DEVELOPMENTAL CHANGE IN FACTORS AFFECTING STRESS PLACEMENT IN NATIVE ENGLISH-SPEAKING CHILDREN

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ABSTRACT

Developmental patterns of stress placement were examined in a cross-sectional study of native English-speaking children. Forty children blended two individually presented, equally-stressed syllables with varying syllable structures to produce disyllabic nonwords in noun and verb contexts. Children who blended the syllables to produce fluent nonwords showed an effect of syllabic structure on stress placement. Only older children and children with large vocabularies showed an effect of lexical class.

Keywords: lexical stress acquisition, stress assignment, syllable structure, lexical class

1. INTRODUCTION

In English, the most frequent type of foot structure is disyllabic with the first syllable receiving main stress (i.e., a trochee) [2]. Trochaic patterns are also thought to be acquired first, which may be why 2-year-old English monolingual children frequently delete initial weak syllables in words and phrases that are not trochaically stressed [3, 9]. Although other stress patterns may be acquired later, there is ample evidence to suggest that school-aged children command a wide variety of English stress patterns [4]. What is less clear is whether children are sensitive to the different phonological and lexical factors that condition stress assignment in English. The goal of the current study was to explore the effects of two important factors on conditioning stress placement in school-aged children's speech in order to understand the acquisition of lexical stress more completely.

Stress placement in adult English is correlated with syllable weight. Heavy syllables, which have either long vowels or final consonant clusters, are more likely to have stress than light syllables. Guion and colleagues [5] have shown that adult English speakers are sensitive to syllable weight, and especially to vowel length, when assigning stress to non-words.

Another correlate to stress placement in adult English is lexical class. Disyllabic nouns in English are usually trochaically stressed, while disyllabic verbs are more often iambically stressed. Adult native English speakers also appear to be sensitive to the lexical classes of noun and verb in assigning stress to nonwords [5].

If knowledge of lexical stress patterns are abstracted across individual lexical items [1], then younger children might be expected to assign stress based on syllabic structure before assigning stress based on lexical class. Such a developmental sequence follows the assumption that children are provided with early and frequent evidence of the correlation between vowel length and stress, and that children must acquire a critical mass of lexical items before lexical classes can emerge [7]. Children are also likely to acquire the less frequent iambically stressed verbs later than the more frequently used monosyllabic verbs, and so may not have access to the generalization that disyllabic verbs are preferentially stressed on the second syllable until late middle-childhood or whenever children begin to acquire these less frequent verb forms.

This study explored the effects of syllabic structure, specifically vowel length, and lexical class on children's stress placement. The Peabody Picture Vocabulary Test (PPVT-4) was used to measure children's receptive vocabulary and the raw scores were used to evaluate whether the effects of syllabic structure and lexical class on stress placement varied as a function of vocabulary size.

2. METHODS

2.1. Participants

Four groups of 10 American-English speaking children participated in the study. The mean ages in each of the 4 groups was 5;3 (±2 mos.), 6;1 (± 3 mos.), 7 (± 3 mos.), and 8 (± 3 mos.).

2.2. Materials

Sixteen, two-syllable non-words with different syllabic structures varying in the placement of a tense or long vowel (C**VV**CVC vs. CVC**VV**C) were designed. Only vowel length was manipulated because consonant clusters are difficult to produce for young children and vowel length was shown to be a stronger factor affecting stress placement than consonant clusters in English monolingual adults' speech [5].

2.3. Procedure

Each syllable of the two-syllable words was recorded as an isolated production so that they were equally stressed. Two isolated syllables were presented with a 500ms inter-stimulus interval. To encode lexical class manipulation, the experimenter presented a frame sentence "I'd like a_" or "I'd like to_" prior to the target syllables for each trial. Children were asked to blend the two isolated syllables into a single word and then say it in a given frame sentence.

Children were allowed to listen to the stimuli twice, if needed. The experimenter repeated the trial when the two isolated syllables were not properly blended and produced with an audible gap. If the child was unable to concatenate the syllables into a single word after a couple of trials, the experimenter continued to the next trial.

