Infant speech processing abilities and later syntactic skills in preschool

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1. Introduction

It is well accepted that from an early age, infants are able to process acoustic input in such a way that helps them parse words from the continuous speech stream and ultimately allows them to learn the language around them. However, most studies linking infant processing abilities to children's later language development have only reported group means and thus have overlooked how individual differences in processing abilities may affect later language. The studies that have looked at this relationship (e.g., Benasich & Tallal, 2002; Tsao, Liu & Kuhl, 2004) suggest that early speech processing skills are related to variability in later language development. However, in most studies of this type, very brief, nonspeech stimuli were used, which becomes problematic when trying to generalize these results to the real-life task of learning language.

Newman et al. (2006) looked closely at the relationship between early speech processing skills and later language abilities. Specifically, this retrospective study examined whether infants' abilities to segment familiarized words from a speech stream at 7-12 months are related to later language profiles at 4-6 years. Infants who had participated in speech segmentation experiments were contacted for follow-up testing at age 2 and again between the ages of 4 and 6. At the 2-year follow-up, results indicated that of the children who had large expressive vocabularies, scoring in the top 15% of the *MacArthur Communicative Development Inventory* (MCDI), 76% had been successful in speech segmenting as infants, whereas only 41% of the children with smaller expressive vocabularies, scoring in the bottom 15% of the MCDI, had been successful as infants. Results from the second follow-up showed that the infants who were able to segment at 7-12 months ("segmenters") performed significantly better on a test of overall language and were rated higher in communicative abilities by their parents at 4-6 years than children who could not segment ("nonsegmenters"), even though the two groups did not differ on a test of generalized cognition.

To further examine the language differences between these two groups, the current study analyzed the spontaneous narratives produced by these children at 4-6 years. Specifically, we looked at the syntactic skills of these children using Developmental Sentence Scoring (DSS) (Lee, 1972).

2. Participants

Participants were a subset of the infants who had participated in speech segmentation studies by Peter Jusczyk at Johns Hopkins University between 7.5 and 12 months of age and who were subsequently seen for follow-up testing between the ages of 4 and 6. Participants were separated into two groups: segmenters (n = 9) and nonsegmenters (n = 17). Segmenters were children who demonstrated the ability to segment the running speech stream as infants and nonsegmenters were children who did not demonstrate this ability as infants in the Johns Hopkins studies (Houston & Jusczyk, 2000; Houston, Jusczyk, Kuipers, Coolen, & Cutler, 2000; Houston, Santelmann, & Jusczyk, 2004; Johnson & Jusczyk, 2001; Johnson, Jusczyk,

Cutler, & Norris, 2003; Mattys & Jusczyk, 2001). Mean age at follow up was matched between groups: segmenters had a mean age of 54.8 months and nonsegmenters had a mean age of 54.9 months. Maternal education was also matched between groups.

3. Syntactic Analysis

Children provided a narrative prompted by the wordless picture book *Frog, Where Are You?* by Mercer Mayer. The narratives were then transcribed and coded using Child Language Data Exchange System (CHILDES) conventions and "Sonic" CHAT (MacWhinney, 2000).

Developmental Sentence Scoring is a well-established system for analyzing children's development of standard grammatical rules in English (Lee, 1974). Transcript utterances were divided into C-units ("communication units"; Loban, 1976), each consisting of an independent clause and its modifiers. DSS scores were first calculated using the CHILDES Computer Language Analysis (CLAN) program, which requires the transcripts be run through a morphological parser to identify each part of speech before assigning point values to the different syntax constructions. The CLAN-DSS program differs from classical DSS analysis in assigning a proportional score that can accommodate narrative samples of differing lengths. It weights complexity of the child's usage in categories such as primary and secondary verbs, conjunctions, personal and indefinite pronouns, negatives, *Wh-* questions and interrogative reversals.

Experimenters reviewed the DSS output for each transcript and revised scores, as needed. In particular, we conducted hand-corrected scoring to include any utterances too stringently excluded from analysis by the morphological parser. Scores were then compared across groups using a two-sample *t*-test.

