Published in final edited form as:

Clin Linguist Phon. 2014 ; 28(0): 463–476. doi:10.3109/02699206.2014.926996.

Unraveling phonological conspiracies: A case study

Daniel A. Dinnsen, **Judith A. Gierut**, and **Michele L. Morrisette**
Indiana University, Bloomington, Indiana, USA

Darcy E. Rose
University of Canterbury, Christchurch, New Zealand

Abstract

This paper focuses on three seemingly unrelated error patterns in the sound system of a child with a phonological delay, Child 218 (male, age 4 years; 6 months) and ascribes those error patterns to a larger conspiracy to eliminate fricatives from the phonetic inventory. Employing Optimality Theory for its advantages in characterizing conspiracies, our analysis offers a unified account of the observed repairs. The contextual restrictions on those repairs are, moreover, attributed to early developmental prominence effects, which are independently manifested in another error pattern involving rhotic consonants. Comparisons are made with a published case study involving a different implementation of the same conspiracy, the intent being to disambiguate the force behind certain error patterns. The clinical implications of the account are also considered.

Introduction

The discovery of phonological conspiracies in fully developed languages (e.g. Kiparsky, 1976; Kisseberth, 1970) convincingly established that it is no accident that certain seemingly unrelated phonological processes co-occur in a grammar and work together to achieve the same end. That discovery posed a significant challenge for rule-based theories (e.g. Chomsky & Halle, 1968), largely because of their inability to capture the unifying generalization behind functionally related processes. The constraint-based framework of Optimality Theory (e.g. Prince & Smolensky, 1993/2004) has emerged as the only currently known framework that offers a solution to this problem. Recent optimality theoretic accounts of conspiracies in the grammars of young children with phonological delays (e.g. Dinnsen, Gierut, & Morrisette, in press; Pater & Barlow, 2003) have also revealed a clinical dimension for conspiracies. Those and other studies have found that some error patterns are merely superficial symptoms of a larger problem, refocusing clinical attention on the driving force behind those error patterns. Moreover, because conspiracies are thought to represent highly stable states that are resistant to change (e.g. Kiparsky, 1976), children's conspiracies can present special challenges for treatment and learning. All of this underscores the importance of arriving at an accurate diagnosis of a conspiracy and properly identifying all of the error patterns that participate in that conspiracy. How, then, can an analyst/clinician

Address for correspondence: Daniel A. Dinnsen, Department of Linguistics, 1021 E. Third St., Indiana University, Bloomington, IN 47405, USA, dinnsen@indiana.edu.

Declaration of Interests The authors report no conflicts of interest.

determine whether a particular error pattern is symptomatic of a specific conspiracy? This question can be especially difficult to answer when an error pattern is symptomatic of more than one problem/conspiracy. This paper attempts to shed some light on this issue by comparing two children's different manifestations of the same conspiracy, the intent being to disambiguate the source of certain error patterns. One of the case studies is drawn from the published literature, and the other is presented anew here. While it will be shown that these two children share the same general conspiracy and some of the same error patterns, those error patterns will be shown to point unequivocally to rather different problems with different treatment implications.

The analytical problem that we want to focus on can be illustrated by first briefly reviewing the Pater and Barlow (2003) case study of a child with a phonological delay, Child LP65 (male, age 3 years; 8 months), who exhibited a conspiracy to eliminate all fricatives from his phonetic inventory. The conspiracy was manifested by two distinct error patterns or repair processes, one that deleted fricatives in a cluster (e.g. [ni:d] `sneeze') and the other that changed fricatives to a stop in all other contexts (e.g. [d̥ up] `soup', [dupi] `goofy', [b̥ ÊŁd̥] `push'). The end result of these two different processes was that fricatives were prevented from occurring in the child's phonetic inventory. It is, however, noteworthy that there was also another co-existing conspiracy operating in Child LP65's phonology, namely a conspiracy to eliminate onset consonant clusters. Again, there were several different ways that onset clusters were repaired to comply with this second conspiracy, sometimes by Coalescence (e.g. [waɪ] `fly') and all other times by Deletion of either the first or the second consonant in the cluster (e.g. [d̥ u] `school', [bɛd] `bread'). The end result of those various reduction processes was the complete absence of onset consonant clusters in Child LP65's speech output. The convergence of these two conspiracies on the Deletion of fricatives in a cluster makes it difficult to know whether Deletion of a fricative might still have been a viable repair for fricatives if the conspiracy against clusters had not been active in that child's phonology. Stated differently, is Deletion truly symptomatic of a conspiracy to avoid fricatives? This is where it is instructive to look to the sound system of another child who excludes all fricatives from the phonetic inventory, but who also produces onset consonant clusters without any interference from a conspiracy against clusters. The focus of the current paper is on the examination of such a case. It will be shown that Deletion remains one of several preferred repairs in response to this child's conspiracy against fricatives, even when onset consonant clusters were tolerated. Our account will employ Optimality Theory (henceforth OT) for its advantages in characterizing this and other conspiracies, offering a unified explanation for the different repairs in different contexts. The clinical challenged posed by conspiracies is also illustrated by considering the implications of our OT account for the selection of treatment targets and the projection of learning.