2.4. Coding and reliability

First, the first author listened to the taped responses and coded them as blended if the child successfully produced the two syllables without inserting a gap. Responses with a change in the vowel length (e.g., 'beitous' for 'bitous') were excluded. Five out of ten 5-year-olds produced words with gaps more than 95% of the time and thus only five 5-year-olds were included in analysis.

Next, the placement of the main stress was coded as having main stress on the first or second syllable. The first two authors listened to the responses that had been removed from the frame sentences. The correlation coefficient for the two ratings was .80.

3. RESULTS

All four groups showed a higher number of successfully blended words for CVVCVC than CVCVVC syllabic structure. Lexical class, however, did not significantly influence blending capability (See Table 1). For stress placement, only syllabic structure played a significant role in for 5-year-olds whereas both syllabic structure and lexical class showed an effect for older children. In logistic regression analyses, syllabic structure made a significant contribution to predicting stress assignment for three child groups, whereas lexical class significantly predicted stress placement for only one of the older child groups. In a separate analysis, children with lower PPVT scores showed a greater effect of syllabic structure and a smaller effect of lexical class than children with higher scores.

3.1. Blending ability

The percentage of fully blended nonwords was obtained for each group by sentence frame. A mixed-model ANOVA assessed the repeated measure effect of lexical class on the percentage of fully blended words. Group and syllabic structure were between group factors. The analysis indicated a significant three-way interaction of group, syllabic structure, and lexical class [$F(3,56) = 3.46$, $p = 0.02$, $\eta_p^2 = 0.16$] as well as a main effect of group [$F(3,56) = 18.42$, $p = 0.00$, $\eta_p^2 = 0.5$] and syllabic structure [$F(1,56) = 24.94$, $p = 0.00$, $\eta_p^2 = 0.31$]. The main effect of lexical class was not significant.

Table 1: Mean percentage of successfully blended words varying in syllabic structure and lexical class produced by 5, 6, 7, and 8 years old children.

Structure	C**VV**CVC		CVC**VV**C	
Class	Noun	Verb	Noun	Verb
5-year-olds	80%	78%	58%	65%
6-year-olds	95%	95%	75%	90%
7-year-olds	90%	90%	84%	78%
8-year-olds	93%	95%	90%	88%

The effect of group was mainly driven by the difference between the 5-year-olds on one hand and 6-,7-,8-year-olds on the other (Tukey test, $p < .05$). As shown in Table 1, CVVCVC syllabic structures were blended more readily than CVCVVC syllabic structure across all groups. Blending ability for CVCVVC words increased with age. In addition, 5- and 6-year-olds were better able to blend CVCVVC syllabic structure when produced in a verb frame sentence.

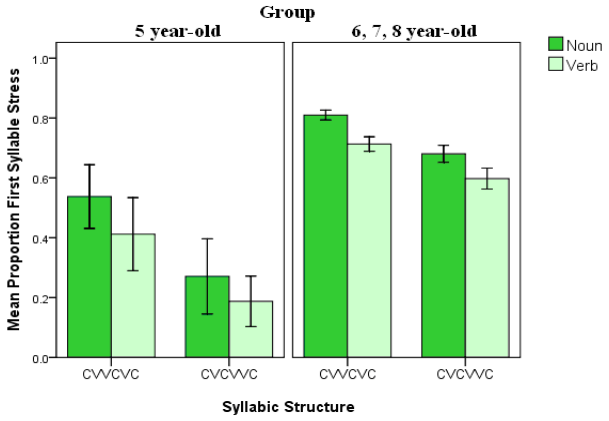
3.2. Stress placement

Stress placement was coded as having main stress on either the first or second syllable. The proportion of first syllable stress responses for