4. Results

Segmenters (children who had succeeded in the infant task) produced stories having higher numbers of scorable utterances than did nonsegmenters (mean 39.9 vs. 35.2), although this difference was not significant. Notably, overall grammatical complexity of narratives produced by successful segmenters was significantly higher than that of narratives obtained from the nonsegmenters (CLAN DSS value 6.59 vs. 5.45, p = .0057).

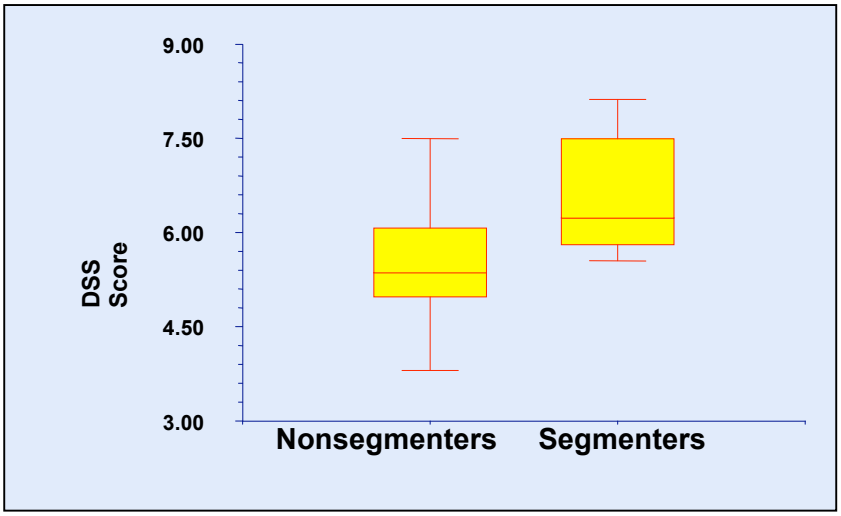

Figure 1 - Overall DSS scores

Post-hoc analysis showed no differences between groups for number of utterances receiving sentence points (grammatically correct utterances) and the majority of scorable categories. However, groups differed significantly in complexity of scorable primary verbs and both *Wh-* questions and interrogative reversal.

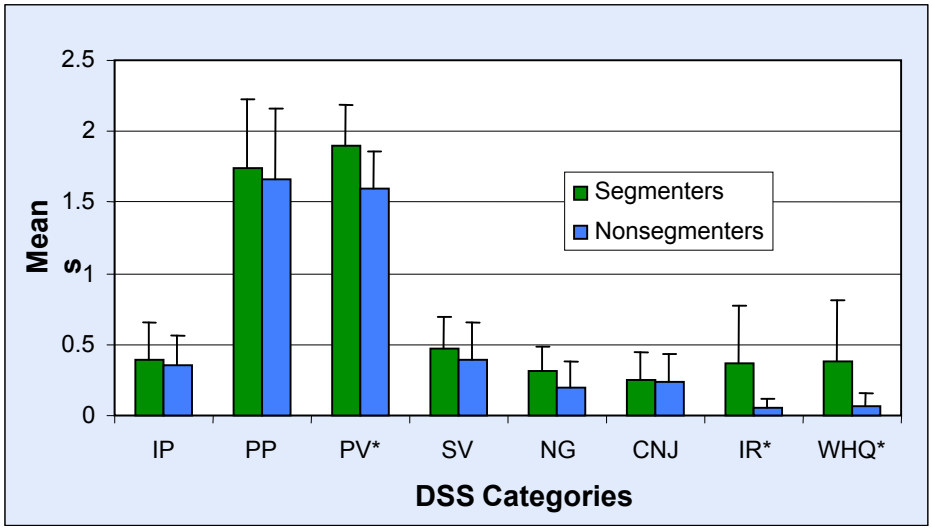

Figure 2 - Comparison of DSS categories. IP: indefinite pronouns; PP: personal pronouns; PV: primary verbs; SV: secondary verbs; NG: negatives; CNJ: conjunctions; IR: inerrrogative reversals; WHQ: wh- questions

Type-token ratio (TTR) and use of non-specific vocabulary were also compared across groups. No difference was found between groups in either of these measures.

