Rhymes as a Window into Grammar[*]

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1. Introduction

Child language displays phenomena that are uncommon in adult languages. Consonant Harmony, i.e. long distance consonant harmony of Place of Articulation, is one such phenomenon. There are several Optimality theoretical accounts of Consonant Harmony, all involving constraints that are highly ranked at the early stages of development, such as REPEAT (Pater 1997) or AGREE (Pater & Werle 2001, 2003), but with development these constraints are demoted to a lower position such that their presence is no longer felt in later stages of acquisition. As this phenomenon is specific to child-language and virtually unknown in adult languages, the question is whether the constraints that play such a dominant role in the early stages of acquisition are child-specific and made redundant in the course of acquisition or are the constraints still available under specific circumstances in phenomenon usually characterized as 'the emergence of the unmarked' (TETU) (McCarthy & Prince 1994). Thus, the central question that we want to investigate in this paper is whether these low-ranked constraints can ever surface after the initial stages of acquisition.

We focus here on an approach to account for the phenomenon of Consonant Harmony, developed by Fikkert & Levelt (2004). They view Consonant Harmony as an epiphenomenon of the general development of Place of Articulation (PoA) features in children's early productions. In their study, the development of PoA from five children between the ages of 1;0 and 2;11 was investigated. They coded all target words and all forms produced by the children

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as abstract PoA patterns, using P for labial, T for coronal and K for dorsal.[1] A target word like *poes* [pus] 'cat' was coded as PvT and a child's rendition of it as [puf] as PvP. Fikkert and Levelt found that word forms show a clear developmental PoA pattern. During the first stage, words share PoA features across the word. Subsequently, a pattern emerges in which children's productions show preferences for specific PoAs in different prosodic positions. Specifically, children show a preference for words beginning with labials, and hence particularly PvP and PvT patterns appear next to TvT and KvK patterns. Later, they show an avoidance of words beginning with dorsals, and typically if the child produced KvK patterns earlier, they are now produced as TvK.

Another important finding is that children are very faithful to PoA features in their early productions. However, although early production forms were faithfully produced with respect to PoA features, later forms often show unfaithful renditions of target words, often leading to Consonant Harmony. Moreover, the unfaithfully produced words often are labial initial in the child's production of target words that do not start with a labial, for instance *zeep* /zep/ 'soap' is now produced as [fep] (Levelt 1994). In addition, unfaithfulness often affects target dorsal initial words, a word like *kip* /kɪp/ 'chicken' is now often produced as [pɪp] or [tɪp]. For those reasons Fikkert and Levelt argue that children's early lexicons give rise to emerging markedness constraints in the children's grammars. That is, children make generalizations over their own production lexicons. If a child's lexicon contains many labial initial words, the child may generalize a (preference) constraint stating that words preferably start with a labial consonant. These emerging constraints are defined as follows:

[LABIAL: words start with labials
*[DORSAL: words do not start with dorsals

Fikkert and Levelt argued that because coronals can occur in any prosodic position, no constraints apply to coronals, and in this sense coronal is the default PoA, which in their view is expressed by underspecification of the coronal PoA. The preferences for PoA in specific prosodic positions is not restricted to child language. One sees similar patterns in adult phonologies, where labials are preferred in syllable initial position and dorsals are preferred in syllable final position (Van der Torre 2003) and a pattern is seen in children with phonological disorders in English, where dorsals are preferentially produced in final position (Dinnsen 2002).

