American Infants' Perception of Cues to Grammatical Units in Non-native Languages and Music: Evidence from Polish and Japanese

Peter W. Jusczyk*

Introduction

During the first year, infants are highly attuned to suprasegmental aspects of speech. This sensitivity may be exploited in the infant's segmentation of the speech stream into clausal units. Hirsh-Pasek, Kemler Nelson, Jusczyk, Wright Cassidy, Druss and Kennedy (1987) examined young infants' sensitivity to the pauses and other suprasegmental cues that coincided with clausal boundaries by inserting artificial pauses at clause boundaries or clause-internally. They found that when the infants were presented with passages that either had pauses inserted at clause boundaries and passages that had pauses inserted clause-internally they preferred the passages that had pauses coincident with clausal boundaries. This was true even in low-pass filtered speech (Jusczyk, 1989), making it clear that infants were sensitive to suprasegmental cues and not segmental cues.

The following studies examine this finding in more detail. They ask whether the sensitivity to the prosodic properties of the clause is language general or not. The Headturn Preference Procedure is used to examine young infants' sensitivity to clausal units in languages with different prosodic and syntactic properties. The degree of tuning to the input language in the performance of these tasks is then assessed. In addition, infants' performance with non-language stimuli is also assessed in order to ascertain which aspects of performance are linguistic in origin and which are more general properties of learning about auditory stimuli.

Experiment 1

This first study examines American infants performance on the pause insertion task with Polish stimuli. Polish is similar to English in that declarative sentences tend to employ a terminal fall in intonation (Bolinger, 1978); however, Polish is different from English in that it has looser word order and non-English phonemes and phonotactics. In addition, Polish, like most dialects of English (and unlike Catalan (syllable-timed) or Japanese (mora-timed)), is usually described as a stress-timed language.[1] Given these facts, we have every reason to expect that if the infants are able to ignore the phonemic and phonotactic differences between to two languages, infants will treat the Polish stimuli similarly to the English stimuli in Hirsh-Pasek et al, (1987).

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* These data were compiled and written by Amanda Seidl following the death of PWJ. The Japanese data result from a collaboration between PWJ and Akiko Hayashi. For additional data from these studies contact seidl@cogsci.jhu.edu.

[1] Although see Ramus et al., (2003) for a different view of Polish that placed it somewhere between stress-timed and syllable-timed. If Polish is truly not stress-timed, this may account for some of the older infants' performance on these tasks. Perhaps the 6-month-old infants may have performed differently on a truly stress-timed, but unfamiliar language, such as Dutch.

Methods

Participants

Twenty-four (15 male, 9 female) 6-month-old infants (mean age =26.1 weeks, range =30.8 to 24.4 weeks) were tested on the Polish. An additional 4 infants were tested, but failed to complete the procedure due to crying or fussiness.

Stimuli

A Polish woman who had recently settled in the U.S. was recorded interacting with her 18-month-old child. 5 or 6 clauses were digitized with natural pauses longer than 450 ms removed and 1 s silences inserted at clause boundaries or clause-internally to create both a Coincident and Noncoincident sample.

Design and Procedure

In the procedure used here, the infant sits in the center of the caregivers' lap on a chair in the center of a three sided booth made of pegboard. A red light and a speaker are mounted on the center of each side panel. A green light is located in the center of the front panel. At the start of a given trial the light on the center panel begins to flash. When the child is facing towards the center light a light will begin to flash on one of the side panels. When the infant turns her head toward that light, speech begins to play, and continues to play until she looks away from the light for longer than two consecutive seconds. The experimenter and a video camera are hidden behind the front panel, and are able to observe or record the infant through small holes in the pegboard. The experimenter presses buttons on a button box to indicate whether the infant is looking to the front, the side or away from a flashing light. The button box is connected to a computer that controls the selection and presentation of stimuli and records the looking time to each stimulus (the dependent measure). Both caregiver and experimenter wear sealed headphones and listen to loud continuous music during the course of the experiment. This music masks the speech stimuli. In this use of the procedure there is a pre-exposure period immediately followed by a test period. An experimental session with each infant included both an 8-trial pre-exposure phase and a 12-trial test phase. Four of the sample pairs were used for pre-exposure trials and the remaining 12 were used for test trials.

Results and Discussion

The average orientation times were 6.2 s for the Coincident versions and 6.41 s for the Noncoincident versions. This difference was not significant ($t(23)= -0.44$). Overall 13 of the infants listened longer to the Coincident versions and 11 to the Noncoincident versions.

