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A Modern Analysis of Consonant Harmony in Theoretical Frameworks

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A MODERN ANALYSIS OF CONSONANT HARMONY IN THEORETICAL FRAMEWORKS

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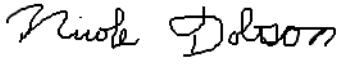

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LING 470Q: The Quest for Phonological Features

Consonant Harmony (CH) is a process that commonly characterizes the phonology of a child's first language acquisition. CH is the means by which non-adjacent consonants partly assimilate to one another in the primary place of articulation of features, e.g. the word *dog* is pronounced as *gog*. This paper provides a modern interpretation of the treatment of CH under successive phonological frameworks: early generative, autosegmental, connectionist, and Optimality Theory (OT). The review highlights the inter-child, intra-child, and cross-linguistic differences between child and adult CH in order to emphasize the contrasts appearing in *child* language. More recent accounts propose a comprehensive analysis of CH that takes into account inter-child, intra-child and cross-linguistic variation. Optimality Theory is shown to provide the most detailed analytical framework to account for CH. The study concludes by suggesting directions for further research.

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1. Introduction

Consonant Harmony (CH) is a process that commonly characterizes the phonology of a child's first language acquisition. CH is the means by which non-adjacent consonants partly assimilate to one another in the primary place of articulation of features. For example, it occurs particularly in Labial and Dorsal features, e.g. *dog* becomes *gog*. In contrast, CH in adult speech always involves secondary place of articulation features and adjacent consonants, predominantly Coronal features (Vihman 1978 and Levelt 2011). While Vowel Harmony (VH) also occurs in both child phonological acquisition and adult phonology, it is a slightly different process and will not be included in my discussion. Although many children will occasionally produce speech with a CH form, only a handful of documented cases describe predictable patterns of CH in child language acquisition (CLA). The fact that cases of CH in child speech are relatively rare indicates that they may not be rule-governed. Nevertheless, phonological frameworks attempt to explain them.

The study of child phonology is important because it is related to adult phonology, though specific speech-language processes in phonological acquisition have been largely regarded as peripheral in the history of phonological theory. In this paper I provide a modern interpretation of the treatment of CH under each successive phonological framework: early generative, autosegmental, connectionist, and Optimality Theory (OT). In my review I will highlight the inter-child, intra-child, and cross-linguistic variations, and differences between child and adult CH in order to emphasize the contrasts and processes appearing in *child* language. Then I will look at more recent accounts that propose a comprehensive analysis of CH that takes into account inter-child variation, intra-child variation, cross-linguistic variation, and development of CLA over time. In Section 2 I give a literature review of early work in

phonology and discuss its impact on subsequent theoretical frameworks. In Section 3 I summarize and evaluate the new insights presented by the autosegmental analysis. I give brief assessments of the slightly different approaches of templatic and planar segregation, in Section 4 and Section 5, respectively. In Section 6, I appraise the connectionist account as a more modern framework that ultimately leads to Optimality Theory (OT), which I argue handles CH most adequately in Section 7. Then I discuss the reanalysis of CH in child language with some advancement in the research of phonological acquisition in Section 8 and the relatively new findings on child language development over time in Section 9. Finally, I summarize my critique of various theoretical frameworks and present a direction for further research in Section 10.

2. Early work: Studies and Data Gathering

The study of acquiring an abstract phonology began with Jakobson (1968 [1941]), who argued that children gradually build up a universal system of contrast. His theoretical position significantly influenced subsequent studies of phonological development with language acquisition diarists heavily influencing his predicted phoneme acquisition order. Stampe (1979) presents a similar view in his dissertation in which he presents his framework of Natural Phonology, in which children proceed from "unlimited and unordered" (1979: ix) processes toward simple CV sequences. The child gradually gains a wider range of phonological oppositions by learning to "suppress" harmony processes. Jakobson and later Stampe both viewed phonological acquisition as the unfolding of a pre-existing feature hierarchy. However, this view has been widely criticized and eventually deemed impossible, particularly by Kiparsky & Menn (1977) and Ferguson & Macken (1983), because child language shows more variation than one would expect if it were based on a universal feature hierarchy. Furthermore, the

universal system of contrast is difficult to falsify. Differences exist in the acquisition of contrasts among children of the same language, as well as of different languages. These variations make it difficult to come up with one, universal framework because doing so requires elaborate rules. Nevertheless, researchers continue exploring the acquisition of contrasts.

A constantly recurring question in phonological acquisition is whether there is a universal order of acquisition of segments and/or features. Jakobson's theory of phonological features proposes the concept of maximal contrast to describe the order of acquisition of phonological oppositions from broad contrasts to more subtle ones. The first stages of acquisition were predicted in Jakobson (1968 [1941]). His original insights and structural methods influenced linguists all over the world and helped define modern linguistics. A summary of his predicted order of acquisition of contrasts is shown in (1) below.