While emerging constraints are argued to be part of children's developing grammars, at a certain point children acquire and produce words beyond the restricted PoAs found at the initial stages. The question then is what is the nature

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1. Fikkert & Levelt (2004) also coded vowels as labial/dorsal (back rounded vowels) (O), coronal (front unrounded vowels) (I) and low (A). However, beyond the earliest stages vowels no longer play an important role and are ignored in this paper.

of these early constraints [LABIAL and *[DORSAL. There are two possibilities. First, these constraints may disappear in the course of development and no longer be a part of the adult grammar. In this sense, the initial stages of child phonology are qualitatively different from the target phonology. The constraints are similar then to Smith's (1973) realizations rules, later renamed incompetence rules (Smith 1989), or Kiparsky & Menn's (1977) invented rules. Second, these constraints may remain a part of the grammar, but become lower ranked. In this latter case, one would predict to find evidence for these constraints as The Emergence of the Unmarked (e.g., Gnandesikan, 2004). The present study is to determine whether these early constraints are still present in later grammars

2. Experiment

To determine whether the early constraints [LABIAL and *[DORSAL are still part of children's and adults' later grammars, we designed a free rhyme task in which participants heard non-word primes which were controlled for PoA. Half of the items were dorsal initial and labial final (KvP), the other half both started and ended with a coronal (TvT). We predicted that participants' preferences for specific PoAs in the initial consonant would reflect their phonological ranking of constraints. While our study was designed to test whether there is evidence for Fikkert and Levelt's early constraints, there are other factors that might influence responses, such as influences of Consonant Harmony, default PoA patterns and frequency. We describe each of these predictions below in relation to both the KvP and TvT primes, and a summary is given in Table 1.

The first predictions are CONSTRAINT-BASED, stemming from Fikkert and Levelt's proposed constraints [LABIAL and *[DORSAL. Given these constraints, the prediction is that participants' responses will show a preference for labial initial responses (PvP and PvT responses), and an avoidance of dorsal initial responses (KvP and KvT responses).

Nevertheless, it is also possible that participants will have a preference for responses that abide CONSONANT HARMONY. A number of accounts have argued that Consonant Harmony is the result a high-ranked constraint, such as AGREE (Pater & Werle 2003, Bernhardt & Stemberger 1998). If Consonant Harmony is independent of the general development of PoA patterns, this constraint could explain a preference for harmonic forms that share PoA across the onset and coda $C_{\alpha PoA}VC_{\alpha PoA}$. In this case we would predict a preference for PvP and TvT responses.

Alternatively, it is possible that participants will have a preference for DEFAULT patterns for PoA. Cross-linguistically the default PoA is coronal, and recall that in Dutch children showed no restriction on where the coronal feature could appear in the word, which suggest that coronal is also default in Dutch. Based on default patterns, a preference is predicted for TvP and TvT responses over other responses.

The last possibility is that the FREQUENCY of the onsets in Dutch might influence participants' responses. If FREQUENCY influences responses, we predict that the most frequent response given by participants will be the PoA that is most frequent in Dutch onset position, which is also coronal. Therefore, a preference is predicted for TvP and TvT responses. In fact, as we will see below, we were interested in knowing whether participants gave more coronal initial responses than expected based on the Dutch frequency patterns. In other words, even though coronal is the most frequent PoA in onset position, do participants respond with even more coronal onsets than expected. Note that the DEFAULT and FREQUENCY predictions are the same, and therefore they have been collapsed in Table 1.

2.1. Method

2.1.1. Participants

A total of 56 subjects took part in the experiment. All were native speakers of Dutch. The participants were divided into 3 groups. Nineteen children were tested between 4-5 years (M = 5;1). An additional 7 subjects were tested but excluded from the analyses, since they could not complete the task and hence responded to less than a third of the items. Sixteen children were tested between 7-8 years (M = 8;0), and sixteen adults were tested (M = 30;2). Children were recruited through the primary schools R.K. Basisschool De Windwijzer in Heerlen and Basisschool De Bongerd in Nederweert. The experiment employed a within-subjects design and all subjects were tested on the same stimuli in a fixed pre-randomized order.

