedness considerations result in the interpolation of the node to support the spread of a licensed feature (Clements & Hume 1995: 294).

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(b) For forms in (1b), spreading blocked by Manner node specified as [+continuant]



(c) Counterfeeding derivation of a form in (1b)

/bʌz+ɪŋ/	'buzzing'
——	assimilation (blocked)
bʌd+ɪŋ	delinking & default fill-in
[bʌdɪŋ]	

While this account certainly seems possible, it does entail rather abstract claims about the nature of this child's underlying representations, especially as relates to fricatives. To claim that the coronal stop in (1b) is a /z/ underlyingly achieves the desired blocking effect, but otherwise is empirically unsupported. Recall that most of the ambient fricatives, including /z/, were not produced by this child in any context. There is thus no evidence that this child represented those coronal stops specifically as /z/ as opposed to any other segment. No information is available on whether this child perceived or comprehended the ambient distinction between /z/ and /d/. However, even if the child correctly comprehended the distinction, it does not follow that the child necessarily represented that distinction exactly as in the ambient system. See in this regard Nittrouer & Studdert-Kennedy (1987) for evidence that children often weight acoustic cues differently from adults. In any event, the differential behavior of these phonetically identical segments is sufficient to motivate an underlying distinction of some kind. For the moment, we will adopt the more widely held assumption that the distinction is represented as in the ambient system. In a later section, a specific alternative proposal for representing this distinction is presented.

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Independent of abstractness considerations, what emerges from this account is that stops can serve as a target of assimilation, the feature [continuant] as a blocker, and the feature [nasal] as a trigger. These interacting effects motivate grouping together the two features [nasal] and [continuant] as dependents of the same Manner node. In the following section, similar effects will be documented for the features [approximant] and [continuant], and an empirical argument against ambient-like underlying representations will also be advanced.

3. The features [approximant] and [continuant]

Two other independent error patterns occurred and interacted in the speech of another phonologically disordered child, Subject 9 (age 3;9), to yield certain asymmetries with respect to glides and fricatives. In (3a), a word-initial glide was replaced by a fricative when a fricative followed later in the word, indicative of assimilation. Glides were otherwise realized correctly. No other segments, including certain other glides, served as targets of such assimilation. Note especially the word-initial glide in (3b), which resisted assimilation even though a fricative followed. The assimilation-resistant glides were the product of another common error pattern, gliding, which replaced an ambient liquid consonant with a glide. This child excluded /r/ from his inventory and usually substituted [w], resulting in a merger with the ambient glide. The liquid consonant /l/ was produced correctly and thus was not subject to gliding or assimilation. Despite the merger of /r/ and /w/ by gliding, the product of this error pattern blocked as a target of assimilation. While ambient /r/s were usually replaced by a glide, there were some instances, as can be seen in (3c), where they were replaced by a fricative, presumably as a result of assimilation. There was thus no predictable correspondence between ambient /r/s and the child's substitute.

(3) Glide/fricative asymmetries (Subject 9, age 3;9)
  (a) /w/s assimilated the stricture of following fricatives
    [veɪv] 'wave' [vʊf] 'wolf'
  (b) Some /w/s corresponding to /r/s did not assimilate
    [wʊf] 'roof' [wʊfi] 'roof (diminutive)'
  (c) Some ambient /r/s did assimilate
    [viθ] 'wreath' [viθi] 'wreath (diminutive)'

One of the many issues raised by these data is why any glide should be vulnerable as a target of an assimilatory process triggered by a fricative. Glides and fricatives would seem to share few features in common, thus limiting the tiers and configurations that are available to participate in assimilation. If, however, stricture (albeit different degrees of stricture) is recognized as a common defining property of consonants and glides, different stricture features could still assimilate if dominated by the same

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organizing node, namely Manner. The feature [continuant] is a manner feature associated with the relatively narrow stricture of stops and fricatives and is characteristic of obstruents. Glides (and liquids) have a lesser degree of stricture defined by the manner feature [approximant], which in turn is characteristic of the nonturbulent air flow of certain sonorants. The general nonassimilatory substitution of glides for liquids suggests that glides are unmarked relative to liquids and thus are underspecified for the manner feature [approximant]. This is also supported by the fact that glides serve as a target of assimilation. The feature [approximant] would thus be supplied by default to a [−consonantal] segment if no other rule filled in a manner feature. As discussed earlier, the marked character of fricatives (relative to stops) would result in their being specified underlyingly for the manner feature [+continuant]. In this way, the specified manner feature of fricatives is available to trigger spreading of that feature to a glide underspecified for manner. An account of the forms in (3a) is depicted in (4a). The multiple linking of the feature [+continuant] results in all associated segments (including the target glide) taking on the licensing properties of the trigger, being interpreted uniformly as obstruents.[4]