(1) *Acquisition of phonological contrasts according to Jakobson (1968)*

1. Contrast between consonants and vowels, resulting in a CV syllable. The optimal contrast is between maximal closure – a labial stop –, and a maximally open vowel: /pa/.
2. Contrast between nasal and oral stops: /p/ versus /m/.
3. Contrast between labials and non-labials (dentals): /p, m/ versus /t, n/.
4. Contrast between wide (low) and narrow (high) vowels: /a/ versus /i/.
5. a. Contrast between front and back vowels: /i/ versus /u/; or b. contrast between high and mid vowels: /i/ versus /e/.

The first two stages make the case for Jakobson's (1960) article 'Why "Mama" and "Papa"?', which explains why *mama or nana and papa or dada* are among the first words in a child's speech for the referents nearly 'mother' and 'father' in every language. Jakobson further claims that there is a relationship between the order of acquisition and the distribution of sounds in the languages of the world. In other words, the features or contrasts that are acquired first are evident in all languages of the world. He subsequently outlines a new principle, *laws of irreversible*

solidarity, which predicts the sequence of oppositions of phonological features among the world's languages. The distribution of phonemes determines the inventories and the kinds of rules that are expected in acquisition, e.g., back consonants presuppose front consonants, and are therefore acquired later. Thus, front consonants are more likely to substitute for back consonants. Other typical orderings: stops are acquired before fricatives, voiceless stops before voiced stops, and fricatives before affricates (Jakobson 1960). Although the predicted phonemic orderings were originally intended to apply to intentional word production, they have been reinterpreted as a schematic expression of sound types which typically emerge with the earliest syllable-based or "canonical" babbling. These make up the highest frequency patterns to be found cross-linguistically in babbling as well as early words (Vihman 1996).

While Jakobson restricted his remarks to the child's overall inventory of contrasting sounds, Moskowitz (1971, 1973) traces language development from short babbling utterances to longer vocalizations which bear adult-like intonation patterns. The child hears the first production unit as the babbled sentence, and later acquires the minimum intonation bearer, the CV syllable. The underanalyzed syllable comes to be equated with the word. Reduplicated words (C_iV_j C_iV_j) are succeeded by partial reduplication (with CH or VH processes). As the child makes progress in comparing parts of these production units, she will eventually discover the segment and the distinctive feature (Moskowitz 1971, 1973).

Smith (1973) defines *regularity* as the consistency with which errors or segment substitutions in child forms are predictable or rule-based. Accordingly, Smith (1973) devises a set of *realization rules* using distinctive features and other notational devices to explain the regularities in his son Amahl's phonological development from age two through four. From the longitudinal data, Smith concludes that phonological development is a mapping from the adult

surface forms to the observed child productions. Smith seeks to find the connection between surface form and underlying representation within the scope of the whole phonological system. His study is exceptional in that it seeks to examine CH in a greater context, whereas many linguistic studies investigate only one particular phenomenon, e.g. only CH, in a set of child language data as do Vihman (1978), Goad (1997), and Pater & Werle (2003).

Similarly, Stampe's "general constraints" consist of realization rules, which are in effect a kind of filtering device of the child's competence and have gradually to be unlearned as the child more and more closely resembles adult language. According to Smith, rules relating any forms that the child might produce to the intended adult target form must reflect the child's actual linguistic competence. A child must correctly perceive the adult surface form for it to become the input to a set of rules. Due to children's greater passive knowledge of language than their active repertoire, Smith argues structural pressure from realization rules must be invoked in order for CH processes to occur. He cites specific examples to show that the child's merger of different adult forms into homophones does not necessarily reflect a failure of discrimination of adult forms. Smith argues that these are universal constraints, "part of a universal template which the child has to escape from to learn his language" (1973: 206).

Other researchers have reanalyzed Smith's longitudinal data and challenged his analysis. His view of the "across-the-board" nature of acquisition has been challenged by Macken (1980) and Grunwell (1982), who independently show that new sounds are not always acquired "across-the-board." For example, Grunwell (1982) shows that Amahl produced both the /tʃ/ and affricate cluster /tr/ as [t]. When he developed the ability to produce the cluster, he treated affricate-initial words as if they were /tr/-initial (*chalk* [tak ~ trak], *chocolate* [taklit ~ traklit]). This suggests an initial misperception of the adult form in the period when the child was not yet producing

either affricates or clusters, followed by a period of variability between competing forms, and requires eventual restructucturing of the underlying representation of affricate initial forms.

Modern reevaluations of early data raise concerns with the validity and reliability of analyses. First, Vihman (1996) believes that Jakobson's sources, along with his theoretical bias, misled him into overemphasizing the formal distinction between babbling and early words. However, much of his analyses of child phonological development remain valid half a century later. Second, Smith's application of regularity to child CH is problematic because instances of child CH make up only fraction of child language. The study of one child Amahl is not representative of universal constraints of all children because it fails to account for individual and cross-linguistic variation. Data from parental diary accounts are questionable for analysis because the parent is likely to document novel and personally interesting utterances. The data would be more credible if it were collected and analyzed by unbiased scientists in a laboratory setting.