The case study

Methods and analysis procedures

As the data for the case study of Child LP65 were drawn from the Developmental Phonology Archive of the Learnability Project at Indiana University (Gierut, 2008), we have opted to consult the same Archive for the identification of another comparable case study that might help disentangle particular elements of the conspiracy against fricatives. The Archive includes phonological data and analyses for more than 234 children (age 3;0 to 7;9) who are typically developing in all respects, except for evidence of a phonological delay. Claims about the children's phonologies are based on comprehensive speech samples and standard phonological analysis procedures that have been described extensively elsewhere (e.g. Gierut, 2008). Briefly, the speech sample for each child was elicited in a spontaneous picture-naming task and was audio recorded. The pictures related to a probe list of 544 words that were familiar to children of that age and that sampled the full range of English consonants in initial, medial, and final positions in multiple exemplars. The audio-recorded sessions were phonetically transcribed by trained listeners who had considerable experience in the transcription of clinical populations. For transcription reliability purposes, 10% of all probes were retranscribed by an independent judge. The overall transcription reliability measure was 92% agreement for all phonologies, which is within the range of what is typically deemed acceptable (e.g. Shriberg & Lof, 1991).

For the purposes of the current study, the pretreatment phonological records of all 234 children in the Archive were examined to establish the status of each child's fricative inventory and to identify the processes affecting fricatives. We were specifically interested in identifying those phonologies that excluded all fricatives but that allowed consonant clusters. The following operational definitions were employed as in our other studies (e.g. Dinnsen, Green, Gierut, & Morrisette, 2011): For any fricative phoneme to be judged as occurring in the inventory, it had to be produced with an accuracy at or above 20% and/or in at least two minimal pairs. Those target fricatives that did not meet this minimal criterion were classified as non-occurring and were especially relevant to the identification of a child's repair processes. Active processes were those that affected a minimum of 25% of relevant words with a specific repair.

Our analysis of the 234 children's phonetic inventories identified 41 children who, like LP65, excluded all fricatives from their inventories. Of those 41 cases, 21 exhibited intact onset consonant clusters of one sort or another. The case of Child 218 (male, age 4;6) was selected from that set to illustrate one especially revealing manifestation of the conspiracy against fricatives. While all fricatives were excluded from this child's inventory, all other target consonants of English did occur and were produced correctly, with a few notable contextual exceptions involving liquid consonants (described below). Additionally (and unlike what was observed for Child LP65), this child did produce certain onset consonant clusters, and, thus, did not exhibit a conspiracy against clusters.

Child 218's putative conspiracy

Child 218 exhibited three formally distinct processes that operated on the entire set of target fricatives, effecting different phonetic outcomes in different contexts. One of those processes was limited to word-initial singleton fricatives, changing all of them to a glide with the same corresponding place feature (Fricative Gliding). For example, while the forms in (1a) show that word-initial labial fricatives were replaced by the labial glide [w], the forms in (1b) illustrate the replacement of grooved coronal fricatives by a palatal glide [j]. It is noteworthy that this process was not one of the observed repairs for fricatives in Child

LP65's phonology. Instead, that child employed Stopping for word-initial singleton fricatives.

(1) Fricative Gliding

a. Word-initial labial fricatives replaced by a labial glide

[w ʊ t] `foot'	[w eɪ t] `face'
[w aɪ b] `five'	[w ɪ ʧ] `fish'
[w aɪ j ʊ r] `fire'	[w æ n] `van'

b. Word-initial grooved coronal fricatives replaced by a palatal glide

[j ɑ k] `sock'	[j u p] `soup'
[j oʊ p] `soap'	[j u] `zoo'
[j ʌ n] `sun'	[j ɪ r oʊ] `zero'

The second process affecting fricatives changed all post-vocalic fricatives to a corresponding obstruent stop with the same primary place of articulation (Stopping). The forms in (2a) illustrate the Stopping process for post-vocalic labial fricatives, and the forms in (2b) do the same for grooved coronal fricatives. By way of comparison, Child LP65 also employed Stopping in this context.

(2) Stopping

a. Post-vocalic labial fricatives replaced by a labial stop

[k ɑ p] `cough'	[w u p] `roof'
[l i p] `leaf'	[l æ p] `laugh'
[n aɪ p] `knife'	[w eɪ b] `wave'

b. Post-vocalic grooved coronal fricatives replaced by a coronal stop

[aɪ t] `ice'	[ʤ u t] `juice'
[m aʊ t] `mouse'	[b ʌ t] `bus'
[n ɔɪ d] `noise'	[n oʊ d] `nose'

The third and final process targeting fricatives deleted them in word-initial clusters (Deletion). The tokens in (3) exemplify this Deletion process in the full range of word-initial fricative clusters.