The assimilation-resistant glides in (3b) must somehow be distinguished underlyingly from those that undergo assimilation. Because of their correspondence with ambient /r/s, it might be assumed that the glides in (3b) are represented in an ambient-like fashion as /r/s. In order for those /r/s to resist assimilation and be distinguished from the other glides and liquids that occurred in this child's system, they must be specified for the manner feature [approximant] and the root node feature [+consonantal].[5] As shown in (4b),

[4] It must remain an open question for now why glides and not stops are targets of this assimilation. Both stops and glides are presumed to be underspecified for manner, and both could in principle serve as targets of this assimilation. While the restriction to glides could be stipulated as a condition on assimilation in this child's system, it could within an alternative constraint-based framework be attributable to a highly ranked markedness constraint favoring syllable onsets with low sonority over the faithful parse of [+sonorant], especially if that value of sonority is expressible from alignment of a specified manner feature. The leftward alignment of [+continuant] would introduce a categorical change in sonority in glides. Stops would not be expected to be replaced by fricatives under these circumstances since faithfulness to [−sonorant] would be more highly ranked than alignment. The replacement of glides by nasals might also be expected since nasals are less sonorous than glides; but this does not occur, due quite possibly to the fact that the decrease would not be categorical. That is, glides and nasals are both [+sonorant]. Also, despite the low sonority of obstruent stops, they would not be expected to trigger a decrease in the sonority of a preceding glide because stops are presumed to be underspecified for manner, rendering alignment of manner irrelevant. Such alternatives are considered further in the concluding section.

[5] An anonymous reviewer has pointed out that the feature [approximant] may be superfluous for liquid consonants in this case given that the glides and liquids can be distinguished by the root feature [consonantal] alone. If this is correct, the feature [approximant] should not be available to block assimilation or to be spread by assimilation. Interestingly, there are relatively few well-documented cases in the literature of true liquid spreading by assimilation (compare Subject 23 in this paper and Spencer 1986). The extent to which

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the assimilation rule would be blocked from spreading the feature [continuant] to those /r/s because of their specified Manner node and a general constraint prohibiting complex (branching) segments. As shown in (4c), a subsequent rule (or set of rules) would then have to change those /r/s to [w]s in all contexts in a counterfeeding relation after assimilation has had an opportunity to apply.

The phonetic nonoccurrence of [r]s does, however, render this account highly abstract. Aside from abstractness considerations, an assumption of ambient-like underlying representations cannot be fully maintained in this case. That is, while ambient /r/s corresponded with glides in (3b), they are replaced by a fricative in (3c). To derive (3c) from an underlying /r/ would require the putative gliding process to be ordered before assimilation in a feeding relation to create a structure to which assimilation could then apply, as shown in (4d). Such an ordering is just the reverse of that required for the forms in (3b), resulting in an ordering paradox. The rules simply cannot be ordered if this child's underlying representations are all assumed to be ambient-like.

At the very least, then, some ambient /r/s must be represented in a nonambient-like fashion. More specifically, those ambient /r/s that are replaced by a fricative when a fricative occurs later in the word act like the ambient glides that undergo assimilation and thus can be represented as [−consonantal] glides, underspecified for manner. The account of the forms in (3a) and (3c) would therefore be as shown in (4a). If assimilation were prevented (for lack of a trigger) from supplying a manner feature to these underspecified segments, they would be realized as a glide by default. An alternative account of the blocking effect in (3b) will be presented in section 5.[6]

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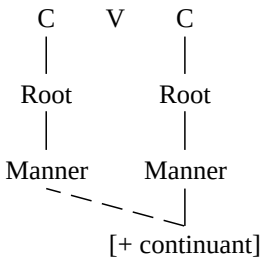
liquids resist manner assimilation is, however, suggestive of their being specified for some manner feature, especially if there is a contrast among liquids. See, however, note 6 below for a discussion of the role of the feature [+consonantal] as a possible blocker of assimilation. Even if the feature [approximant] should prove to be redundant for consonants, an argument for the distinctive character of the feature is available for glides as made explicit in section 5.

