

Production of /st/ Clusters in Trochaic and Iambic Contexts by Typically Developing Children

Joanne Arciuli and Sharynne McLeod

University of Sydney, Australia and Charles Sturt University, Australia

E-mail: jarciuli@usyd.edu.au

Abstract

English has variable lexical stress - disyllables can exhibit either a trochaic pattern of lexical stress ('ZEbra') or an iambic pattern ('girAFFE'). The majority of English disyllables have trochaic stress and children are sensitive to this statistical property of the language. However, an iambic pattern of stress becomes more apparent in language input with increasing age and, thus, it could be argued that increasing vocabulary knowledge may assist in accommodating both trochaic and iambic patterns in English. A recent study by Sokol and Fey [1] examined singleton consonant production in unstressed syllables in trochaic vs. nontrochaic contexts in 8 typically developing 28-32 month-old children. Their analyses revealed more accurate production in trochaic contexts. The current study differs from Sokol and Fey's study in examining the consonant cluster /st/ with a larger sample of 70 typically developing children from 7-10 years and by including of a vocabulary test. Our results demonstrate: (1) accuracy of production of the /st/ cluster is moderated by lexical stress, (2) these effects are seen in children as old as 10 years of age, and (3) the lack of age effects might be due to the fact that our did not exhibit significant differences in vocabulary knowledge.

1 Introduction

The opposition of stressed and unstressed syllables within individual words, termed lexical stress, is a fundamental distinction in English. English has variable lexical stress and disyllables can exhibit a trochaic pattern of lexical stress (strong-

weak - 'ZEbra') or an iambic pattern of lexical stress (or weak-strong - 'girAFFE'). The majority of English disyllables exhibit a trochaic pattern of stress and it is known that children are sensitive to this statistical property of the language [2].

It has been suggested that, in English, the trochee may function as a kind of metrical template that guides phonological development [3,4]. Certainly, young children do appear to omit unstressed (or 'weak') syllables that fall outside the trochee pattern (e.g., a child might omit the unstressed syllable in 'banana' or 'tomato' and instead pronounce just 'nana' or 'mato'). Adults do not make these mistakes so it seems clear that at some point children learn to produce words that vary from this pattern.

Recent research provides important information that helps us to understand the gap between children's preference for the trochee and adult mastery of iambically stressed words. Perhaps the gap is bridged by virtue of statistical patterns in the very language that people are exposed to over their years. It has now been empirically demonstrated by Monaghan, Arciuli and Seva that an iambic pattern of stress becomes more apparent in language with increasing age [5]. Specifically, Monaghan et al. examined a database of age-based English reading materials for children aged 5-12 years and found that the percentage of iambically stressed disyllabic word increases from 11.94% in the reading materials of 5/6 year olds up to 16.41% in the reading materials of 11/12 year olds (and, remember, much of children's reading is, in fact, reading *aloud*). The dominant pattern of trochaic stress remains throughout these elementary years (at least in terms of children's reading materials). However, there is clearly an

increase in the proportion of iambically stressed words that children are exposed to as they get older.

Interestingly, the total number of disyllabic words in these age-appropriate reading materials increased from 3743 for the 5/6 year olds up to 5833 for the 11/12 year olds. Thus, it could be hypothesised that increasing vocabulary knowledge may assist children to accommodate both trochaic and iambic patterns in English their speech production.

There is a growing body of research examining stress assignment mechanisms in children. However, much of the research has examined syllable truncation and preservation and stress shift [6]. Very little is known about how lexical stress does or does not affect the production of particular phonemes, in particular, the production of consonants. This is perhaps because it is known that, in English, vowels have a close relationship to stress, and, it has often been assumed, a closer relationship to stress than consonants. However, research has shown that consonants carry stress information [7].

Recently, Sokol and Fey (2006) reported a study of singleton consonant production in unstressed syllables of trochaic vs. nontrochaic contexts in 8 typically developing 28-32 month-old children. Their analyses revealed more accurate production in trochaic than nontrochaic contexts. This appears to be in line with the view that very young children might be guided by a trochaic pattern of lexical stress in that segmental productions in their unstressed syllables are more accurate when preceded by a strong syllable.

The current study differs from Sokol and Fey's study in its examination of consonant cluster production, in particular production of /st/, its focus on a range of older primary-school-aged children and the inclusion of a measure of vocabulary knowledge (PPVT).