2.1.2. Stimuli

The stimuli consisted of 20 non-words. Ten non-words began with a dorsal obstruent and ended in a labial obstruent (KvP). Dutch has two dorsal obstruents in the phoneme inventory: /k/ and /x/; therefore, five of the items began with /k/ and five began with /x/. Ten non-words began and ended with coronal obstruents (TvT). Dutch has four coronal obstruents in the inventory: /t/, /d/, /s/ and /z/. The stimuli were distributed so that five began with plosives (/t/ or /d/) and five began with fricatives (/s/ and /z/). Similarly, five of the non-words began with voiceless obstruents (/t/ or /s/) and five began with voiced obstruents (/d/ or /z/). A full list of the stimuli is given in Table 2.

Table 1
Summary of predictions, separately for the two type of primes

Theory	KvP primes	TvT primes
PoA constraint [LABIAL	PvP	PvT
PoA constraint *[DORSAL	*KvP	*KvT
Harmony	PvP	TvT
Default/Frequency	TvP	TvT

2.1.3. Procedure

The experiment used a rhyming task. Participants heard a non-word and were asked to produce a rhyme as quickly as possible. Five practice items were given to make certain that the task was understood. To ensure participants responded quickly, a sand glass was used and subjects were encouraged to complete the experiment before the 'time' (45 seconds) ran out. There was a short break after 10 items and then the sand glass was reset for the last 10 items. Both word and non-word responses were allowed. Before the rhyming task, participants also completed another experiment in which subjects were given a PoA prime and asked to choose between two different POA non-words.

2.2. Results

2.2.1. Data coding

Only CVC responses that rhymed were analyzed. Responses with onset clusters (e.g. a response like /sxaf/ to a prime /kaf/), with empty onsets (e.g. a response like /af/ to a prime /kaf/), disyllable responses (e.g. the response /patɑt/ to a prime /tɑt/) and non-rhyming responses (e.g. a response /pɔt/ to prime /sɔs/) were excluded from analyses, a total of 36 items. The initial consonants of the responses were coded for their manner of articulation: obstruents (60% of the responses), liquids (20% of the responses), nasals (14% of the responses), glides (4% of the responses) and [h] (2% of the responses). As obstruents were the largest group of responses, and because the 'primes' contained obstruents, only obstruent responses were included in the analyses. The percentage of obstruent responses was very high in group 1, over 70%.

Obstruent responses were then coded as being words or non-words. The criterion for 'word' status for the two groups of children was based on a previously published survey given to teachers to establish what words should be known to young children acquiring Dutch approximately 6 years-of-age (Schaerlaekens, Kohnstamm, & Lejaegere 1999). Words that were reported to be known to at least 50% of the children were considered words, and below 50% were non-words. For the adults, word-status was based on whether it appeared in the van Dale dictionary (Sterkenburg 1994). In total, 49% of the responses were non-words, and 51% were words. The analyses did not reveal any differences between word and non-word responses; therefore, they have been collapsed for all the analyses.

Table 2
Non-word stimuli, separated for the KvP and TvT PoA primes

PoA	Non-word stimuli
KvP	kaf, xœyf, kɪf, kuf, kœp, xɪp, xup, xɛp, xop, xœf
TvT	tɪs, tɑt, tot, dyt, dœys, sɔt, sɔs, zɑs, zus, zœt

Table 3
Summary of subject's responses separated by type of prime and onset of the responses

		KvP			TvT		
Group	Responses	PvP	TvP	KvP	PvT	TvT	KvT
4-5	202	68	12	18	64	13	27
7-8	167	19	31	23	55	18	21
Adults	153	30	24	16	51	15	17

The initial consonants were then coded for PoA: labial (P), coronal (T) or dorsal (K). The frequency of the different responses for the different primes and different age groups is summarized in Table 3.