[6] An anonymous reviewer has suggested as a possible alternative an account which spreads the feature [+consonantal] from the fricative to the glide given the presumably shared [+continuant] feature of glides and fricatives. The glides corresponding to /r/s in (3b) would block as targets of spreading since they would already be specified as [+consonantal]. Some other assumption would have to be made about those ambient /r/s in (3c) that do undergo assimilation. A similar proposal for consonantal spreading has been advanced by Kaisse (1992) for other phenomena, but the advantages of such an account in this instance are questionable. First, the account assumes a geometry that is language-specific rather than universal. It also requires the feature [consonantal] to be a dependent of the root node so that it can be spread. This is contrary to the more standard assumption that the feature is a nonspreadable annotation of the root node. In addition, if glides are assumed to be specified as [−consonantal], that feature specification would be on the same tier as the feature [+consonantal] and should therefore cause glides instead to resist as targets of [consonantal] spreading. Also, the presumed motivation for

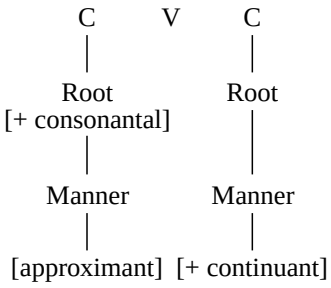
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(4) Geometric account of glide/fricative asymmetries

(a) Specified manner feature spreads to underspecified Manner node of [−consonantal] segment



(b) Spreading blocked by /r/s specified for manner as [approximant]



(c) Counterfeeding derivation of a form in (3b)

/rʊf/	'roof'
——	assimilation (blocked)
wʊf	gliding
[wʊf]	

(d) Feeding derivation of a form in (3c) (ordering paradox)

/riθ/	'wreath'
wiθ	gliding
viθ	assimilation
[viθ]	

consonantal spreading, namely that glides and fricatives share the feature [+continuant], mixes levels. That is, the feature [continuant] is potentially distinctive for obstruents but never for glides. Thus, while the feature is entirely redundant for glides, it crucially must be assumed to be available to trigger the spread of the feature [consonantal]. Finally, whether it is the [consonantal] or manner feature that spreads, both accounts are apparently equal in requiring a further change in the root feature [sonorant]. Similarly, all accounts must assume that at least some /r/s (namely, those in (3c)) are represented in a nonambient fashion. Ultimately, an account which spreads manner features has the advantage of providing a unified account of the phenomena in this and the other cases presented here.

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In the case of Subject 9, then, the feature [continuant] triggered the spread of that feature to glides underspecified for the manner feature [approximant]; spreading was also blocked by other segments, most notably /r/s, which are presumed to be specified for the feature [approximant]. Such effects motivate grouping together the features [continuant] and [approximant] as dependents of the same Manner node. Given the relationship between the two features [continuant] and [approximant] in this case and the relationship between [continuant] and [nasal] in the case of Subject 29, a relationship might also be expected to obtain between the features [nasal] and [approximant]. In the following section, this relationship will be documented for an assimilation involving glides and nasals.

4. The features [nasal] and [approximant]

The nasal harmony error pattern of Subject 29 found stops to be a possible target for nasal spreading and the manner feature [continuant] a possible blocker. A different version of this error pattern was also evident in the speech of Subject 23 (age 4;8). As can be seen in (5a), glides were replaced by a nasal when a nasal consonant occurred later in the word. Glides were produced correctly under other circumstances. While glides served as targets of such assimilation, other segments could not, including certain other glides, as shown in (5b). The glides in (5b) were (as in the prior case study) the product of a general gliding error pattern, which merged the distinction between liquid consonants and glides. That is, /r/s did not occur in this child's inventory and were replaced by a glide. These two error patterns interacted in a way that prevented the product of gliding from being a target of nasal harmony.[7] The forms in (5c) illustrate that fricatives and /l/ occurred without nasal substitutions.

[7] An anonymous reviewer has noted that the data in (5) are not entirely comparable in that the targets of assimilation in (5a) are word-medial and the blockers of assimilation in (5b) are word-initial. A more restrictive possibility is thus suggested by which the harmony process does not interact with gliding and is stipulatively restricted to word-medial contexts. The available data cannot definitively resolve the potential for an interaction between gliding and nasal harmony, although the assimilation of word-initial glides to a following /l/ in the word *yellow* may be indicative of the more general account. This would assume that /l/ is specified for manner as [approximant] and that that manner feature is available to spread to the underspecified glide, possibly by the same process that spreads the feature [nasal]. Independent of whether nasal harmony and lateral harmony are the same process or whether nasal harmony and gliding interact, the fundamental representational issues remain. That is, glides must be represented in such a way as to be vulnerable as a target of nasal harmony, and other segments (such as those in (5c)) must be represented in such a way as to block as targets of assimilation. On a somewhat different point, the blocking effects in (5b, c) do not seem to be attributable to a distinction between derived and nonderived forms since words such as *crayon* and *yellow* are nonderived and still undergo assimilation.