In terms of research on children's speech production processes most previous research concerning acquisition processes has focused on individual consonants. There has been limited investigation of the production of consonant clusters despite these being very common in English. Regardless of the prevalence of consonant clusters in English research has shown that their acquisition is slow in even typically developing children. While

some very young children can produce consonant clusters correctly some older children of around 9 years of age may still be mastering production of consonant clusters [8]. A recent study conducted by McLeod and Arciuli [9] examined 74 typically developing children aged 5-12 years and found the average age of mastery of consonant cluster production in monosyllables to be younger than Smit et al. (1990). With regard to particular clusters, the study showed that the /st/ cluster was accurately produced 97.4% of the time. Thus, we chose a cluster without a strikingly low or high level of difficulty.

All the cluster studies mentioned above examined consonant cluster production in monosyllables where there is no stress variation. As mentioned earlier, Sokol and Fey did look at the effect of stress context but only in terms of singleton consonant production. To our knowledge, there has been no previous study that has examined the effect of lexical stress placement on consonant cluster production in typically developing English-speaking children. Here, we examined production of the /st/ cluster in stressed and unstressed syllables of trochaically and iambically stressed nonsense words that conformed to the phonotactic rules of English – in a large sample of typically developing children from age 7-10 years.

We expected that consonant cluster production would be more accurate in stressed syllables. We hypothesised that accuracy of consonant cluster production (especially in unstressed syllables) might increase with age – perhaps in line with vocabulary growth (which presumably results in increased exposure to iambically stressed words). We chose to use imitation to elicit productions and to construct nonsense words after a search revealed that it would be impossible to select an equal number of real words that containing the /st/ cluster in initial vs. final syllable position and with trochaic vs. iambic stress patterns (i.e., 4 conditions). This is in line with the methods used by Sokol and Fey.

2 Method

Participants Seventy typically developing children aged 7-10 years were participants in this research: 7 years (n=20), 8 years (n=18), 9 years (n=15) and 10 years (n=17). Participants were

recruited from primary schools in the Western Sydney – Central West region of NSW, Australia. According to their teacher/parent, each of the participants were reported to have no speech difficulties (e.g., they had not received speech therapy), no hearing difficulties, or any other disabilities. They were reported as being ‘typical’ of their age group on cognitive tasks such reading.

Stimuli There were four conditions containing 6 disyllabic items each: nonsense words with initial /st/ and a trochaic pattern of lexical stress (‘STUven’), nonsense words with initial /st/ and an iambic pattern of lexical stress (‘stavENE’), nonsense words with final /st/ and trochaic pattern of lexical stress (‘TAMist’), and, nonsense words with final /st/ and an iambic pattern of lexical stress (‘relEST’). The average length of items in terms of number of phonemes was the same across conditions (6 phonemes). There were no other consonant clusters present in 23 of the 24 nonsense words (exception was ‘STAdent’ which also contained a word-final cluster). All items were recorded by a female speaker of Australian English and verified by a second person as having the intended stress assignment. Two list orders were created and half the children received one order while the other half received the alternative order.

Procedure Children were tested individually in a quiet room. They were simply asked to listen to the recorded nonsense words and imitate each one. They were also given the Peabody Picture Vocabulary Test (4th Edition) (PPVT-IV) that is a test of vocabulary knowledge.

Scoring Here, we report the productions of the /st/ clusters only. We utilised a dichotomous scale (accurate/not accurate), including all substitutions, deletions and distortions as errors. Scoring was conducted on the basis of perception (in accordance with native Australian English).

3 Results

We conducted a 2 (stress pattern: trochaic vs. iambic) x 2 (position: initial vs. final) x 4 (age) ANOVA with stress pattern and position as repeated measures and age as a between subjects measure. The results revealed only one significant effect – a significant interaction between stress pattern and

position ($F(1,66) = 17.31, p < .0001$). Follow-up t-tests confirmed that regardless of age, participants produced /st/ clusters more accurately in initial position when in a trochaic context vs. an iambic context (93.26% vs. 86.83%, $t(69) = 2.98, p = .004$) and in final position when in an iambic context vs. a trochaic context (94.7% vs. 89.17%, $t(69) = -3.47, p = .001$). We also assessed the vocabulary of our participants using the PPVT-IV. A one-way ANOVA with age as a non-repeated measure with four levels (7, 8, 9, 10 years) revealed no significant difference in vocabulary knowledge amongst participants of different ages ($F < 1$).

4 Discussion

There is a growing interest in stress assignment mechanisms in children. To date, investigations have primarily focused on syllable truncation/preservation and stress shift. Much less attention has been paid to whether lexical stress affects the production of particular phonemes – especially consonants and consonant clusters. This is not to say that the production of consonants in singleton and cluster contexts has not been widely investigated. However, it is true that their production has usually been examined in monosyllabic utterances [10].

