

Infants Use Prosody to Learn About Clauses

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Introduction

Human babies appear to be helpless, yet they are capable of learning all the complexities of any human language in a relatively short amount of time and without explicit instruction. This is a particularly amazing feat given that there are no spaces or pauses between words or between most syntactic units to help with the task of identifying words and syntactic constituents. However, an infant must be able to pick words out of the speech stream before she can learn what those words mean, and she must be able to identify phrase and clause boundaries before she can learn the hierarchical sentence structure that is crucial for sentence comprehension. This is a daunting task, yet infants are sensitive to clause boundaries by 4.5 months (Jusczyk, 1989), and they can segment many words from the speech stream by 7.5 months (Jusczyk et al., 1999).

According to the Prosodic Bootstrapping Hypothesis (Gleitman & Wanner, 1982; Morgan, 1986), infants can use prosodic boundaries to learn about certain syntactic structures. It is well-established that there are reliable prosodic cues, such as pausing and final-syllable lengthening, at the boundaries of clauses (Fisher & Tokura, 1996; Soderstrom et al., 2008), and that infants are sensitive to these cues (Hirsh-Pasek et al., 1987). Similarly, several studies (Mandel et al., 1994; Nazzi et al., 2000; Soderstrom et al., 2005; Seidl, 2007) have found that infants more easily remember strings of words that are prosodically well-formed, suggesting that words that are grouped together prosodically are more likely to be remembered together. However, these studies do not directly speak to whether infants and children use prosody for syntactic learning.

Our Approach

Previous work exploring the Prosodic Bootstrapping Hypothesis has focused on whether infants and children can use prosodic cues to segment the speech stream into linguistically relevant units. We extend this line of research to ask if children treat words within prosodically marked units as being more cohesive than words that cross prosodic boundaries. This is a first step toward asking whether prosody can be used to locate syntactic constituents. To approach this question, we are building on the fact that syntactic constituents can often be moved to different positions within a sentence. In fact, movement is a classic test of syntactic constituency: words that move together belong to the same constituent. The ability to recognize a sequence of words that has been moved within a sentence has even been used as an indicator for learning of syntactic constituency in artificial grammar experiments with adults (Takahashi & Lidz, 2007).

Movement is a particularly potent test for constituency when looking at prosody's roll in signaling constituent structure. The present study focuses on clause-level constituents, and the prosody of a clause is different, depending on where it falls within a sentence. For example, compare the prosody of "John came home" in (1) and (2).

(1) [While I ate] [John came home] → (2) [John came home] [while I ate]

If children use prosody to locate syntactic constituents, we predict that they will treat words within a prosodically marked clause as more cohesive than words that cross a prosodic boundary, even when that clause has been moved to a different position in a sentence and has a new prosodic contour. Therefore, they should differentiate between the grammatical movement

exemplified in (1) vs (2) and the ungrammatical movement shown in (3) vs (4), even when the sentences are made of nonsense words from an artificial grammar.

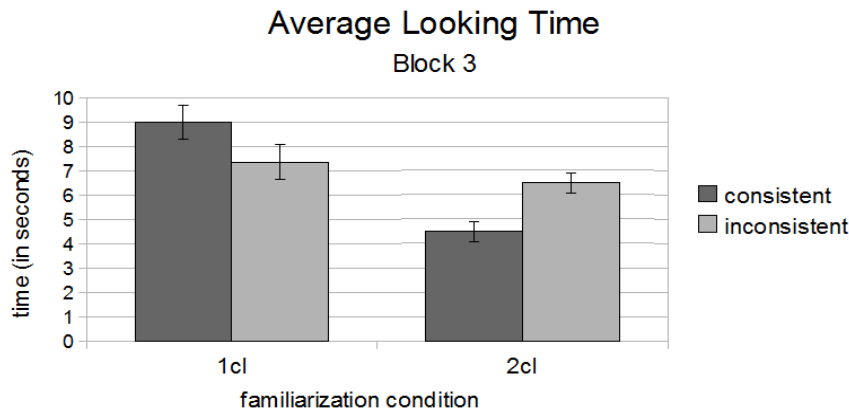
(3) [While I ate][[John came home] → (4) *[I ate John] [came home while]

Experiment 1

In Experiment 1, 24 English-acquiring 17-month-olds were familiarized with an artificial grammar composed of sentences with six nonsense words each. This age group was chosen because 17-month-olds are old enough to learn a simple phrase structure grammar based on brief exposure to a novel language (Gerken, Wilson, & Lewis, 2005), and they are old enough to comprehend sentences that contain movement (Seidl & Hollich, 2002). The children were divided into two groups, based on the prosody of the familiarization sentences. Half of the children were familiarized with sentences with 2-clause prosody of the form [ABC, DEF], and half with prosodically 1-clause sentences of the form [ABCDEF]. Each letter (A, B, C, etc.) represents a class of nonsense words, with two tokens in each class. For example, *bup* and *nim* were the two words in class A.