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(5) Nasal/glide asymmetries in nasal harmony (Subject 23, age 4;8)

(a) Glides as targets of nasal harmony

[sonɪŋ]	'sewing'	[blonɪŋ]	'blowing'
[fonɪŋ]	'throwing'	[nonɪŋ]	'snowing'
[fwɛnanz]	'crayon'		

(b) Glides corresponding to liquids blocked as targets of assimilation

[weɪn]	'rain'	[weɪnɪŋ]	'raining'
[wʌn]	'run'	[wʌnɪŋ]	'running'

(c) Fricatives and /l/ blocked as targets of assimilation

[kɔfɪŋ]	'coughing'	[dwaɪvɪŋ]	'driving'
[bʌzɪŋ]	'buzzing'	[fɪsɪŋ]	'fishing'
[sʌvlɪŋ]	'shoveling'		

In order for glides to serve as a target of nasal harmony, they must be underspecified for a feature of the same general type as the specified triggering feature. This would place the features [approximant] for glides and [nasal] on the same tier at some level of structure. Furthermore, if, as before, glides are assumed to be underspecified for the manner feature [approximant] and nasals are assumed to be specified for manner as [nasal], glides would be a likely target for nasal harmony. The spreading of the feature [nasal] to the underspecified Manner node of glides is illustrated in (6a), accounting for the forms in (5a). Nasal harmony may be motivated in this case (in contrast to the case of Subject 29) by a more general constraint which favors syllable onsets that are consonantal. That is, while glides are permissible as onsets, the association (or leftward alignment) of an available specified manner feature such as [nasal] would result in all associated segments being realized as consonants. The favored status of consonantal onsets was also evident in this child's replacement of a glide with the liquid consonant [l] in words such as *yellow*.[8] If the triggering liquid consonant is assumed to be specified for manner as [approximant], that consonantal manner feature would be available to spread to the glide which is underspecified for manner. Whatever the motivation for assimilation, the two features [nasal] and [approximant] interact, either by both spreading or by one blocking the other, as might be expected if both features were dominated by a single node.

The assimilation-resistant glides in (5b) corresponded with ambient /r/s and thus might be assumed to be represented underlyingly as such with manner specified as [approximant]. That specification and a general constraint against complex segments would cause /r/s to block as a target of [nasal] spreading. As illustrated in (6c), a gliding rule would then have to be ordered after assimilation in a counterfeeding relation to convert all /r/s to glides. The postulation of underlying /r/s in this child's system raises the

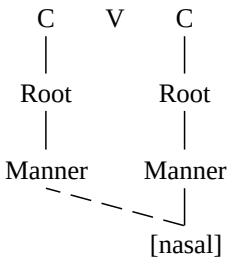
[8] It might be expected that this constraint would also result in the replacement of a glide by a fricative if followed by a fricative. Relevant data is, however, not available on this point.

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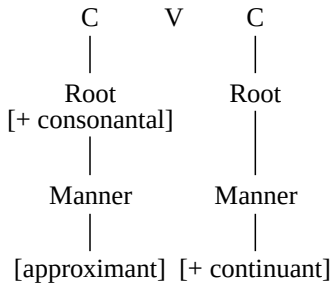
same abstractness concerns noted in the other two case studies and will be considered further in the following section.

(6) Geometric account of glide/nasal asymmetries

(a) Underspecified glides as targets of nasal spreading



(b) /r/s specified for manner as [approximant] block as targets of spreading



(c) Counterfeeding derivation of a form in (5b)

/reɪn/	'rain'
——	assimilation (blocked)
weɪn	gliding
[weɪn]	

Independent of the representational issue of those glides corresponding with /r/s, the other segments that blocked as targets of assimilation, namely fricatives and the liquid /l/ in (5c), would be specified for the manner features [+continuant] and [approximant]. Spreading to another segment with a specified Manner node would result in illicit complex segments. A somewhat different explanation must be sought for the fact that obstruent stops, which are underspecified for manner, did not also serve as targets of spreading. This may within a constraint-based framework be attributable to one or more highly ranked constraints which favor a faithful parse of the feature [−sonorant] and/or license the feature [nasal] only for sonorants (Mohanan 1993). Additionally, since stops are consonants, the replacement of a stop

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with a nasal would not contribute further to the satisfaction of the constraint favoring consonantal onsets.

In sum, in the case of Subject 23, certain glides (those underspecified for manner) served as targets of an assimilatory process triggered by the feature [nasal] and to a more limited extent by the feature [approximant]. Spreading was, however, blocked by segments specified for various different manner features, including fricatives, /l/ and those glides corresponding with ambient /r/s. The particular interaction in this case of the two features [nasal] and [approximant] supports their being grouped together as dependents of the same node. The further interaction of the feature [continuant] with each of the two other features [nasal] and [approximant] evident in this and the other two case studies fills out the expected range of relations for features that are indeed grouped together in a feature geometric sense. With this motivation for Manner as an organizing node of the geometry, the issue of how to represent underlyingly the blockers of assimilation is returned to in the next section.