2.2.2. Analyses

The analyses tested whether participants' responses of the initial consonants' PoA were significantly different from expected, based on the inventory and frequency of onsets in Dutch. The reason for this is that the set of obstruents with different PoAs is not equal, and the frequency of different onsets with different PoAs is also not equally distributed. Expected frequencies of the onsets were based on token counts from the Van de Weijer corpus (Van de Weijer 1998). For example, given the prime KvP, the chance of responding with an initial labial was .20 (four labial obstruent onsets in the Dutch inventory /p, b, f, v/ with a combined token frequency of 4778 words); the chance of responding with an initial coronal was .64 (four coronal obstruent onsets in the Dutch inventory /t, d, s, z/, with a combined token frequency of 15, 642, and the chance of responding with an initial dorsal was .16 (two dorsal obstruent onsets in the Dutch inventory /k, x/, with a combined token frequency of 3832.5, which has been divided by 2, since one out of the two dorsals was already in the onset of the prime and could therefore not be chosen as the onset of a rhyming response). For the TvT primes, the chances were calculated in the same way. The expected frequencies are given in Table 4.

To determine whether the pattern of results differed significantly from expected, chi-square goodness-of-fit tests were used which compared whether PoA patterns occurred significantly more often then chance (α=.05). This was the case for all 3 groups for each of the prime types. For the 4-5-year-olds the

Table 4
Expected responses based on token frequency, separated by type of prime and onset of the responses

		KvP			TvT		
Group	Responses	PvP	TvP	KvP	PvT	TvT	KvT
4-5	202	19.6	62.7	15.7	20.8	49.9	33.3
7-8	167	14.6	46.7	11.7	18.8	45.1	30.1
Adults	153	14.0	44.8	11.2	16.6	39.8	26.6

responses to both the KvP prime and the TvT prime are different than one would expect based on the token frequency of the onset (χ^2 = 160.878; p < *.001* and χ^2 = 118.214; p < *.001* respectively). The same is true for the 7-8-year-olds (χ^2 = 17.586; p < *.001* and χ^2 = 88.746; p < *.001* respectively) and for the adults (χ^2 = 30.000; p < *.001* and χ^2 = 90.251; p < *.001* respectively).

Further analyses in which each time only two levels of the factor prime type were compared, revealed several significant differences. The chi-square value and p-value for each comparison across the different age groups are given in Table 5. The number of comparisons increases the probability of getting a Type 1 error, therefore, the alpha-value was lowered to α=.02 using Bonferroni's correction.

For the youngest group (aged 4-5 years), there was a significant difference in the number of labial initial responses for both primes compared to coronal and dorsal initial responses (PvP > TvP, PvP > KvP, and PvT > TvT, PvT > KvT). There was also a significant difference in coronal versus dorsal responses for both primes (KvP > TvP and KvT > TvT). Thus, strikingly, coronals are significantly less often produced than chance. With the middle age group (aged 7-8 years), for the KvP primes, there was no difference in the initial labial responses versus other PoAs as compared to chance. There was a significant difference in coronal versus dorsal responses (KvP > TvP). With TvT primes, there was a significant difference between labial initial responses versus other PoAs (PvT > TvT and PvT > KvT). There was no significant difference between coronal versus dorsal responses as compared to chance. For the adults, significant differences in the number of labial responses compared to coronal and dorsal responses depended on the prime: for KvP primes, PP > TP but PP = KP, and for TvT primes labial responses were significantly more frequently produced than either coronal or dorsal: PT > TT and PT > KT). Similarly, significant differences in the number of coronal responses compared to dorsal responses differed according to the prime (for KvP primes dorsal responses differed significantly from coronal responses (KP > TP), but for TvT primes this was not the case (KT = TT).

Table 5
Summary of Chi-square analyses per comparison of response types

	KvP			TvT		
Gr.	PP - TP	PP - KP	KP - TP	PT - TT	PT - KT	KT - TT
4-5	PP>TP	PP>KP	KP>TP	PT>TT	PT>KT	KT>TT
	X^2=115.24	χ^2=20.13	χ^2=30.00	χ^2=109.52	χ^2=40.37	χ^2=12.60
	P<.001	*p<.001*	*p<.001*	*p<.001*	*p<.001*	*p<.001*
7-8	PP=TP	PP=KP	KP>TP	PT>TT	PT>KT	KT=TT
	X^2=1.52	χ^2=1.62	χ^2=17.23	χ^2=76.14	χ^2=38.10	χ^2=3.12
	P=.217	*p=.203*	*p<.001*	*p<.001*	*p<.001*	*p=.078*
Ad.	PP>TP	PP=KP	KP>TP	PT>TT	PT>KT	KT=TT
	X^2=16.79	χ^2=1.94	χ^2=10.00	χ^2=74.70	χ^2=39.51	χ^2=2.30
	P<.001	*p=.164*	*p=.002*	*p<.001*	*p<.001*	*p-.130*