As mentioned earlier, Sokol and Fey did look at the effect of stress pattern but only in terms of singleton consonant production. Their results showed that singleton production in unstressed syllables was more accurate in trochaic contexts. To our knowledge, there has been no previous study that has examined the effect of lexical stress on the accuracy of consonant cluster production in typically developing English-speaking children. In the current study, we examined production of the /st/ cluster in *both* stressed and unstressed syllables of trochaically and iambically stressed disyllabic nonsense words – by eliciting imitations from a large sample of typically developing children aged 7-10 years.

Broadly speaking, our results revealed three findings: (1) the accuracy of production of the /st/ cluster is moderated by lexical stress, (2) these effects can be seen in typically developing children as old as 10 years of age and (3) the lack of age effects might be due to the fact that our participants representing the four age groupings did not exhibit significant

differences in vocabulary knowledge. Specifically, our results showed that the highest accuracy rates were seen in stressed syllables regardless of whether those stressed syllables appeared in a trochaic or an iambic context (93.26% and 94.7% respectively). A more direct comparison with Sokol and Fey's analysis is the comparison of production accuracy in *unstressed* syllables in trochaic vs. iambic contexts. Here, our study revealed similar accuracy rates of 89.17% and 86.83% respectively. Thus, taken together the results we have reported do suggest that stress pattern affects production accuracy of the /st/ cluster (in that they perform better in stressed syllables), however, by 7 years of age children appear to be able to produce the consonant cluster /st/ in stressed syllables no matter whether those stressed syllables are in trochaic or iambic contexts. We had expected a more gradual developmental trajectory in line with the stress patterns that children are exposed to in disyllables they are exposed to in language (at least in terms of their reading materials) but, then again, our children did not appear to differ in terms of vocabulary knowledge.

Future research might extend this topic of investigation production by older children, adolescents and adults. It would also be valuable to compare consonant cluster production accuracy rates in spontaneous productions vs. imitation. Here, we only examined imitation because we found it difficult to construct the necessary four conditions using the /st/ cluster in real words (real words are easier to utilise in a spontaneous production design). Other consonant clusters might be easier to work with in an orthogonal design using real word stimuli. Moreover, comparison of production of various consonant clusters is another interesting avenue for research in order to address the question of whether the results we report here are in some way unique to the /st/ cluster – though we think this unlikely. Finally, if such real word stimuli using a variety of clusters and in spontaneous vs. imitation conditions can be designed, it would be interesting to examine the impact of other lexical variables such as word frequency.

5 Acknowledgment

This research was supported by an Australian Research Council grant awarded to the first author (LX0775703).

6 References

- [1] Sokol, S., & Fey, M. (2006). Production of 'sh' in trochaic and nontrochaic weak contexts. *Clinical Linguistics and Phonetics*, 20(9), 677-689
- [2] Jusczyk, P., Cutler, A., & Redanz, N. (1993). Infants' preferences for the predominant stress pattern of English words. *Child Development*, 64, 675-687.
- [3] Gerken, L. (1994a). A metrical template account of children's weak syllable omissions from multisyllabic words. *Journal of Child Language*, 21, 565-584.
- [4] Gerken, L. (1994b). Young children's representation of prosodic phonology: Evidence from English-speakers' weak syllable productions. *Journal of Memory and Language*, 33, 19-33.
- [5] Monaghan, P., Arciuli, J., & Seva, N. (2008). Constraints for computational models of reading: Evidence from learning lexical stress. *Proceedings of the Cognitive Science Conference*, Washington, USA.
- [6] Kehoe, M. (2001). Prosodic patterns in children's multisyllabic word productions. *Language, Speech, and Hearing Services in Schools*, 32(4), 284-294.
- [7] Van Dalen, R., Wiggers, P., & Rothkrantz, L. (2005). Modelling lexical stress. In *Lecture Notes in Artificial Intelligence*, 3658, 211-218.
- [8] Smit, A. B., Hand, L., Freilinger, J. J., Bernthal, J. E., & Bird, A. (1990). The Iowa articulation norms project and its Nebraska replication. *Journal of Speech and Hearing Disorders*, 55, 779-798.
- [9] McLeod, S., & Arciuli, J. (in preparation). School-aged children's production of /s/ and /r/ consonant clusters.
- [10] James, D. G. H., van Doorn, J., & McLeod, S. (2008). The contribution of polysyllabic words in clinical decision making about children's speech. *Clinical Linguistics and Phonetics* 22(4), 345-353.