5. Extended theory of underspecification

The previous sections documented cases of manner assimilation where particular segments (stops or glides) served as targets of assimilation but also in the same child's system blocked as targets under superficially similar circumstances. Because these blockers corresponded with other sounds of the ambient system (that is, with fricatives and /r/s, respectively) and were the product of independent error patterns, it was hypothesized, consistent with widely held assumptions about acquisition, that they might be represented underlyingly as in the ambient system. At the point assimilation would apply, the hypothesized representations were sufficiently specified to resist as targets of assimilation. A subsequent rule of absolute neutralization was then needed to convert in a counterfeeding relation all relevant fricatives or /r/s to stops or glides, respectively. Such accounts are acknowledged to entail rather abstract claims about the children's underlying representations inasmuch as the postulated segment types never occurred phonetically in the children's sound systems. Additionally, in at least the case of Subject 9, it was not possible to maintain ambient-like underlying representations for all forms without incurring an ordering paradox. Problems of this sort have long challenged theoretical accounts of acquisition and are equally relevant to the characterization of phenomena in fully developed systems involving absolute neutralization. One reason for the persistence of these problems is that the substance of underlying abstract distinctions is inherently difficult to motivate. Many different features are potentially available to distinguish sounds at the underlying level, any one of which would be sufficient, especially since the distinction is absolutely neutralized at the phonetic level.

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In this section, a more constrained alternative is considered for the acquisition facts which accounts for the differential behavior of phonetically identical segments but which does so by limiting the available features to those that are consistent with the children's production facts. This alternative employs an extension to underspecification theory which allows default features (and only those features) to be both specified and underspecified underlyingly. This is in addition to the conventional assumption that the more marked (or nondefault) features, if evident, must be specified underlyingly.

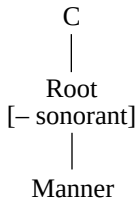
Within this approach, underlying feature specifications are determined on the basis of how sounds behave and how they are produced. While the emphasis might appear to be on production facts, presumed perceptual abilities of children are also equally relevant and compatible. Thus, if a child comprehended a distinction of the ambient system but did not produce that distinction in his or her own speech, the differential behavior of the segments in a perceptual task would motivate a distinction of some kind. Let us consider how the substance of an underlying distinction might be motivated within this approach. In the case of Subject 29, for example, the differential behavior among coronal stops with respect to nasal harmony requires in any account an underlying distinction of some kind. The fact that some coronal stops were targets of assimilation and others were blockers suggests on principled grounds that the distinction is one of underspecification versus specification. The only real issue then is how the blockers of assimilation are specified. Since the blockers of assimilation were produced as stops, compatibility with the production facts would support their being represented underlyingly as stops and thus specified as [−continuant]. We can further surmise that the relevant specified feature is a manner feature if the blocking effect in this case obtains for the same reason that other segments are blockers, that is, complex (branching) segments are prohibited. The postulation of any manner feature other than the feature [continuant] would suffer from the same abstractness concerns noted earlier. A phonological distinction would thereby be achieved as shown in (7) between underspecified and specified stops for purposes of assimilation.[9] By specifying the Manner

[9] Given that two fricatives occurred in word-initial position in this child's system, the question might arise whether a possible three-way distinction is warranted between obstruents that are underspecified for manner, those that are specified as [−continuant], and those that are specified as [+continuant]. Since fricatives never occurred in post-vocalic contexts, the available evidence supports at most a two-way distinction in any context. That is, post-vocalically the distinction is between underspecified and specified stops, and word-initially between underspecified stops and specified fricatives. However, even if it turned out that a three-way distinction were necessary in this or other cases of developing systems, it should be noted that comparable situations have been motivated in fully-developed systems (see especially note 10 below referring to the cases cited in Archangeli & Pulleyblank (1994) and Inkelas (1994)).

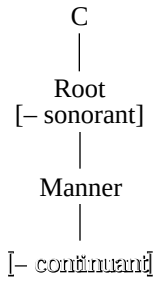
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node of the assimilation-resistant stops as [−continuant], the desired blocking effect is achieved. That is, spreading of the feature [nasal] to a specified Manner node would result in a complex segment. The phonological distinction between underspecified and specified stops would not, however, result in a phonetic distinction when the triggering [nasal] feature is not present elsewhere in the word. That is, in the absence of assimilation, the underspecified segment would have [−continuant] filled in by default, resulting in a phonetic merger with those segments that are specified underlyingly as [−continuant].

(7) Underlying representation of stops
   (a) Stops that are targets of assimilation



   (b) Stops that are blockers of assimilation



This account represents an extension to radical underspecification theory by allowing the underlying specification of a default feature in addition to the underspecification of that same feature, what has been termed SHADOW-SPECIFICATION (Dinnsen 1993).[10] Shadow-specification was originally put forward as an alternative account of various other acquisition phenomena which have commonly been taken as evidence for ambient-like underlying

[10] A similar proposal is embodied in combinatorial specification (Archangeli & Pulleyblank 1994: 73–83, 98–101, 273–274) to account for similar phenomena in various fully developed languages, for example, Barrow Inupiaq high front vowels, Ainu low back vowels and Kalenjin ATR harmony.