2.3. Discussion

If we compare children's responses in the first age group (between 4-5-year-old) to the predictions, we see that the only theory which matches the data is the CONSTRAINT-BASED approach. Table 6 gives a summary of 4-5-year-olds responses, where shading indicates that children's responses matched the predicted pattern.

For the 4-5-year-olds, labial initial responses were preferred regardless of the rhyme prime. This can only be explained by the PoA constraint: [LABIAL. HARMONY is ruled out as a general preference strategy because there is only evidence for this with KvP primes, but not with TvT primes. The results also argue against the DEFAULT/FREQUENCY account because no preference was found for coronal initial responses (neither TvP nor TvT). However, the constraint-based approach only goes so far because there is no evidence for *[DORSAL. It is difficult to determine whether the null effect for *[DORSAL means that this constraint is no longer a part of the grammar or whether the constraint is too low ranked in the grammar to play an active role. As children already have many dorsal initial words in the lexicon by aged 4-5, *[DORSAL must be demoted below the relevant Faithfulness constraint which requires the feature dorsal to surface. There may be a fundamental difference between the two constraints though. [LABIAL gives rise to labial initial words, which are frequently attested in Dutch, in both child and adult lexicons. However, *[DORSAL would also disqualify many of the real words that are part of Dutch.

Given that there was evidence for [LABIAL in the grammar, we argue that the most cohesive account for the data is the CONSTRAINT-BASED approach, where the early constraints remain an active part of the grammar and where children's early and later grammars are not qualitatively different from one another.

A similar summary is given for the 7-8-year-olds (Table 7). Here, no theory was able to fully account for participants' responses. There was a preference for labial initial responses, but only with TvT primes. In the case of KvP primes, PvP responses did not differ significantly from KvP responses. In other words, the preference for initial labials does not show up in the condition where it would result in harmonic patterns, clearly against the HARMONY theory. Rather, the results seem to indicate an avoidance of harmonic forms, which in the case of KvP primes conflicts with the constraint [LABIAL. In the TvT condition, [LABIAL does not compete with constraints against disharmony, and here labial

Table 6
Summary of results for 4-5-year-olds with respect to predictions

Theory	KvP	TvT
PoA constraint [LABIAL	PvP	PvT
PoA constraint *[DORSAL	*KvP	*KvT
Harmony	PvP	TvT
Default/Frequency	TvP	TvT

Table 7
Summary of results for 7-8 year-olds with respect to predictions

Theory	KvP	TvT
PoA constraint [LABIAL	PvP	PvT
PoA constraint *[DORSAL	*KvP	*KvT
Harmony	PvP	TvT
Default/Frequency	TvP	TvT

responses are the preferred pattern. Therefore, one could argue that there was mild support for [LABIAL. As with the 4-5-year-olds, there was no support with the older age group for *[DORSAL. The results argued clearly against the DEFAULT/FREQUENCY accounts, as they cannot account for the observed patterns. In all conditions less coronal initial responses were found than predicted.

Finally, for the adults, the pattern was very mixed, as shown in Table 8. Labial responses differ significantly from coronal responses in the KvP condition, again showing an avoidance of coronals, and a preference for labial. But, as with the 7-8-year-olds, in the KvP condition, labials are not preferred over dorsals, again suggesting competition with constraints against disharmony. Labial responses do however not differ significantly from coronal responses in the TvT condition, but labial responses differ significantly from dorsals in this condition. Although it is difficult to interpret these mixed results, it is never the case that either coronal or dorsal responses are significantly more often produced than chance, whereas labial responses are significantly more often produced than chance under certain conditions. Again, the results are only compatible with the predictions of the CONSTRAINT-BASED approach which are not always confirmed, but not rejected either.