3. Autosegmental Analysis

New assumptions and enriched representations allowed for new insight in CLA and CH. Goldsmith (1979) suggests that the first stage in phonological acquisition may involve an "autosegmental" representation of certain features that would lead to "rampant harmony processes in early speech." A later stage involves "de-autosegmentalization" to incorporate segmental level of features initially specified at a higher level except in cases where particular aspects of the language, e.g. tonality properties in some African languages, provide reasons to maintain a feature at a higher level in prosodic structure. I am skeptical of this framework because it does not seem to account for the variety of outputs that child language exhibits.

After Menn's (1978) landmark paper that outlines an autosegmental framework, two basic approaches to investigating the construction of a system of contrast develop; one focuses on featural representation and the other focuses on lexical representation (Fikkert 2000, 2007). Rice & Avery (1995) concentrate on contrasts and processes of child language whereby children's feature representations give rise to processes evident in child language. Brown & Matthews (1997) argue that the development of a system of contrast corresponds with the acquisition of lexical representations in which early words are underrepresented. Features that play a role in the adult phonological processes are acquired early. Although child language and adult language are not fundamentally different, child language differs in the sense that the child's phonological system is immature, i.e. it does not allow all the contrasts that adult language exhibits (Fikkert 2007).

The first account of CH was made by Menn (1978) using an autosegmental framework. She posits that CH is the result of the child's attempt to comply with a general constraint on his or her output structure. The proposed child-language-specific output constraint, termed a "consonant harmony constraint," refers to the tendency of consonants within a word to be of one place type; a child can either delete all but one consonant or render the differing consonants of an adult target word of one place type. In this approach, CH is integrated into the child's phonological system instead of existing as an isolated phenomenon. Menn posits the following "output lexical entry" for the words *stuck, duck,* and *truck,* all of which the child Daniel produces as [gʌk].

(2) *Output lexical entry for* stuck, duck, *and* truck

tier 3	stop position	#		velar			#
tier 2	fricative	#		Ø			#
			C	V	C		
tier 1	word structure	#	+voice	low-mid	-voice		#
			g	ʌ	k		

Menn (1978) derives the rule based on the output representation in (1): "If an entry in the recognition lexicon contains a velar, then select [velar] as the stop-position specification for the corresponding entry in the output lexicon." The underlying stored form is altered so that in a form that contains [coronal] or [labial] and [velar], only the feature [velar] will be realized in the consonant positions in the word. This is a classic case of autosegmental spreading, where the intervening vowel is not problematic. Therefore it is not affected by the harmonizing process.

Stemberger & Stoel-Gammon (1989, 1991) and Stoel-Gammon & Stemberger (1994) present a more theoretically detailed autosegmental analysis of CH. The process is considered to be an "unconscious" one caused by underspecified consonants in the child's inventory and by a tendency for unmarked to assimilate to marked segments. Thus, CH is viewed as a feature-filling process, whereby a consonant specified for place spreads to another consonant that is unspecified for place. The illustrated CH form of [gʌk] for *duck* is shown.

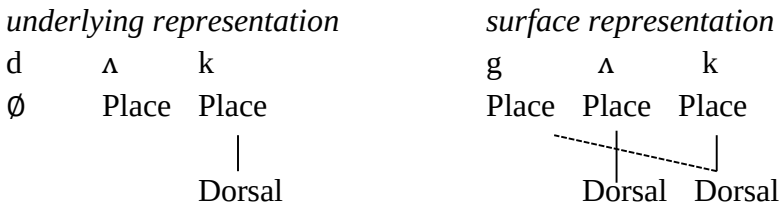
(3) *A procedural representation of consonantal harmony*

underlying representation			*surface representation*		
d	ʌ	k	g	ʌ	k
Ø		Place	Place		Place
		|			|
		Dorsal			Dorsal

In addition to consonants, vowels, have a Dorsal place specification in the feature representation adopted by Stemberger and Stoel-Gammon (1991) and that of Sagey (1986). The spreading of

Dorsal from /k/ to the initial consonant position would entail crossing association lines as in (4) that were prohibited by Goldsmith's (1976) Line Crossing Prohibition.

(4) *Consonant harmony and crossing association lines*



Stemberger and Stoel-Gammon argue that the intervening vowels do not block the harmony process. In order to address this, McCarthy's (1989) planar segregation propositions that consonants and vowels were reside in different planes when the process takes place. In contrast, Clements' (1985) feature model suggests that vowels and consonants have different sets of place features. In the framework proposed by Clements, the consonants and vowels are partially segregated. Place features are divided into "primary" place for consonantal place features and "secondary" place for vocalic place features. Place features of consonants can spread across vowels and place features of vowels can be spread across consonants. CH is characterized as feature spreading, acting only on the primary place node. There is no interference with vowels. Further elaboration on his feature model in Clements (1991) shows how both vowels and consonants have a primary consonant-place node in order to exclude the possibility of consonants spreading their place features across vowels in any of the world's languages. Although the autosegmental framework addresses CH in the world's languages, I remain skeptical because it does not account for why CH occurs in some instances and not others in child speech.