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representations in either a one- or two-lexicon model of children's early sound systems (compare Smith 1973, Menn 1976). More specifically, despite the fact that many children's error patterns result in a phonetic merger, the merged sounds often behave differently, especially with respect to a child's presumed perceptual abilities, the operation of phonological rules and/or the elimination of an error pattern. In each case, shadow-specification provided a means within a one-lexicon model for differentiating segments underlyingly in terms of just those features that occurred in the child's speech. That distinction accorded with the child's perceptual judgment that there was a difference (although the substance of the distinction differed from that employed in the ambient system). That distinction was also sufficient to differentiate those segments that could undergo a particular nonassimilatory rule from those phonetically identical segments that did not. And finally, that distinction was sufficient to identify uniquely those words that were produced in error and ultimately needed to change from those that were correct and would remain unchanged. The evidence presented here further supports shadow-specification in several respects. First, the range of phenomena exhibiting differential behavior of segments is here extended to include assimilatory phenomena. Secondly, earlier work has had to assume somewhat arbitrarily which of the two phonetically identical segments is shadow-specified and which is underspecified. The observed asymmetries associated with what can block or be a target of assimilation do, however, provide empirical evidence for the choice. For example, in the particular case of Subject 29, it must be the ambient stops that are underspecified for manner, given that they served as targets of assimilation. Those stops that happened to correspond with ambient fricatives and more importantly blocked assimilation must be shadow-specified as [−continuant].[11] To represent ambient fricatives as stops through shadow-specification does entail the postulation of underlying representations that are different from those of the ambient system, but this should not be interpreted as a drawback to the account. There is, of course, no a priori reason to expect that children's underlying representations be ambient-like, especially in the early stages of development. In fact, it is more likely, as Rice & Avery (1995) have argued, that children's underlying representations evolve over time becoming more elaborated and deriving from structures with few specified features. As the child recognizes more features of the ambient system to be contrastive, more features would need to be specified underlyingly by the child. A child's

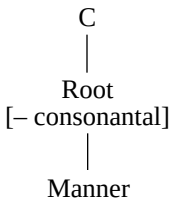
[11] While in this and some other cases, the sound produced in error is shadow-specified, there are cases where shadow-specification does not coincide with an error. That is, shadow-specification is unnecessary in those cases where there is no empirical distinction between merged sounds, and there are other cases where a distinction is necessary and it is the target appropriate realizations that are shadow-specified. For a discussion of some such cases, see Dinnsen et al. (1997). This was also evident to some extent in the case of Subject 9, where under any account, some ambient /r/s had to be represented as glides.

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recognition of a contrast does not, however, require the child to represent that contrast in exactly the same way an adult would. See especially Nittrouer & Studdert-Kennedy (1987) for evidence that children often weight acoustic cues differently from adults. Also, nonambient-like underlying representations have been motivated elsewhere to account for individual differences within and across children in terms of their error patterns and learning (for a review, see Dinnsen (1996b, in press). Shadow-specification would seem to arise as an intermediate stage of development prior to full mastery but after an early stage where ambient contrasts are merged at both the underlying and phonetic levels. This intermediate stage of development reflects a child's recognition of an ambient contrast and the representation of that contrast, albeit in terms of features that are drawn from the child's own production repertoire. While this may result in underlying representations that differ in substance from those of the ambient system, distinctions of at least some sort are being preserved. This differs from other more abstract accounts by disallowing underlying distinctions which contradict (or are otherwise incompatible with) the child's own production facts.

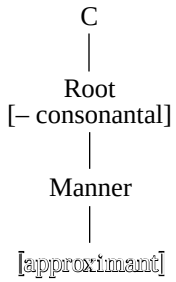
Turning to the cases of Subjects 9 and 23, there was differential behavior among the glides relative to manner assimilation, motivating an underlying distinction. If the blockers of assimilation are assumed to be specified for some manner feature, then they would properly resist as targets of a process that spread some other manner feature. That is, spreading would result in an illicit complex segment. Furthermore, if that specified manner feature is selected on the basis of the children's production facts, the only available feature consistent with those facts is the feature [approximant]. Shadow-specification provides a means for distinguishing these glides from the others that did undergo assimilation, as illustrated in (8). Specifically, the assimilation-resistant glides would be represented as [−consonantal] segments with a Manner node shadow-specified for the feature [approximant], as in (8b). That specification would be sufficient to block assimilation in just those forms and would be distinct from the other [−consonantal] segments in (8a) that are underspecified for manner. The two different types of glides would also remain distinct from the liquid consonant /l/ as a result of the [+consonantal] root feature specification, as shown in (8c).