each syllabic structure type produced in a noun or verb frame was obtained for each participant. These proportions were arcsine transformed to ensure normality and analyzed using a three-way analysis of variance (ANOVA). The main effects of group [$F(3,56) = 22.78$, $p < 0.001$, $\eta_p^2 = 0.55$], syllabic structure [$F(1,56) = 23.7$, $p < 0.001$, $\eta_p^2 = 0.30$], and lexical class [$F(1,56) = 8.31$, $p = 0.006$, $\eta_p^2 = 0.13$] were significant. In particular, 5-year-olds were significantly different from older children (Tukey test, $p < 0.05$). The older children returned significant effects of both syllabic structure [$F(1,46) = 17.49$, $p = 0.00$, $\eta_p^2 = 0.28$] and lexical class [$F(1,46) = 11.97$, $p = 0.001$, $\eta_p^2 = 0.21$]. Only the effect of syllabic structure, however, was significant for 5-year-olds [$F(1,14) = 5.44$, $p = 0.035$, $\eta_p^2 = 0.28$].

Figure 1 shows that in all age groups CVVCVC words were more likely to be produced with main stress on the first syllable than CVCVVC words, regardless of lexical class. However, the proportion of first syllable stress responses was substantially lower in 5-year-olds. In older children, nouns were produced with first syllable stress more often than verbs in both syllabic structures. 5-year-olds showed a non-significant trend in this direction.

Figure 1: Mean proportion of first syllable stress responses for nonwords varying in syllabic structure and lexical class produced by 5 and 6, 7, 8 years old children.



3.3. Logistic regression

3.3.1. Effect of age

In the ANOVA, older children were found to more reliably apply knowledge of lexical class than 5-year-olds were, and syllabic structure affected stress placement in all ages of children.

To further examine the magnitude of these two variables' contribution to the prediction of stress placement, logistic regression analyses were conducted. For each age group, the independent variables of syllabic structure and lexical class were entered as predictors of the dependent variable of main stress placement. The individual contribution of each variable was obtained by removing each in turn. Significantly reduced goodness of fit was interpreted to indicate a significant, independent contribution of the variable to stress placement.

The results of the regression analysis are shown in Table 2. The significance of the predictor variable(s) varied by group. For 5-year-olds, the odds ratio (*Exp* (*B*)) of syllabic structure indicated that the odds of a nonword receiving main stress on the first syllable was 3.18 times greater if it was a CVVCVC than a CVCVVC word. Syllabic structure made a smaller, yet significant contribution to predicting stress placement for two of the older groups. Lexical class was a significant predictor only for 7-year-olds.

Table 2: Results from the logistic regression across different age groups. (*$p < .05$).

Predictor Variables	B(*S.E.*)	Wald (df =1)	Odds Ratio	Diff. in -2LL
5 year				
Structure	1.16(.42)	7.62	3.18	*8.11(p<.05)
Class	0.55(.41)	1.81	1.83	1.83(p>.05)
Constant	-1.94(.87)	4.94	0.14	
6 year				
Structure	0.40(.27)	2.32	1.50	2.33(p>.05)
Class	0.43(.27)	2.62	1.54	2.65(p>.05)
Constant	-2.16(.59)	13.61	0.12	
7 year				
Structure	0.62(.26)	5.56	1.85	*5.64(p<.05)
Class	0.80(.26)	9.31	2.22	*9.55(p<.05)
Constant	-2.76(.60)	21.08	0.06	
8 year				
Structure	1.13(.29)	15.27	3.11	*16.36(p<.05)
Class	0.12(.28)	0.19	1.13	0.19 (p>.05)
Constant	-3.08(.66)	21.83	0.05	

3.3.2. Effect of vocabulary size (PPVT score)

On the assumption that phonological knowledge is abstracted from the lexicon, an additional question investigated was whether children with larger vocabularies would show different effects of the variables than children with smaller vocabularies. While lexical development is generally correlated with chorological age, individual differences abound. Accordingly, children were divided based on their PPVT scores to predict stress placement

from the syllabic structure and lexical class variables.