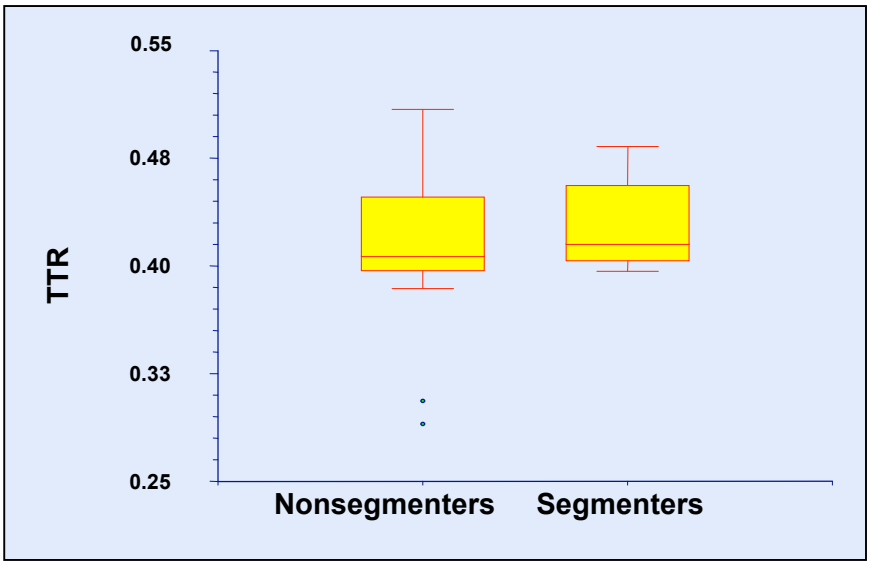

Figure 3 - Type-token ratio

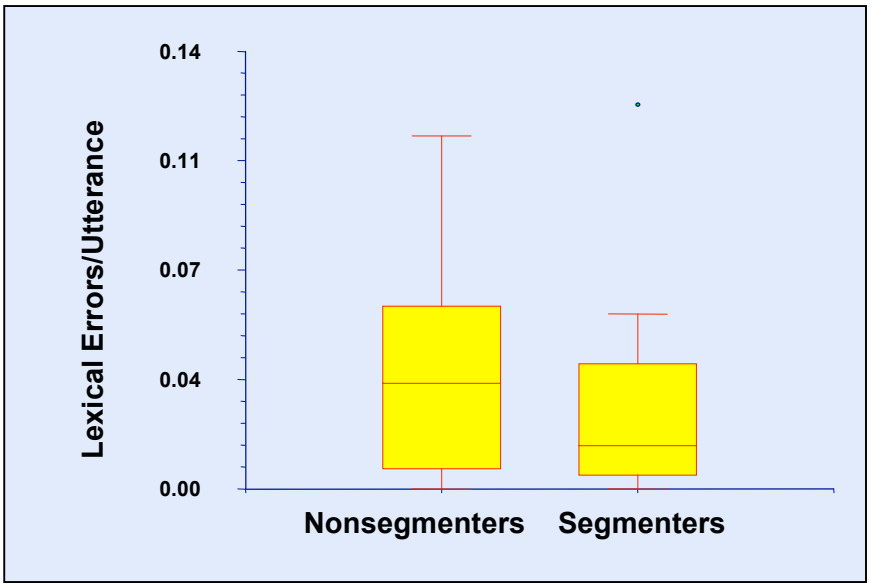

Figure 4 - Lexical errors produced per utterance

5. Discussion

Results extend earlier findings that some aspects of infant perceptual ability, specifically the ability to segment words from fluent conversational speech as infants, may predict certain later language abilities, particularly the development of certain syntactic skills.

The DSS categories of Primary Verb, Interrogative Reversals, and Wh- Questions are all syntactic skill areas that typically develop later in childhood (see, for example, Menyuk, 1977). It appears that the infants with good infant speech segmentation skills have developed and used these skills earlier than the nonsegmenter group. The DSS categories that did not show differences between groups can be considered earlier developing (such as marking simple negation and pronoun usage) or more lexical in nature (such as use of varied conjunctions). Thus, whatever advantage the "segmenters" have over their peers by the preschool years appears to be more syntactic than lexical in nature.

While it is not yet clear what skills underlie successful segmentation ability in infancy, or how such skills directly mediate language acquisition strategies and achievements, we note that segmentation appears to relate more strongly to the early abstraction and use of grammatical rule systems rather than item-based learning of individual lexical items at ages 4-6.

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