(8) Underlying representation of glides and liquids
  (a) Glides that are targets of assimilation

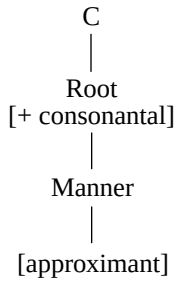


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(b) Glides that block as targets of assimilation



(c) /l/s that block and trigger assimilation



Interacting error patterns of the sort described here are by no means limited to manner features. Similar asymmetries have been observed in other cases of acquisition involving place features (Dinnsen et al. 1997). In these cases, long-distance consonantal place assimilation interacted with another common and independent error pattern which replaced a velar consonant with a coronal. The result was that some coronals served as targets of place assimilation, while others did not. These additional cases of interacting error patterns further motivate the extension to radical underspecification theory that allows the underlying specification of default features (shadow-specification) in addition to the underspecification of those features. Given that shadow-specified representations may be motivated in the course of acquisition, it is not unreasonable to expect such representations to survive or persist into fully-developed systems. For discussion of some cases amenable to such an account see, for example, Archangeli & Pulleyblank (1994: 73–83, 98–101, 273–274) and Inkelas (1994). It might also be speculated that those cases in fully-developed systems which presumably motivate contrastive specification (Steriade 1987) may have evolved from shadow-specification after the loss of a distinction that had been associated with an underspecified representation.

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6. Conclusion

In each of the cases considered here, some form of manner assimilation was triggered by either a nasal, fricative or (to a lesser extent) a liquid. The targets of assimilation were limited to a nonoverlapping class of sounds, either obstruent stops or glides. In each case, some feature different from the triggering feature caused a segment to block as a target of assimilation. For example, in the case of Subject 29, the feature [nasal] was blocked from spreading to segments specified for the feature [continuant]. In the case of Subject 9, the feature [continuant] was blocked from spreading to segments specified for the feature [approximant] or [nasal]. And finally, in the case of Subject 23, the feature [nasal] was blocked from spreading to segments specified for the feature [approximant] or [continuant]. In order for these different features to interact (block and trigger assimilation) in this way, they must be on the same tier at some level of structure. Also in each case, assimilation resulted in the replacement of a default feature by a different more marked feature of the trigger. That is, the default features for obstruent stops and glides ([−continuant] and [approximant], respectively) were replaced by other manner features through assimilation. These obstruent stops and glides also never triggered assimilation. For a segment to be a target of assimilation, it must have some structural affinity with the triggering feature in order to attract the assimilating (spread) feature. That affinity can be achieved by grouping the features on the same tier with one feature underspecified and the other specified. The underspecification of stops and glides would also explain why they never triggered assimilation. Thus, both in terms of which features can block or trigger assimilation and which segments can serve as a target of assimilation, there is motivation for grouping together the three different features [continuant], [nasal] and [approximant] as dependents of the same node, namely Manner.[12] In this way, the particular asymmetries follow from spreading some specified manner feature to a segment underspecified for manner. Since glides and obstruent stops would be underspecified for manner, they are vulnerable as targets of assimilation. Also, since fricatives, nasals and liquids are specified for manner, they are likely triggers and blockers of assimilation. Some obstruent stops and glides did, however, block as targets of assimilation. Those stops and glides were found to be the product of other independent error patterns, stopping and gliding, respectively. The interaction of these error patterns with assimilation revealed that these stops and glides must be represented differently from those that could serve as targets of assimilation.

[12] No claim can be made here about the location of the Manner node in the geometry. In the absence of evidence, it is arbitrarily assumed that the Manner node is a dependent of the root node.

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Whatever the precise nature of that distinction, it is clear that those obstruent stops and glides that block as targets of assimilation must be specified for some manner feature. Abstractness considerations argue against the specified manner feature being ambient-like. Even beyond considerations of abstractness, in some instances, the child's underlying representations must be assumed to be nonambient-like, that is, they contradict feature specifications in the ambient system. The contribution of shadow-specification to this issue is that some segments can be expected to have been internalized differently, but those differences will be limited to features evident in the children's productions. For example, those obstruent stops and glides that blocked as targets of assimilation would not be represented as ambient fricatives and liquids because such representations would contradict the children's production facts. Instead, they would be shadow-specified for manner in terms of features consistent with their own production facts. This entails their being specified underlyingly for a default manner feature, namely [−continuant] for obstruents and [approximant] for glides. That specification would be sufficient to distinguish those stops and glides from the others that do serve as targets of assimilation. Moreover, the blocking effects are achieved in terms of features that are entirely compatible with the child's production facts.