4. Templatic approach

Moskowitz (1971), and Iverson & Wheeler (1987) take a slightly different Templatic approach to CH. They argue that words appear as unanalyzed units and that many phonological phenomena are the result of association features with suprasegmental constituents. Well-formedness templates act on the child's output representations by characterizing and filtering the set of permissible words in the child's language. The predicted well-formedness template for CH productions are [kok] for *coat* and [gag] for *dog*; shown in (5).

(5) *Output template for* coat *and* dog

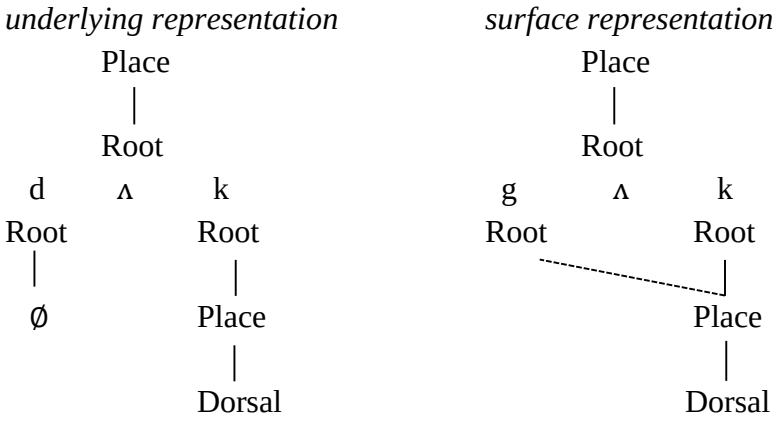
WORD
[-anterior]
C V C

It is predicted that all the consonants will be harmonized to the feature [-anterior], like both *coat* and *dog*. Iverson & Wheeler do not view child representations as derivational processes in which children try to reproduce or approximate the adult output representation, but rather the child's output representations represent the child's knowledge of the phonological system of his or her target language (i.e. the underlying representation). The child must learn to associate features with the segments instead of larger units like syllables or words. The child-language-specific aspect is that features link to entire words rather than segments. This account is similar to Menn's (1978) account: there is a child-specific template and a floating place feature that will be linked to C-slots in the template. The intervening vowel is still not viewed as problematic as long as the feature [anterior] is being associated. As an instance of how this works, Levelt (2011) proposes that the intervening vowel does not disrupt the linking process because vowels are not specified for [anterior].

5. Planar Segregation vs. Feature Geometry

McDonough and Myers (1991) make advances on the account for child CH under planar segregation. According to McCarthy (1989), this organizational structure can only apply if the relative order of consonants and vowels is predictable (Levelt 2011). McDonough and Myers propose that many children at this stage of development have quasi-templatic constraints on the structure of words, thus consonant-vowel planar segregation can be assumed. Their representation of CH involves spreading a specified place node onto an adjacent root node unspecified for place on the consonant plane, seen below.

(6) *Consonant harmony and planar segregation*



The problem with this account is the assumption that CH is present in child language at the stage in development where the order of consonants and vowels in a word is predictable (Levelt 2011). Children initially reduce the syllable structure of adult target words to simple consonant-vowel sequences; however, this does not necessarily happen at the time they have CH productions, as the Dutch examples in (7) show (Levelt 2011):

(7) *CV sequences and Robin's CH forms*

a. CV structure

CVC	*niet*	/nit/	[nit]	'not'
VCC	*eend*	/ent/	[ɪnt]	'duck'
CVCC	*fiets*	/fits/	[fits]	'bicycle'
VCV	*auto*	/oto/	[oto]	'car'

b. *Consonant Harmony*

schommelen	/sχɔmələ/	[vomə]	'to swing'
Grover	/χrorər/	[fofə]	(name)
stoep	/stup/	[fup]	'sidewalk'

The data in (7) show that the vowel immediately adjacent to the consonant is not predictable at the stage where CH forms are produced. Levelt (2011) therefore asserts planar segregation cannot be evoked at the segmental or feature level. Locality is cited as a serious problem for accounts of CH in child language; however, it can be reconciled by assuming that CH is going to ignore vowels and VH is going to ignore consonants. Clements & Hume (1995) might say CH is targeting nonsyllabic material.