(3) Deletion in fricative clusters

a. /s/+nasal

[m oʊ k] `smoke'	[n eɪ k] `snake'
[n i d] `sneeze'	[n æ k] `snack'
[n oʊ m æ n] `snowman'	[m ɛ ʊ] `smell'

b. /s/+stop

[d ɑ r] `star'	[d ɑ p] `stop'
[b u n] `spoon'	[b eɪ t] `space'
[g ʌ ŋ k] `skunk'	[g eɪ t] `skate'

c. Fricative+/l/

[l ɔ r] `floor'	[l i p] `sleep'
[l aɪ] `fly'	[l ɛ d] `sled'
[l æ g] `flag'	[l aɪ d] `slide'

d. /f/+/r/ (also Rhotic Gliding)

[w u t] `fruit'	[w ɪ n d] `friend'
[w ɑ g] `frog'	[w ʌ n t̚] `front'
[w ɪ n t w aɪ d] `french fries'	[w ɔ g i] `frog i'

e. /s/+glide

[w ɪ m] `swim'	[w i p] `sweep'
[w ɪ ŋ] `swing'	[w i t] `sweet'
[w ɪ m i n] `swimming'	[w ɛ d ə r] `sweater'

The data in (3) reveal an important property of liquid consonants in Child 218's sound system. Notice that /l/ was produced target-appropriately in word-initial onsets (3c), while /r/ underwent Rhotic Gliding in that same context (3d)[1]. We will see that these observations also hold for liquids in stop clusters (4) as well as for target singleton liquids in word-initial position (5). By way of comparison, Child LP65 excluded all liquid consonants from his inventory.

In contrast to the behavior of fricative clusters in (3), a significant property of Child 218's phonology was that onset clusters beginning with a target stop were produced as a cluster, as can be seen in (4). No such clusters were tolerated in Child LP65's phonology.

(4) Target stop clusters (No Deletion)

a. Stop+/l/

[b l oʊ w i n] `blowing'	[g l aʊ d] `cloud'
[p l eɪ] `play'	[g l i n] `clean'
[p l eɪ n] `plane'	[g l u] `glue'

b. Stop+/r/ (Rhotic Gliding)

[g w oʊ] `grow'	[k w i m] `cream'
[p w ɛ t ʊ] `pretzel'	[b w ɛ d] `bread'
[t w eɪ n] `train'	[d w i] `tree'

c. Stop+glide

[d w ɪ ŋ k i] `twinkie'	[k w i n] `queen'
[t w i d i] `tweety'	[g w ɪ k] `quick'
[t w ɛ ʊ b] `twelve'	[g w æ k] `quack'

[1]The behavior of /fr/ clusters is somewhat ambiguous in that the child's output might conceivably have followed from Deletion of the rhotic consonant and Gliding of the fricative. We reject this interpretation because rhotic consonants did not delete in any other contexts, and labial fricatives patterned with other fricatives in all other clusters.

The data in (4) also serve to reiterate the points regarding liquid consonants in word-initial onsets, even when produced in a cluster. Notice, for example, in (4a) that stop+/l/ clusters were produced target-appropriately, while in (4b), stop+/r/ clusters underwent Rhotic Gliding.

The forms in (5) illustrate the behavior of singleton liquid consonants when not in a target cluster. Again, we see that /l/ was produced target-appropriately in word-initial position (5a), while /r/ underwent Rhotic Gliding in that same context (5b). The additional fact of interest is that /r/ was produced target-appropriately in post-vocalic contexts (5c). An unrelated set of processes that will not be considered further here caused post-vocalic /l/ to be produced in error. One consequence of this child's contextual restrictions on liquid consonants was that /l/ and /r/ were produced target-appropriately in complementary contexts. While such distributional asymmetries can be suggestive of an allophonic relationship, this child's liquid consonants remained distinct in their substitution patterns, with neither sound ever replacing the other in any context.

(5) Target liquid singleton consonants

a. /l/ produced target-appropriately in word-initial position

[l aɪ t] `light'	[l ɛ g] `leg'
[l æ d ʊ r] `ladder'	[l i p] `leaf'
[l æ p] `laugh'	[l æ m p] `lamp'

b. /r/ replaced by a glide word-initially (Rhotic Gliding)

[w ʌ n] `run'	[w eɪ n] `rain'
[w ɑ k] `rock'	[w aɪ d] `ride'
[w i d] `read'	[w æ p] `raft'

c. /r/ produced target-appropriately in post-vocalic contexts

[d ɪ r] `deer'	[dʒ ɛ r] `chair'
[w aɪ j ʊ r] `fire'	[d ɑ r] `star'
[d ɔ r] `door'	[b aɪ d ʊ r] `spider'

A rule-based account of these facts would require three formally distinct rules to capture the generalization that fricatives were disallowed in Child 218's phonetic inventory. Also, while that same generalization held for Child LP65, it would have to be expressed by a different set of rules with different repairs in different contexts. A rule-based account must also treat as accidental the fact for Child 218 that both fricatives and rhotic consonants were realized as glides in word-initial position. Finally, it remains to be explained why Child 218 employed Deletion instead of Stopping as a repair of fricative clusters, especially given that Stopping was an active process in another context, and a stop substitute would have yielded an otherwise permissible cluster for this child. In response to these questions and the shortcomings of a rule-based account, we turn to an OT account of the facts in the next section.