After two minutes of familiarization, the children were tested via the Head-Turn Preference Procedure. Both groups of children were tested on sentences with two-clause prosody of the forms [DEF, ABC] and [EFA, BCD]. The [DEF, ABC] items are *consistent* with the clause-like units that were presented to the children from the 2-clause familiarization group, because the clauses (ABC and DEF) are simply switched. In contrast, the [EFA, BCD] items are *inconsistent* with the clause-like units that the 2-clause children heard during familiarization, since the clauses (EFA and BCD) are different.

If children from the 2-clause group treat words within prosodically marked clauses as more cohesive than words that cross a prosodic boundary, they should be more likely to discern the difference between consistent and inconsistent test items than children in the 1-clause group. The children from the 1-clause group should not prefer one type of test item over the other, since the sentences they heard during familiarization had no internal prosodic constituents. Although there was no significant interaction of familiarization condition (1- vs 2-clause) with test condition (consistent vs inconsistent), a closer examination including test block as a factor (the test items were presented in three consecutive blocks of four test items each) indicates that children from the 2-clause group showed a trend towards discriminating between consistent and inconsistent test items for the items in the 3rd and final block of the experiment ($F(1, 22) = 3.91, p < .1$).

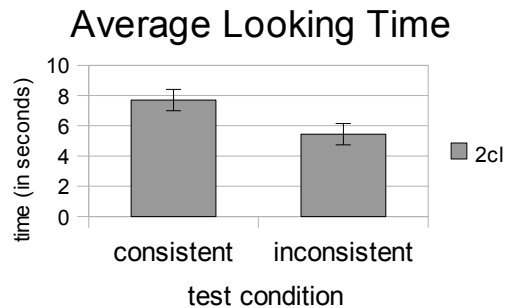


These results, while inconclusive, suggest that 17-month-olds may be able to use prosody to locate clause-like units in an artificial grammar, but that they need more exposure to the grammar before they are able to do so.

Experiment 2 (In Progress)

In order to obtain more convincing results about prosody's usefulness as a cue to syntactic constituency, we replicated Experiment 1 with two small changes. First, we tested slightly older children – 19-month-olds (11 participants, to date) – in order to mitigate the possibility that 17-month-olds were too young for the experimental task. Second, we added a 10 minute period of pre-familiarization to give the children more time to learn the grammar. During the pre-familiarization phase, the child played quietly with his or her parents while listening to either 1- or 2-clause sentences, depending on the familiarization condition they were placed in. After the 10 minute pre-familiarization phase, the child moved into the testing room, where everything proceeded just the same as in Experiment 1.

Preliminary data from this experiment suggest that 19-month-olds treat words that are prosodically grouped together in clause-like units as more cohesive than words that cross a prosodic boundary. Children in the 2-clause group listened significantly longer to the consistent test items throughout all three of the test blocks ($F(1,106) = 6.52, p < .05$) (data from the 1-clause (control) group are pending), suggesting that they can recognize clauses that are solely marked via prosody, even when those clauses occur in a new position in a sentence and with a different prosodic contour.



Conclusions

Since Experiment 2 changed two variables – the age of participants (from 17 months to 19 months) and the duration of the familiarization period (adding an additional ten minutes), it is not clear whether the children's success in Experiment 2 is due to their increased age or the longer learning period. However, by 19 months and with a sufficient familiarization period, children can recognize prosodically grouped nonsense words as cohesive, clause-like units when they have been moved within an utterance and have a new prosodic contour. This finding is consistent with prior research showing that prosody can be used to segment the speech stream and that prosodic structure influences children's memory for linguistic units. By using movement, a linguistic test for syntactic constituency, our study extends research on the Prosodic Bootstrapping Hypothesis more clearly into the realm of syntactic learning.

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