6. Connectionist account

The locality problem is not present in Berg & Schade's (2000) model, which postulates a local connectionist processing account rather than a representational one. Berg & Schade analyze CH as a mispronunciation, i.e. a speech error. It is not a low-level articulatory plan precisely because the harmony is not co-articulatory. Rather it involves units at a distance based on the idea that the level of activation differs between segments. Depending on the child's developmental status, links between phoneme-like units and their constituting features can be stronger or weaker. Weaker links lead to hypo-activation, in which the features can be too weak to be available for production. The activation levels in the network of nodes constitute a word and select the node that has the highest activation level, and thus greater saliency. The hypo-

activated feature is replaced by the feature which is more strongly activated, allowing for CH to result. This is seen in the previously described processing version of the representational underspecification account of Stemberger and Stoel-Gammon. The other way CH occurs is that a certain hyper-activated node feature in the network masks the less activated nodes. Direction of harmony usually occurs right to left, i.e. *regressive harmony*, which is accounted for by self-inhibition. Once an onset consonant is selected, the activation level is temporarily set to zero due to self-inhibition. The onset is unable to interfere with the following consonant because the following consonant is already active due to parallel activation. Since consonant harmony is viewed as typical for child language, this view accounts for the existence of both hypo- and hyper-activated states in the developmental system. Consonant harmony is lost from the child system with advances in cognition whereby children possess an increased ability to recognize and differentiate phoneme-like units. In the following theory, the nature of analysis is shifted slightly from activation spreading to focus on constraints.

7. Optimality Theory

The current dominant linguistic theory phonological Optimality Theory fundamentally changes the previously dominant theoretic approach by doing away with phonological rules (McCarthy & Prince 1993; Prince & Smolensky, 1993). Instead, possible output structures are generated from a given input. The optimal candidate among all output candidates is selected through a language-specific ranking of universal but violable constraints (Fikkert 2000). In the new theoretic framework, Boersma & Levelt (2003) show that CH results from either (1) a high-ranked markedness constraint that requires Place of Articulation (PoA) feature agreement between consonants in a word, or (2) a constraint that requires a relation between a specific PoA

feature and a specific edge or head of some domain. Standard analysis of directionality of local assimilation in both child and adult language uses positional faithfulness, i.e. the matching of output to input while preserving certain features or segments in specific positions of the word, to protect the second consonant (Pater & Werle 2003). However, Pater & Werle argue that directionality in child language assimilation is not due to positional faithfulness, but rather a markedness constraint, e.g. AGREE-L [Dors], that specifies that the consonant preceding a dorsal must agree in place of articulation with it. Their view accounts for directionality, as well as the cases in which dorsals, but not labials, trigger assimilation. For example, this occurs in Korean in addition to child language. Compton & Streeter (1977) characterize the CH pattern in the longitudinal data of Trevor using Optimality Theory (OT) in (8).

(8) Coronal Targeting of Harmony

	Regressive			Progressive		
Velar	a. [gɔg]	*dog*	1;5.14	b. [kok]	*coat*	1;5.18
	c. [gɪːguː]	*tickle*	1;7.26	d. [kæːg]	*cat*	1;3.4
	e. [gʌg]	*bug*	1;5.18	f. [kʌk]	*cup*	1;5.13
	g. [gɪgʊ]	*pickle*	1;9.2			
Labial	h. [bɛːp]	*bed*	1;6.17			
	i. [pap]	*top*	1;6.8i.	j. [bʌbə]	*butter*	1;7.20

The data in (a-f) show velar harmony and (g-j) labial harmony. The back consonant spreads to the front one in regressive harmony (a, c, e, g, i) and conversely front consonant spreads to back in progressive harmony (b, d, f, h, j). Coronals are targeted in (a-d, h-j), non-coronals in (e-g), across back vowels (a, b, e, f, i, j) and across front vowels (c, d, g, h). This shows coronals are particularly susceptible to harmony. Their analysis maintains a language-specific ranking through universal constraints.

Pater & Werle (2003) argue that CH in child language is related to place agreement in consonant clusters in adult languages. The constraint AGREE requires two successive consonants

to be homorganic. Children and adults differ with respect to the domain of application. In child language the two consonants can be separated by a vowel, whereas in adult language the process is strictly local and applies only to adjacent consonants. Therefore language development in OT consists of narrowing the domain in which the constraint applies to a more localized domain.

Labial and dorsal consonant harmony features usually occur because they are independently regulated by a universal faithfulness hierarchy for place, whereby FAITH [Dors] and FAITH [Lab] are ranked above FAITH [Cor]. In other words, in order to comply with AGREE one place feature from the input form needs to be left out in the output form. Thus, the form to be left out will likely to be coronal rather than dorsal or labial. Child language data from Trevor in Pater & Werle (2003) show this point in (9) and (10).

(9) *Interaction of* AGREE *and* FAITH

/dɔg/	AGREE	FAITH [Dors]	FAITH [Cor]
☞ a. [gɔg]			*
b. [dɔd]		*!	
c. [dɔg]	*!		

(10)

/tap/	AGREE	FAITH [Dors]	FAITH [Cor]
☞ a. [pap]			*
b. [tat]		*!	
c. [tap]	*!		