The Optimality Theoretic Account

We have adopted here the constraint-based framework of OT in an effort to provide a unified account of this child's conspiracy. This framework enjoys well documented advantages not available in other approaches in the characterization of conspiracies and acquisition. Additionally, OT makes a number of substantive claims about the universal and language-specific properties of grammar that account for phonological phenomena. For example, while there are no universal or language-specific rules within OT, violable constraints are employed instead, and those constraints are presumed to be universal. On the other hand, the ranking of the constraints (i.e. the constraint hierarchy) is determined largely on language-specific grounds. Constraints are of two types, i.e. markedness and faithfulness, and they often conflict in their demands. Conflict is resolved by ranking the constraints. Higher ranked constraints carry more weight in the evaluation and selection of the winning output candidate. Markedness constraints refer exclusively to properties of output representations, without regard to the input (or underlying) representations, and militate against typologically marked structures in potential output candidates. Faithfulness constraints, on the other hand, refer to a correspondence relation between input (underlying) and output representations, demanding identity between the two. Output candidates that differ from the input are, thus, disfavored by faithfulness constraints. The output candidate that best satisfies the constraint hierarchy (i.e. the candidate that incurs the least serious violations from highly ranked constraints) is selected as optimal (i.e. the winner).

OT makes a number of other assumptions that have special significance for acquisition and learning. For one, it is assumed that markedness constraints outrank faithfulness constraints by default in the initial-state (e.g. Smolensky, 1996). This accounts for children's predisposition for production errors in early phonological development. To eliminate those errors, it is then left to the child to demote the relevant markedness constraints below the critical faithfulness constraints based on positive evidence from the target language. Several different formal learning algorithms have been put forward (e.g. Prince & Tesar, 2004, and references therein), but the basic idea is that a constraint that had favored the child's previous output must now be demoted just below the highest ranked constraint (markedness or faithfulness) that the child's previous output violated. Related to this point is the further assumption that faithfulness constraints remain ranked as low as possible throughout the acquisition process. Finally, OT maintains via `Richness of the Base' that there can be no language-specific restrictions on input representations (e.g. Smolensky, 1996). This is a significant departure from earlier theories of phonology, but the consequence for accounts of acquisition is that we, as analysts, must allow for the possibility that children have internalized richly specified underlying representations, essentially as rich as target (underlying) representations might require. This shifts the analytical burden entirely to the constraint hierarchy to derive the observed output no matter what might be assumed about the child's underlying representations.

The initial set of constraints most relevant to the characterization of this child's error patterns is given in (6) with associated definitions. The markedness constraint *fric abbreviates a family of constraints disfavoring all of the different subclasses of fricatives. Rhotic consonants constitute another set of late acquired, relatively marked sounds that would incur a violation from the independent markedness constraint *r. Finally, the Sonority Sequencing Principle (SSP) disfavors onset consonant clusters with level or falling sonority profiles (e.g. Clements, 1990). This constraint is highly ranked in English and allows onset consonant clusters, provided that they have a rising sonority slope. The faithfulness constraints in (6b) are antagonistic to the markedness constraints and make reference to features that are implicated in the various repairs that were documented in the previous section. For example, Stopping results in a violation of ID[cont] because it entails a change in the feature [continuant] when an input fricative changes to a stop in the output. Gliding of either fricatives or rhotic consonants implicates a change in the feature [consonantal] and, thus, a violation of ID[cons]. Finally, any segment of the input that is deleted in the output will incur a Max violation.

(6) Preliminary set of constraints

a. Markedness

*fric: Fricatives are banned

*r: Rhotic consonants are banned

Sonority Sequencing Principle (SSP): Onset clusters with level or falling sonority are banned

b. Faithfulness

ID[cons]: Corresponding segments must have the same specification for the feature [consonantal] (No Gliding)

ID[cont]: Corresponding segments must have the same specification for the feature [continuant] (No Stopping)

Max: Every segment in the input must have a correspondent in the output (No Deletion)

We turn now to the specifics of our account. Child 218 employed Gliding to eliminate all singleton fricatives in word-initial position. The required ranking of these constraints is given in (7). The notation `>>' indicates a crucial ranking of constraints, and constraints that are separated by a comma are unranked relative to one another. Note first that the markedness constraint against fricatives is undominated, i.e. it is never violated. This is consistent with the default ranking of markedness over faithfulness, and we will see that it also conforms to standard schemata for conspiracies, namely one or more markedness constraints ranked over two or more crucially ranked faithfulness constraints. Finally, because Gliding appears to be the default repair for fricatives in this context, ID[cons] must be ranked relatively low among the faithfulness constraints. The ranking arguments for these and other constraints will be made clear as we work through the various tableaux.

(7) Preliminary ranking of constraints

*fric, SSP, *r >> ID[cont] >> Max >> ID[cons]

The tableau in (8) considers the behavior of target word-initial singleton fricatives and shows how the Gliding candidate (b) is selected as optimal given the ranking in (7). A solid vertical line between constraint columns denotes a crucial ranking of the respective constraints, and the dotted vertical line indicates that those constraints are unranked relative to one another. The asterisk (*) in a cell indicates that the associated candidate violates the constraint heading the column. The manual indicator points to the optimal output candidate. We include in this and subsequent tableaux only those constraints that are relevant to the most likely competitor candidates. Notice that the fully faithful candidate (a) with an initial fricative incurs a fatal violation of the undominated markedness constraint *fric and is eliminated from the competition. The Deletion candidate (c) and the Stopping candidate (d) incur a violation of Max and ID[cont], respectively, and both of those violations are more serious than the ID[cons] violation incurred by the Gliding candidate (b). Therefore, candidate (b) is selected as the winner.