Table 3: Results from the logistic regression between low and high PPVT score groups. (*p < .05)

Predictor Variables	B(*S.E.*)	Wald (df =1)	Odds Ratio	Diff. in -2LL
Low				
Structure	0.84(.20)	17.45	2.30	*17.87(p<.05)
Class	0.39(.20)	3.72	1.47	3.75(p>.05)
Constant	-2.51(.45)	30.74	0.08	
High				
Structure	0.53(.20)	7.48	1.70	*7.54(p<.05)
Class	0.49(.20)	6.24	1.62	*6.30(p<.05)
Constant	-2.27(.44)	26.80	0.10	

Table 3 shows that the difference in -2LL when the variable was removed from the model was significant for syllabic structure for the low PPVT score group and significant for both syllabic structure and lexical class for the high PPVT score group. The odds ratio indicates that lexical class became one of the primary predictors for stress placement with growing vocabulary size.

4. DISCUSSION

Overall, children's stress placement was more influenced by syllabic structure than lexical class. Children showed a strong preference for producing stress on tense or long vowels, indicating their sensitivity to syllable weight. Knowledge of lexical class, however, was employed only in older children's production. In this way, children differ substantially from adults in that adults rely more heavily on lexical class than syllabic structure when assigning main stress [5]. Furthermore, the effect of syllabic structure decreased and the effect of lexical class increased with vocabulary size.

The relatively greater predictive strength of lexical class in adults as well as in children with higher PPVT scores suggests that English monolingual children may need a larger lexicon to abstract the higher order stress patterns. Children are known to develop abstract patterns from statistical regularities of lexical input. Generalization may first be realized on the phonological level (i.e., stress distributions related to syllabic structure). Thus, children may not be able to abstract patterns related grammatical information (i.e. noun vs. verb) until their lexicons are large enough for robust lexical categories to have developed.

Finally, it is worth noting that overall preference for iambic stress placement in 5-year-olds' productions contrasted with older children's preference for trochaic patterns. Future work will explore the acoustic correlates of lexical stress production across the groups to better understand the basis for this difference and how it might relate to developmental differences in stress production. Our intuition, based on listening to the productions, is that the F0 cues to stress were stronger than the temporal cues in 5-year-olds' productions. Developmental changes in the relative weighting of F0 and temporal cues to stress would be consistent with the finding that younger English-speaking children are less capable of vowel reduction than older children and adults [8].

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6. REFERENCES

[1] Beckman, M., Edwords, J. 2000. The ontogeny of phonological categories and primacy of lexical learning in linguistic development. *Child Development* 71, 240-249.

[2] Culter, A., Carter, D.M. 1987. The predominance of stress initial syllables in the English vocabulary. *Computer Speech and Language* 2, 133-142.

[3] Gerkin, L.A. 1994. The metrical template account of children's weak syllable omissions from multisyllabic words. *Journal of Child Language* 21, 565-584.

[4] Goffman, L. 2004. Kinematic differentiation of prosodic categories in normal and disordered language development. *Journal of Speech, Language, and Hearing Research* 47, 1088-1102.

[5] Guion, S.G., Clark, J.J., Harada, T., Wayland, R.P. 2003. Factors affecting stress placement for English nonwords include syllabic structure, lexical class and stress patterns of phonologically similar words. *Language and Speech* 46(4), 403-427.

[6] Kehoe, M. 2001. Prosodic patterns in children's multisyllabic word productions. *Language, Speech, and Hearing Services in School* 32(4), 284-294.

[7] Li, P., Farakas, I., MacWhinney, B. 2004. Early lexical development in a self-organizing neural network. *Neural Networks* 17, 1345-1362.

[8] Redford, M.A., Gildersleeve-Neumann, C.E. 2009. The development of distinct speaking styles in preschool children. *Journal of Speech, Language, and Hearing Research* 52, 1434-1448.

[9] Schwartz, R.G., Goffman, L. 1995. Metrical patterns of words and production accuracy. *Journal of Speech, Language, and Hearing Research* 38, 876-888.