The constraints are ranked the highest from left to right. The possible outputs (candidates) generated by the GEN component of the grammar are listed row by row. Each candidate is evaluated for each constraint and assigned an asterisk for each violation. The optimal candidate, indicated by the pointing hand, has the fewest violations of the most highly ranked constraints. In (9), [gɔg] is optimal because it has no violations of AGREE, where AGREE means harmonize consonant place. FAITH [Dors] indicates faithfulness to input of Dorsal consonants, which are preserved in (9). However, faithfulness (preservation) of [Cor] to the input

(the [d] of [dɔg]) is violated, producing the harmony of [dɔg] to [gɔg]. Similarly, in (10), [pap] is the optimal candidate for /tap/ because it has no violations of AGREE.

Both progressive and regressive CH would follow from this general AGREE constraint. Therefore the more specific form of AGREE is invoked to capture regressive harmony, i.e. AGREE-L, which mentions the direction of agreement. For example, in the directional AGREE constraint, AGREE-L [Dors] affects only *dog*, as shown in (11).

(11) AGREE-L [Dors] *for* dog *and* coat

/dɔg/	AGREE-L [Dors]	FAITH [Cor]
☞ a. [gɔg]		*
b. [dɔg]	*!	

/kot/	AGREE-L [Lab]	FAITH [Cor]
☞ a. [kot]		*
b. [kok]	*!	

The data show a developmental pattern where Dorsal CH is initially both progressive and regressive. Labial triggers both progressive and regressive harmony when other target consonants are coronals. Later there is only regressive harmony. The developmental changes are captured by the demotion of markedness constraints below faithfulness constraints. In the case above, AGREE is demoted below FAITH [Cor], and AGREE-L [Dors] is demoted below FAITH [Lab]. Pater & Werle seem to be making an unnecessarily elaborate account for CH. The growing awareness of variability in Compton & Streeter's connectionist account is a step in the right direction but there needs to be a simpler way to communicate it.

Similarly, AGREE-L [Dors] plays a role in Korean where labial and coronals assimilate only regressively to dorsals (de Lacy 2002). The relevance of Korean assimilation to child CH is that it "provides a striking parallel to patterns found in Trevor's data" (quoted in Pater & Werle 2003: 5). CH is a phonological pattern that is present in both adult Korean speakers and child English

speakers. In addition it "also highlights differences in directionality effects between child language and adult language, which correlate with the absence of right edge faithfulness in child language, and the robustness of onset faithfulness in adult language" (Pater & Werle 2003: 6). The data in (12) show the role of assimilation of Korean labials to dorsals, which parallels the findings of consonant harmony.

(12) AGREE-L [Dors] *in Korean* (de Lacy 2002)

a.	/əp+ko/	→ [əkko]	'bear on the back + CONJ'
	/kamki/	→ [kaŋki]	'a cold/influenza'
b.	/pat+ko/	→ [pakko]	'receive + CONJ'
	/han+kaŋ/	→ [haŋkaŋ]	'the Han river'
c.	/kot+palo/	→ [koppalo]	'straight'
	/han+bən/	→ [hambən]	'once'
d.	/paŋ+to/	→ [paŋto]	'room as well'
	/kuk+pap/	→ [kukpap]	'rice in soup'

This data supports the analysis. However, two concerns arise in terms of agreement between two non-adjacent consonants in which the domain for AGREE changes from "Word" in childhood to "string-adjacent consonants" in adulthood. One of the concerns is that Domain changes of AGREE imply that the learner would have to perform an extra set of rerankings (Levelt 2011). A learner goes through different rankings in order to get to the different FAITH [Place] constraints in higher positions in the constraint hierarchy than the AGREE constraint, a development which will naturally rule out CH candidates. When the child domain of AGREE changes into the string-adjacent adult domain, the grammar needs to undo all the rerankings of the FAITH [Place] constraints with respect to AGREE leading to string-adjacent consonants to agree in primary place of articulation—as is the case in the target adult language (Levelt 2011). The second concern is the child-language-specific, non-local domain for AGREE itself. This focus, in which the intervening vowel does not impede the agreement between non-adjacent consonants, implies that

the solution to the locality problem is that there is no locality requirement in child language (Levelt 2011).

Trevor's longitudinal data point to progressive velar assimilation and labial assimilation. Moreover, "regressive velar assimilation continues to target labials when progressive velar assimilation is limited to coronals." "These facts point to the existence of an elaborated AGREE constraint that demands that a consonant preceding a velar be homorganic with it (AGREE-L-DOR). This constraint applies to Korean as well. The fact that similar CH processes occur in both English and Korean is evidence that CH is a linguistic trend. Such a finding is similar to the widely acclaimed but problematic Jackobsonian concept of "universality" which necessitates reexamination.