(8) Gliding of singleton fricatives word-initially

`foot'

/ fʊt /	*fric	ID[cont]	Max	ID[cons]
a. fʊt	*!			
☞ b. wʊt				*
c. ʊt			*!	
d. pʊt		*!		

The tableau in (9) accounts for the Deletion repair in a target fricative cluster and provides the ranking argument for ID[cont] needing to be ranked over Max. The fully faithful candidate (a) is eliminated by its violation of *fric. Notice, however, that the clusters in (a) and (b) do not violate the SSP. The relevance of the SSP becomes clear in its elimination of the ill-formed cluster of glides in candidate (d)[2]. The ranking of ID[cont] over Max explains why Stopping in candidate (b) is not a viable repair for fricative clusters. The Deletion candidate (c) is, thus, more harmonic than the Stopping candidate (b) and is selected as optimal.

(9) Deletion of fricatives in word-initial clusters

`swim'

/ swɪm /	*fric	SSP	ID[cont]	Max	ID[cons]
a. swɪm	*!				
b. twɪm			*!		
☞ c. wɪm				*	
d. ywɪm		*!			*

The same hierarchy of constraints accounts for Rhotic Gliding in word-initial position, as illustrated in (10). The faithful candidate (a) with an initial rhotic consonant is eliminated by its fatal violation of *r. The Deletion candidate (c) and the Stopping candidate (d) violate Max and ID[cont], respectively, and are eliminated in favor of the Gliding candidate (b).

[2]Deletion of either the first or second glide in a cluster would violate Max equally. We assume that Deletion of the second segment of a cluster would incur an added violation from the faithfulness constraint Contiguity, which demands that segments that are adjacent in the output must have adjacent correspondents in the input. Contiguity would, thus, eliminate a candidate that deleted the second (but not the word-initial) segment of a cluster. This constraint also explains why Deletion is not employed as a repair for fricatives (or any other segments) in word-medial contexts.

(10) Gliding of word-initial rhotic consonants

`run'

/ rʌn /	*r	ID[cont]	Max	ID[cons]
a. rʌn	*!			
☞ b. wʌn				*
c. ʌn			*!	
d. pʌn		*!		

Our account thus far has focused exclusively on the error patterns associated with word-initial position. However, as formulated, this account would fail to predict the observed behavior of fricatives and rhotic consonants in post-vocalic contexts. Recall that singleton fricatives underwent Stopping post-vocalically, and rhotic consonants were produced target-appropriately in that context. To deal with these and the earlier facts, certain refinements of our account are warranted. The first refinement requires that the markedness constraint banning rhotic consonants (*r) be ranked somewhat lower in the hierarchy given that rhotic consonants did occur and were produced target-appropriately in certain contexts. Additionally, to prevent fricatives and rhotic consonants from undergoing Deletion or Gliding in post-vocalic contexts, two additional, highly ranked faithfulness constraints are needed, as defined in (11). One of those faithfulness constraints, Anchor-R, demands that the right edge of the lexical word have a correspondent at the right edge of the prosodic word. This effectively prevents Deletion of any segment word-finally. This constraint does not, however, prevent changes in the featural specification of word-final segments. Consequently, we must appeal to the second faithfulness constraint, ID-Prom[cons], which prohibits any changes in the specification of the feature [consonantal] in strong or prominent contexts. This constraint blocks fricatives and rhotic consonants from undergoing the otherwise active process of Gliding in post-vocalic contexts. Motivation for our claim about the prominence of certain contexts comes from some of our earlier research (e.g. Dinnsen & Farris-Trimble, 2008), which has found that many young children treat word-final position as strong or prominent. Prosodic structures with final prominence can include final rhymes of syllables, the final syllable of a foot, and the final foot in words with three or more syllables. Final prominence is just the opposite of what has been observed in fully developed languages. Nevertheless, the relevance of prominence is that contrasts tend to be preserved in prominent contexts and are weakened in non-prominent contexts. Put a different way, contexts that are strong or prominent tend to resist change, whereas weak or non-prominent contexts are vulnerable to change. Dinnsen and Farris-Trimble (2008) have argued that, at the point that prominence effects begin to emerge, prominence is assigned to final position by default in those early stages of phonological development and only later does prominence shift to initial position. It, thus, should not be surprising that both of these faithfulness constraints, which preserve certain properties of underlying representations at the right edges of words, would be active in this child's phonology.

(11) Additional faithfulness constraints

Anchor-R: The right edge of the lexical word must have a correspondent at the right edge of the prosodic word (No Deletion at the right edge of the word)

ID-Prom[cons]: Corresponding segments must have the same specification for the feature [consonantal] in a prominent context (No Gliding in prominent contexts)

The revised constraint hierarchy in (12) integrates the two additional faithfulness constraints and ranks them above the ban on rhotic consonants (*r), but below the other markedness constraints by default.