Taken together the results are in conflict with the approaches based on HARMONY, FREQUENCY or DEFAULT, but not with the CONSTRAINT-BASED approach, although the expected avoidance of dorsals is not attested. This could be due to the fact that there are already many dorsal initial words in the lexicons of the participants. Moreover, it seems that adults give a more varied response pattern than children, both in terms of Place of Articulation and in terms of Manner of Articulation. This suggests that the task is not as suitable for adults as for the youngest children. For them the rhyming task is quite difficult, as is evident from the fact that some of the youngest children could not perform the task. Also in the youngest age group, there were a fair amount of items in which

Table 8
Summary of results for adults with respect to predictions

Theory	KvP	TvT
PoA constraint [LABIAL	PvP	PvT
PoA constraint *[DORSAL	*KvP	*KvT
Harmony	PvP	TvT
Default/Frequency	TvP	TvT

children did not give a response. If the processing demands are high, children seem to fall back on unmarked structures, i.e. the early emerged constraints.

3. Conclusion

Previous research by Fikkert & Levelt (2004) found that young children have initially two emerging constraints: [LABIAL and *[DORSAL. The goal of the experiment was to test whether these early constraints are still present in children and adults' later grammars. Our results illustrate that there is evidence that [LABIAL is active for 4-5-year-olds children because the youngest children preferred labial initial responses over coronal and dorsal initial responses for both primes. There was no evidence that *[DORSAL played a role in these same children's grammars. For the older children and adults there was only mild support for [LABIAL, and again no evidence for *[DORSAL.

It is difficult to determine whether the null effect for *[DORSAL means that this constraint is no longer a part of the grammar or whether the constraint is too low ranked in the grammar to play an active role. As children already have many dorsal initial words in the lexicon by aged 4-5, *[DORSAL must be demoted below the relevant Faithfulness constraint which requires the feature dorsal to surface. Given that there was evidence for [LABIAL in the grammar, we argue that the most cohesive account for the data is the CONSTRAINT-BASED approach, where the early constraints remain an active part of the grammar and that children's early and later grammars are not qualitatively different from one another. Still, it is possible that a change may occur between the ages of 4-5 and 7-8, and further experiments are needed to determine whether these constraints have disappeared in the course of development and are no longer a part of the adult grammar. One possible change in the system that is worth investigating is the avoidance of harmonic forms in older children and adults, which seems to indicate that adult-like systems prefer disharmonic forms, in other words that they have an OCP constraint on Place of Articulation (see Frisch, Pierrehumbert & Broe 2004). We also argued in favor of the CONSTRAINT-BASED approach given that we have evidence against the HARMONY approach because TvT responses were never favored across any of the age groups. Moreover, T-initial responses were always less than expected, which further rules against the predictions that participants would favor the DEFAULT PoA or the most FREQUENT PoA onset.

Further experiments will expand on the types of primes used in the rhyming task, for example to look at primes such as PvT which begin with an initial labial to determine whether the preference for labial segments holds. We also will look further at the role of manner of articulation. Recall that only obstruent responses were analyzed in this experiment. An analysis of children's responses was also done with manner of articulation to determine whether participants' responses mirrored younger children's production patterns in initial position – here young children prefer plosive and nasal segments (Fikkert 1994, Fikkert et al. 2004). In the results from this experiment, we found that the youngest age group had a significant preference for plosive and nasal responses in initial position, whereas no preference was found with the two older age groups. Again, here we find a pattern where younger children's early production patterns were mirrored older children's preferences. We also have planned a number of memory tasks to determine whether children are better at recalling lists of non-words with specific places of articulation. Lastly, we currently are conducting a learning task to determine whether children are better at perceiving and producing non-words which are controlled for PoA.

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