8. Re-analysis of CH in child language

Smith (1973) assumed, based on his own case study, that CH is a "universal" function of early child rules. However, increases in the samples of systematically analyzed child phonologies reveal extensive individual differences in child phonologies, which contradict the universality function of early child rules. Vihman (1978) finds CH to range in use from one percent for a Chinese speaking child to 32% for Amahl Smith. Macken's analysis of the child named Si is sufficient to argue that CH, though present in her case as well, may play a negligible role in some children's phonological development. Likewise, some children exhibit scarcely a trace of CH while, for others, harmony seems likely to become established as a milestone of the developing system. Vihman & Roug-Hellichius (1991) document the parallel emergence of CH in Estonian (at 1;3) for Vihman's son Riavo ([dɑdɑ] *head aega* /hea'taeka/ 'goodbye,' [mumɑ] *muna* 'egg'). The investigators also described a "melodic" template, involving a shift from syllabic

consonant production ([ʂ] *viskɑ* 'throw,' *vesi* 'water') to monosyllabic, closed-syllable productions with a schwa nucleus ([məs] as an imitation of both *mʉts* 'hat' and *musi* 'kiss'; [nən] as a spontaneous form for *lind* 'bird,' *rind* 'breast,' *king* 'shoe,' and *kinni* 'closed'). These data were originally documented in Vihman (1981) and cited in Vihman (1996). These data suggest children are not necessarily limited to "harmony grammars" or "melody grammars" as suggested by Macken (1992), but rather may exhibit templates characteristic of both types. Parental diary accounts have been the major source of data for child phonology researchers for a long time. From Vihman's (1978) data, a child named Virve produced the second-highest proportion of harmonized words (25 percent). Together with Amahl Smith, the data compose "nearly half of the total harmony corpus" (1978: 307). The fact that the largest proportion of harmonized forms derives from two children whose data are collected by parental diary report, rather than recorded sessions transcribed by independent observers, raises a legitimate methodological concern.

Researchers have struggled to reach an account that explains the presence of primary place articulation CH data exclusively in child language without contradicting present theoretical frameworks (Fikkert 2007). The assumption that the learner's developing phonological system differs from the adult system in certain respects is essential in a thorough analysis of child-specific language processes. Like Menn (1978, 1983) and Iverson & Wheeler (1987), Levelt (1994) and Fikkert & Levelt (2004) advocate the view of CH in child language as integrated into the speech-language processes, rather than an isolated phenomenon. In an attempt to come up with a comprehensive account of developing place of articulation patterns in child language, they found CH present in two different developmental stages. The data in both stages are the result of a grammatical state specific to development. This is the reason that similar data are not found in

adult languages. Their data support the appropriateness for the resurgence of continuity in the analysis of CH.

The past ten years have shown a revival in the research of phonological acquisition alongside the introduction of OT. Accounts of phonological development include concepts of *markedness* and *constraints on phonological acquisition* as integral parts of OT. This makes a strong point for acquisition research in that the concepts play an important role in studies of child language phonology. Moreover, the new concepts allow researchers to express many aspects of child language phonology that they were previously unable to express within the context of a formal theory. The most fundamental change in the framework is that it has reinstated *continuity*, the concept that developmental grammars and final adult grammars have the same representational units and organizational principles (Boersma & Levelt 2003). This change makes OT currently the most insightful framework with which to analyze CH. Jakobson and Stampe viewed the development of grammar as a continuous process, but subsequent work, most notably, by Smith and by Kiparsky & Menn viewed it as a non-continuous process.

9. Stage I: One Word, One Feature

In the data analysis of the CLPF (an acronym for Claartje Levelt & Paula Fikkert) corpus of Dutch children's early word production, Levelt (1994) and Fikkert in (1994) found that the meaningful words in the first stage of phonological acquisition consisted of consonants and vowels produced with the same PoA feature. Low vowels /a/ and /ɑ/ can be combined with either coronal, labial, or dorsal consonants. This is illustrated by data from Robin at 1;5,11 (13):

(13) Robin's initial vocabulary

a.	*die*	/di/	[ti]	'that one'
	huis	/hœys/	[hœys]	'house'
	niet	/nit/	[n̩t]	'not'

	thuis	/tœys/	[tœs]	‘home’
	zes	/zɛs/	[sɛs]	‘six’
	tiktak	/tɪktɑk/	[tita]	‘tick-tock’
	aan	/an/	[an]	‘on’
	daar	/dar/	[ta]	‘there’
b.	*pop*	/pɔp/	[pɔ]	‘doll’
	mamma	/mɑma/	[mɑma]	‘mommy’
	aap	/ap/	[ap]	‘monkey’

The productions in (13a) consist of coronal consonants (or placeless /h/) and coronal or low vowels. Productions in (13b) have labial consonants and round or low vowels. The salient aspect is that adult target words have this same pattern (Levelt 2011). Robin produces new words that follow this pattern (at 1;5.21-1;6.9):

(14) New words produced by Robin

a.	Coronal forms			
	deze	/dezə/	[tis]	‘this one’
	televisie	/teləvisi/	[zizi]	‘television’
	trein	/trɛin/	[tin]	‘train’
	ijs	/ɛis/	[æis]	‘ice-cream’
	*sesamstr*ɑɑ*t*	/sesɑmstrat/	[zisa]	‘Sesame Street’
	uit	/œyt/	[œyt]	‘out’
b.	Labial forms			
	boom	/bom/	[bom]	‘tree’
	mooi	/moi/	[boːi]	‘beautiful’
	bal	/bɑl/	[bɑo]	‘ball’

Levelt (2011) characterizes the initial stage of language acquisition as “one word, one PoA feature.” Levelt (1994) and Fikkert & Levelt (2004) explain that this is caused by the fact that the initial unit for specification of PoA in the child’s phonological system is the unsegmentalized word (Levelt 2011). Levelt (1994) represents early productions, e.g. (13) and (14), as {WORD, Coronal} and {WORD, Labial}. That is to say, words have a single place specification in early child language rather than individual segments in their own place.