(12) Revised constraint hierarchy

*fric, SSP >> Anchor-R, ID-Prom[cons] >> *r >> ID[cont] >> Max >> ID[cons]

With this revised hierarchy, we can see in (13) why Stopping was invoked for post-vocalic fricatives. More specifically, the faithful candidate (a) with a final fricative is eliminated due to its fatal violation of undominated *fric. The Gliding candidate (c) and the Deletion candidate (d) incur one violation each from one or the other of the two added faithfulness constraints presented in (11). While the remaining Stopping candidate (b) violates the lower ranked constraint ID[cont], that violation is less serious, resulting in its selection as the winner.

(13) Stopping of post-vocalic fricatives

`cough'

/ kɑf /	*fric	Anchor-R	ID-Prom[cons]	ID[cont]	Max	ID[cons]
a. kɑf	*!					
☞ b. kɑp				*		
c. kɑw			*!			*
d. kɑ		*!			*	

We are now in a position to illustrate the final element of our analysis, i.e. the target-appropriate realization of rhotic consonants post-vocalically. The tableau in (14) considers the three most likely output candidates for a target word with a final /r/. The undominated markedness constraints (*fric and SSP) obviously play no role here because they would not compel any changes relevant to the input representation of such words. On the other hand, the two highest ranked faithfulness constraints assign fatal violations to the Gliding candidate (b) and the Deletion candidate (c), leaving the fully faithful candidate (a) as the only viable option. While candidate (a) does violate the lower ranked constraint *r, that violation is less serious, allowing /r/ to be realized faithfully.

(14) Target-appropriate realization of post-vocalic rhotic consonants

`deer'

/ dɪr /	Anchor-R	ID-Prom[cons]	*r	Max	ID[cons]
☞ a. dɪr			*		
b. dɪw		*!			*
c. dɪ	*!			*	

In sum, OT has afforded a unified account of Child 218's three different fricative error patterns by encapsulating them in a single constraint hierarchy that derived their repairs as a natural response to a single problem, namely a conspiracy to avoid fricatives. Child 218 and Child LP65 both exhibited the same conspiracy against fricatives, but that conspiracy manifested itself in somewhat different ways for the two children. While both children employed Stopping and Deletion as repairs for fricatives, those processes differed in their generality and contextual restrictions. For example, Child LP65 extended Deletion to all clusters, whereas Child 218 limited the process to fricative clusters; target stop clusters were immune to Deletion. Similarly, Child LP65 extended Stopping to all singleton fricatives, while Child 218 limited Stopping to post-vocalic contexts. Finally, Child 218 employed a repair for fricatives not attested by Child LP65, namely Gliding. Interestingly, that process was restricted to word-initial singleton fricatives, exactly the same context and repair for rhotic consonants.

OT captures both the commonalities and differences in these children's manifestations of the conspiracy. What makes the conspiracy the same for both children is the undominated ranking of *fric over several crucially ranked faithfulness constraints. The different manifestations of the conspiracy follow from different rankings of certain constraints. One of the most important differences in this regard relates to the ranking of a constraint we have not yet discussed, namely *Complex-Onset. This constraint bans onset consonant clusters. It was undominated in Child LP65's phonology and compelled Deletion in all onset clusters. This constraint was the focal point of the child's other co-existing conspiracy. For Child 218, on the other hand, this constraint was inactive and low-ranked, as evidenced by the fact that target stop clusters could and did occur in the child's phonology. What, then, compelled Deletion in fricative clusters for Child 218, and why Deletion rather than Stopping? The answers to these questions reside in the tableau in (9), where it was shown that ID[cont] outranked Max. The consequence of this ranking, coupled with *fric being undominated, is that underlying, but not derived, stops were permitted to occur in onset clusters. Child LP65 evidenced the reverse ranking of these two faithfulness constraints along with the undominated ranking of *Complex-Onset and *fric.

Another significant factor leading to the different manifestations of the conspiracy was Child LP65's complete absence of contextual prominence effects. This suggests that the prominence-related faithfulness constraints cited in (11) were ranked lower in his hierarchy. One consequence of this lower ranking was the absence of contextual variants for singleton fricatives and rhotic consonants. On the other hand, Child 218 ranked these same faithfulness constraints relatively high, resulting in two different contextually conditioned repairs for singleton fricatives along with contextual variation in the realization of rhotic consonants.

The OT accounts of these children's conspiracy make different substantive claims about the nature of the problem confronting each child. The next section considers the implications of those claims for the design of clinical treatment plans and the projection of learning.

Clinical implications

Conspiracies pose a novel set of problems both for children with phonological delays and for clinicians interested in eradicating the error patterns associated with a conspiracy. Part of the problem is that conspiracies are presumed to represent natural, stable states that are resistant to change (e.g. Kiparsky, 1976). The stability of a conspiracy should not be surprising given that different forces or processes are working together to achieve the same end. Elimination of one of those processes may, thus, have no necessary consequence for the other processes. So, if a child presents with a conspiracy comprised of several different processes, which process should be targeted for treatment? An OT constraint hierarchy characterizing a conspiracy offers some insight and guidance in designing a clinical intervention plan. Consider again the final revised constraint hierarchy in (12) for Child 218 (repeated here as (15)).