The phenomena and issues considered here have been cast within a conventional derivational theory, which assumes that rules mediate between levels of representation. These phenomena and issues prove to be relevant and challenging for alternative nonderivational constraint-based theories as well. For example, within the framework of optimality theory (Prince & Smolensky 1993), a ranked set of violable universal constraints selects the optimal output for any given input (underlying representation). This leaves differences in input representations and constraint rankings as the only elements of grammar that can vary. The nature of children's input representations thus remains a fundamental issue. Also, while the constraints are presumed to be universal, the precise formulation of those constraints is far from being agreed upon. It thus remains important to motivate the phonological structures (features and units of organization) relevant to the expression of those constraints. Given the relationship of the various manner features considered here, a higher order organizing Manner node (or alternatively within feature class theory (Padgett 1995), a class of manner features) is potentially relevant to the formulation of those constraints. The harmony or assimilation effects would obtain from some constraint which favors the multiple linking of features associated with the manner class. Some possible constraints and rankings have been alluded to throughout this paper. For example, the replacement of a glide by a fricative, nasal or liquid may be the result of ranking some well-formedness constraint which favors syllable onsets that are consonantal over some other constraint which requires faithfulness to the input. Such an effect can be achieved through the

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alignment of specified manner features, which are themselves licensed by consonantal segments. If glides are underspecified for manner as argued here, they can be associated with manner by alignment from another consonantal segment that is specified for manner elsewhere in the word. The claim in this instance is that it is more important for a segment to have manner than to faithfully parse the particular root feature [−consonantal]. When the harmony effects happen to be more limited, for example, glides are replaced by fricatives but not by nasals or liquids as in the case of Subject 9, then a highly ranked well-formedness constraint might select as optimal a candidate with an onset of low sonority over other candidates with more sonorous onsets. Again, alignment of a specified manner feature must take precedence over the faithful parsing of [−consonantal]. The difference in this case is that the family of alignment constraints is exploded with faithfulness considerations intertwined. That is, an input glide underspecified for manner would be replaced by a fricative if that glide were associated with the manner feature [+continuant] by alignment, and that constraint outranked the faithful parsing of [−consonantal]. Those same glides would not be replaced by nasals or liquids if the faithful parsing of [−consonantal] in turn outranked alignment of the other manner features. It is this interspersing of faithfulness constraints within a family of well-formedness constraints that obviates the apparent contradictions that are sometimes observed in conventional derivational theories. A challenge for these theories is accounting for harmony and the lack of harmony when another error pattern such as gliding or stopping interacts. Recall, for example in the case of Subject 9, that glides corresponding to ambient /r/s were not replaced by a fricative even though under the same circumstances other glides were. The theoretical problem is that glides as syllable onsets must be favored and disfavored at the same time. This problem cannot be resolved by assuming that this child's underlying representations are ambient-like, as has been assumed for other children in much of the optimality work (see Demuth 1995, Gnanadesikan 1996, Smolensky 1996). One reason for this is that the equivalent of a sequential derivation involving a counterfeeding interaction would be required for some words. That is, faithfulness constraints would have to be dominated by some constraint(s) that would favor a glide as an optimal output for an input /r/ but would also favor a fricative as an optimal output for an input glide. Even if it were possible to formulate and rank some constraints to achieve the effect of this counterfeeding interaction (compare Kirchner 1996), the facts of this particular case would also require just the opposite ranking for certain other words where ambient /r/s did undergo assimilation. These problems appear to be attributable to the questionable assumption that the child's underlying representations are ambient-like. If, however, our assumptions about underlying representations are modified to allow some inputs to differ from those of the ambient system through shadow-specification as developed here, the problems are obviated. For

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example, then, those glides that might undergo assimilation would be underspecified for manner in the input representation, and a highly ranked alignment constraint would select as optimal an output that has a specified Manner node associated with the input glide and some other segment in the word. For those other glides that behave differently by resisting assimilation, their being shadow-specified for manner would comply with both alignment and faithfulness, accounting for the lack of assimilation. To the extent, then, that certain segments must resist assimilation, those outputs that are shadow-specified represent optimal outputs with respect to both alignment and faithfulness. Appeals of this sort to underspecification theory generally and shadow-specification in particular need not be judged incompatible with constraint-based theories (see Inkelas 1994, Itô et al. 1995). Additionally, whether a derivational or constraint-based theory is adopted, it appears that some form of underspecification theory is needed to account for other acquisition phenomena, including most notably the facts associated with the acquisition of phonemic contrasts (Dinnsen & Chin 1995; Dinnsen 1996a, b).

Through an examination of consonantal assimilations in the developing systems of young children, some expected and some unexpected asymmetries in what can serve as a potential trigger, blocker and target of assimilation have been revealed. The existence of these asymmetries has further supported specific claims about the (under)specification of phonological representations and has elucidated certain aspects of the internal geometric structure of segments.

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