Dutch serves as an interesting cross-linguistic comparison. In Dutch children’s CH, labials are seemingly stronger than Dorsals. Pater & Werle (2003) claim that previous analyses

by Fikkert & Levelt (2002) fail to provide an explanation for the difference between child English and child Dutch. In fact, child Dutch data contradict the proposal that velars are universally preferred triggers. Pater & Werle maintain that "it may be that the propensity for labial harmony in Dutch is related to the prevalence of vowel-to-consonant assimilation (Levelt 1994), which usually involves spreading of labiality" (2003: 3). In dealing with the variable application of harmony, Pater & Werle adopt the proposal that "variation results from partial ordering of the constraint set." (2003: 11). Yet this is problematic because it requires further elaboration to the process of CH which a fraction of children's productions exhibit.

Gafni (2012) argues in contrast to previous studies, such as Stoel-Gabbon & Stemberger (1994), Pater & Werle (2003), and Tzakosta (2007), that CH is not governed by a trigger-target markedness hierarchy. Based on his analysis of longitudinal data, he argues that many of the harmonic shaped utterances are expected to result from non-assimilatory phonological processes, i.e. *stopping*, which seems to result from harmony in /geezer/ 'carrot' which becomes realized as [geder] as well as in /zeev/ 'wolf' [deev]. These findings challenge the view of CH as a universal grammatical process proposed by Fikkert & Levelt (2004). Furthermore Gafni suggests that CH may have some correlation to patterns within the developing grammar. CH is rare and not entirely predictable in form, though not completely random. Thus Gafni (2012) proposes that CH is not an integral part of a child's grammar even though it does have a grammatical base. He suggests it is the result of a performance error such as a "slip of the tongue" resulting from the cognitive overload typical of acquisition process of new segmental or prosodic material. His interpretation, together with conclusions of other studies, is innovative in that it casts doubt on CH processes as rule-governed phenomena and challenges the idea of CH as a universal process.

Although OT maintains a language-specific ranking of universal constraints, it allows for greater recognition of variation of language processes.

10. Conclusion

Although there has been increased attention and discussion to the processes of CH in child language phonology, no definite conclusion has been made regarding the functions and properties of child CH. In my own research I find this to be accurate; no single phonological framework adequately explains CH processes in one language over child phonological development or by cross-linguistic comparisons. Nevertheless, it appears that OT is the most promising framework to date.

Non-linear phonology and prosodic morphology were the dominant theories of the eighties and nineties. Due to the impulse of phonological acquisition research during that time new representations followed. Recent research concerns acquisition of segmental phonology as well as *suprasegmental phonology,* or higher phonological levels.

Jakobson, Stampe, and Smith all seek to demonstrate how child CH processes could be considered universal constraints. However, Jackobson's work has been widely criticized due to the fact that child language shows more variation than expected based on a universal feature hierarchy. Each decade a new phonological framework has served to explain linguistic phenomena other than CH, which eventually becomes explained peripherally. For example, the notion of planar segregation was introduced into adult phonology theory to account for Semitic languages with morphological templates requiring only consonants (Vihman 1996). It was not created with the intention of treating child CH but it was later utilized to do so. CH in child language has never been the central focus of previous phonological theorists' research. CH in

child language requires increased attention by researchers taking inter- and intralinguistic differences into account. Further complicating the problem is the tendency of frameworks to oversimplify, as Vihman summarizes: “In short, planar segregation, underspecification features and default features are all ways of expressing a relative lack of complexity in the child’s initial representations” (1996: 22). In the limited cases in which CH is documented, it has been found to occur in systematic ways, ruling out the possibility of it being characterized as a speech error however the lack of documented cross-linguistic data of CH makes it problematic to generate universal rules.

A possible reason for the lack of a definite conclusion on the functions and properties of child CH is the lack of communication between scientists in the field despite the surge of research on child acquisition of phonology. Discrepancies exist in the collaboration between the domains of learnability and data-driven studies. Points for further research include the use of a larger corpora and the use of cross-linguistic research to account for all of the data and contrasts in different languages. Future collaboration could be done to further connect these two domains by creating more studies in emphasizing the range of variation rather than uniformity, taking intra- and inter-child variation into account, considering the whole lexicon, and carefully conducting experiments in laboratory settings. Neurolinguists and psycholinguists might provide insight into what’s happening in the brain while more extensive corpora over a wider variety of languages would allow for the creation of a typology and better understanding of linguistic universals and therefore of constraint rankings of the theoretical framework of phonological theory.

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