(15) Child 218's presenting constraint hierarchy (repeated from (12))

*fric, SSP >> Anchor-R, ID-Prom[cons] >> *r >> ID[cont] >> Max >> ID[cons]

First, the markedness constraint at the top of the hierarchy, *fric, identifies the problem that is at the heart of the conspiracy. That markedness constraint must be demoted below a conflicting faithfulness constraint to yield a target-appropriate production of a fricative. Given the hierarchy in (15), several demotion options present themselves, some more efficacious than others. One option might be to focus treatment on the suppression of the post-vocalic Stopping process. This would entail demoting *fric below ID[cont]. This could presumably be achieved by a standard treatment method (e.g. Barlow & Gierut, 2002) that contrasted words with a final fricative versus a final stop (e.g. `bus' versus `but'). If successful, the resultant hierarchy would appear as in (16).

(16) Resultant hierarchy if post-vocalic Stopping were suppressed

SSP >> Anchor-R, ID-Prom[cons] >> *r >> ID[cont] >> *fric >> Max >> ID[cons]

Unfortunately, the hierarchy in (16) would allow the Gliding and Deletion processes to persist. Additional rounds of treatment would likely be called for to suppress those error patterns.

An alternative treatment plan for the presenting hierarchy in (15) might focus instead on the suppression of Deletion in fricative clusters. This would require the demotion of *fric below Max. Teaching a fricative cluster versus its repair (e.g. `flight' versus `light') should present the child with the information needed to achieve that demotion, i.e. the recognition that fricatives can occur in clusters. While the resultant hierarchy given in (17) would be expected to eliminate Deletion, it would also have the further desirable consequence of eradicating post-vocalic Stopping, without directly treating that error pattern. This option takes advantage of the implicational relationship that holds between the Stopping and Deletion processes, which follows from the language-specific ranking of ID[cont] over Max. The one drawback of this plan is that Gliding would still be predicted to persist.

(17) Resultant hierarchy if Deletion were suppressed

SSP >> Anchor-R, ID-Prom[cons] >> *r >> ID[cont] >> Max >> *fric >> ID[cons]

Finally, an even more efficacious treatment plan for the hierarchy in (15) would be to focus treatment on the suppression of Fricative Gliding. This would require *fric to be demoted below ID[cons] as in (18). This might be accomplished by contrasting pairs of words with a word-initial fricative versus an initial glide (e.g. `fun' versus `one'). Inasmuch as ID[cont] and Max outrank ID[cons], the suppression of Gliding should also have the consequence of eliminating the implicationally related processes of Stopping and Deletion, without directly treating either of those two error patterns. Moreover, if the set of treatment stimuli were expanded to include the presentation of a minimal triplet such as `fun', `one' and `run', the Rhotic Gliding error pattern could also be targeted, motivating the concomitant demotion of *r and *fric below ID[cons] (See Morrisette and Gierut (2008) for the results from a similar form of treatment involving another set of related error patterns).

(18) Resultant hierarchy if Fricative Gliding were suppressed

SSP >> Anchor-R, ID-Prom[cons] >> *r >> ID[cont] >> Max >> ID[cons] >> *fric

By way of comparison, the treatment options for Child LP65 would be rather different, as described in more detail in Dinnsen (2008). Briefly, the most efficacious plan would employ a simultaneous focus on the markedness constraints that drive the child's two co-existing conspiracies. That is, *fric needs to be demoted below ID[cont] to suppress Stopping, and *Complex-Onset needs to be demoted below Max to suppress Deletion. This might be achieved by contrasting pairs of words such as `sweet' and `tweet'. Such a pair would demonstrate that onset clusters do occur and moreover that fricatives contrast with stops. At the very least, these OT accounts suggest that children with some of the same error patterns and the same conspiracy may require rather different treatment targets with different learning outcomes.

The above discussion serves to illustrate the role that OT can play in the selection of treatment targets and the projection of learning when a child presents with a conspiracy. It must be left to future clinical treatment research to properly evaluate these optimality theoretic claims and predictions.

Conclusion

This paper set out to unravel the inner workings of a conspiracy against fricatives. The case study of Child LP65 served as the backdrop for the current study. Child LP65's conspiracy was manifested by the two repairs of Stopping and Deletion. That child also evidenced another co-existing conspiracy that banned onset consonant clusters. Deletion was one of the preferred repairs for that conspiracy as well. In an effort to isolate the cause of Deletion relative to these two conspiracies, a comparable case study of another child, Child 218, was selected for consideration, documenting a different manifestation of the same conspiracy against fricatives. This child employed Gliding, Stopping, and Deletion in response to the ban on fricatives. Importantly, Child 218 opted for Deletion of fricatives in a cluster, despite the fact that he evidenced no prohibition against onset consonant clusters. That is, stop clusters could and did occur, but never as a repair for fricative clusters. OT provided the theoretical framework to explain the different manifestations of the fricative conspiracy, including its contextual variants. More specifically, Child 218 was shown to exhibit early developmental prominence effects such that final position behaved as a relatively strong or perceptually salient context (e.g. Dinnsen & Farris-Trimble, 2008). This was evidenced by target-appropriate realizations of rhotic consonants post-vocalically and the more limited set of repair options for fricatives (Stopping) in that context. Initial position behaved as a weak context, with fricatives undergoing either Deletion or Gliding, while rhotic consonants also underwent Gliding in that context.

Our appeal to OT also served to demonstrate that a given error pattern, such as Deletion, can come about from different sources or problems (e.g. a ban on fricatives or a ban on consonant clusters). The flip side of that coin is a hallmark of conspiracies and was clearly instantiated by the two case studies considered here. That is, a given problem (e.g. a ban on fricatives) can be resolved or repaired in different ways within and across children (e.g. Stopping, Deletion, and Gliding, among others). Finally, OT was shown to offer some guidance in confronting the special clinical challenges that are posed by conspiracies. In general terms, given the constraint hierarchy for a conspiracy, the markedness constraint at the top of the hierarchy pinpoints the heart of the problem, and it is that constraint that needs to be demoted. The prediction is that the most efficacious treatment plan should demote that highest ranked markedness constraint below the lowest ranked faithfulness constraint that is violated by the default repair. In the case of Child 218, that meant that *fric should be demoted below ID[cons] (i.e. the Gliding repair). The novelty of this treatment plan is that it takes advantage of the implicational relationship that held among the other error patterns of the conspiracy, predicting that it should be possible to eradicate the entire conspiracy without directly treating those other error patterns.

The descriptive and explanatory value of OT has been amply demonstrated in the broader literature for a range of phonological phenomena in developing and fully developed languages. Phonological theorizing and clinical practice are now in a better position to benefit from future experimental evaluations of these and other clinical predictions that derive from OT accounts of the sound systems of young children with phonological delays.

Acknowledgments

This and other papers from our research team have benefited from Tom Powell's many rigorous and enduring contributions dating back to his early years as a student and research assistant at Indiana University. We are also especially grateful to Jessica Barlow for her helpful comments on an earlier draft of this paper and to the members of the Learnability Project for their assistance in the collection and analysis of the data presented here. This research was supported in part by a grant from the National Institute on Deafness and Other Communication Disorders of the National Institutes of Health under Award Number R01DC001694. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References

Barlow JA, Gierut JA. Minimal pair approaches to phonological remediation. Seminars in Speech and Language. 2002; 23:57–68. [PubMed: 11938491]

Chomsky, N.; Halle, M. The Sound Pattern of English. Harper & Row; New York: 1968.

Clements, GN. The role of the sonority cycle in core syllabification. In: Kingston, J.; Beckman, ME., editors. Papers in laboratory phonology I: Between the grammar and physics of speech. Cambridge University Press; New York: 1990. p. 283-333.

Dinnsen, DA. Fundamentals of optimality theory. In: Dinnsen, DA.; Gierut, JA., editors. Optimality theory, phonological acquisition and disorders. Equinox Publishing Ltd; London: 2008. p. 3-36.

Dinnsen, DA.; Farris-Trimble, AW. The prominence paradox. In: Dinnsen, DA.; Gierut, JA., editors. Optimality theory, phonological acquisition and disorders. Equinox Publishing Ltd; London: 2008. p. 277-308.

Dinnsen, DA.; Gierut, JA.; Morrisette, ML. Children's incipient conspiracies. In: Yavas, M., editor. Unusual Productions in Phonology: Universals and Language-specific considerations. Taylor & Francis; p. xx-xx.in press

Dinnsen DA, Green CR, Gierut JA, Morrisette ML. On the anatomy of a chain shift. Journal of Linguistics. 2011; 47:275–299. [PubMed: 22389522]

Gierut, JA. Phonological disorders and the Developmental Phonology Archive. In: Dinnsen, DA.; Gierut, JA., editors. Optimality theory, phonological acquisition and disorders. Equinox Publishing Ltd; London: 2008. p. 37-92.

Kiparsky, P. Abstractness, opacity and global rules. In: Koutsoudas, editor. The application and ordering of grammatical rules. Mouton; The Hague: 1976. p. 160-186.

Kisseberth CW. On the functional unity of phonological rules. Linguistic Inquiry. 1970; 1:291–306.

Morrisette, ML.; Gierut, JA. Innovations in the treatment of chain shifts. In: Dinnsen, DA.; Gierut, JA., editors. Optimality theory, phonological acquisition and disorders. Equinox Publishing Ltd; London: 2008. p. 205-220.

Pater J, Barlow JA. Constraint conflict in cluster reduction. Journal of Child Language. 2003; 30:487–526. [PubMed: 14513466]

Prince, A.; Smolensky, P. Optimality Theory: Constraint Interaction in Generative Grammar. Blackwell; Malden, MA: 1993/2004.

Prince, A.; Tesar, B. Learning phonotactic distributions. In: Kager, R.; Pater, J.; Zonneveld, W., editors. Constraints in phonological acquisition. Cambridge University Press; Cambridge, UK: 2004. p. 245-291.

Shriberg LD, Lof GL. Reliability studies in broad and narrow phonetic transcription. Clinical Linguistics and Phonetics. 1991; 5:225–279.

Smolensky, P. Rutgers Optimality Archive, ROA-154. 1996. The initial state and “Richness of the Base” in Optimality Theory.