There are two possible conclusions from these data. Alternative 1: Infants need to be familiar with a language in order to detect the prosodic markers that coincide with clausal units. Alternative 2: Infants are sensitive to the suprasegmental correlates of clausal units in Polish, but are distracted by the unfamiliar phonotactics and phonemes present in a non-native language. To examine this possibility, a second experiment was conducted with low-pass filtered versions of the Polish stimuli.

Experiment 2

This experiment had exactly the same design and methods as Experiment 1 except that the stimuli were low-pass filtered.

Methods

The method, design and procedure were identical to Experiment 1.

Participants

Thirty-two (16 male, 16 female) 6-month-old infants (mean age =27.9 weeks, range =31.7 to 23.7 weeks) completed the study. An additional 3 infants were tested, but failed to complete the procedure due to crying or fussiness. One additional infant was not included in the analyses because he looked less than 3 s to each stimulus.

Stimuli

The Polish stimuli from Experiment 1 were low-pass filtered at 400 Hz.

Results and Discussion

Once again there was no evidence of a significant difference between Coincident and Noncoincident samples. The mean orientation time was 8.66 s to Coincident versions and 7.97 s to Noncoincident versions ($t(23) = 0.97$). Even though orientation times between Coincident and Noncoincident versions were not different, infants did seem to be distracted by the phonological structure of Polish –orientation times were longer for the filtered versions in Experiment 2 than they were for the non-filtered versions in Experiment 1 and this difference was significant by an ANOVA ($F(1, 92)=11.66$, $p<.001$).

It may be that by 6 months of age infants have already begun to be attuned to the specific prosodic characteristics of the native language and have become less able to discriminate non-native prosodic patterns (see Nazzi, Jusczyk and Johnson, 2000 for a discussion of similar findings with respect to language discrimination). To explore this possible explanation a third experiment was conducted on younger infants.

Experiment 3

Experiment 3 was identical to Experiment 1 except that the infants tested were 4.5-month-olds instead on 6-month-olds.

Methods

The method, design, procedure and stimuli were identical to Experiment 1.

Subjects

Twenty-four (12 male, 12 female) 4.5-month-old infants (mean age =21.4 weeks, range =23.2 to 20.1 weeks) were tested on the Polish samples. An additional 4 infants were tested, but failed to complete the procedure due to crying or fussiness

Results and Discussion

The mean orientation times were 10.01 s to the Coincident versions and 7.75 s to the Noncoincident versions. This difference was significant: $t(24)=3.69$, $p<.001$.

At 4.5 months of age, the American infants displayed a reliable preference for the Coincident version of the Polish passages. Thus, at an early stage of development familiarity with a language is not a prerequisite for sensitivity to the prosodic markers of clausal structure. The next experiment explores whether this sensitivity is present for languages from a different rhythmic class.

Experiment 4

Japanese differs from English in the same dimensions as Polish with respect to word order (it is SOV instead of SVO) and the inventory of phonemes, but it also differs in one further dimension: rhythmic class. This experiment looked at infants' sensitivity to clausal units in this mora-timed language.

Methods

The method, design and procedure were identical to Experiment 1.

Subjects

Twenty-four (17 male, 7 female) 4.5-month-olds (mean age =21.3 weeks, range =23.5 to 18 weeks) completed the study. An additional 3 infants were tested, but failed to complete the procedure due to crying or fussiness.

Stimuli

The stimuli were recorded versions of a Japanese mother talking to her infant.

Results and Discussion

Infants did not significantly prefer the passages with pauses coincident with clause boundaries over passages with non-coincident pauses (t (23), p =.93). The lack of a preference for one passage type (coincident vs. non-coincident) is also exemplified by the average looking times. On average, infants looked equally to the coincident versions and non-coincident versions (average looking time to each stimulus type was 11.5 s).

The lack of an effect in this experiment is interesting in light of the finding that infants at this age *are* sensitive to prosodic correlates of clausal units in Polish stimuli. Perhaps, mora-timed languages present problems for the English-learning infant that stress-timed languages do not. These findings suggest that, despite the finding that infants at this age are sensitive to prosodic correlates of clauses in Polish, it may be that 4.5-month-olds already show some tuning to language specific properties. This early tuning appears to occur with respect to gross rhythmic classes at 4.5 months, but not with respect to more fine-grained rhythmic classes or word order until 6 months of age.

Since infants seem to be sensitive to prosodic cues to structural units in at least some non-native languages at 4.5 months, one question that arises is whether this sensitivity is specific to language or not. In the next study we ask whether infants are sensitive to musical units in the same way they are sensitive to language units and whether the rhythmic typology of the music affects this sensitivity in the same way the typology of language does.

Experiment 5

Previous studies have shown that infants at 4.5 months of age are sensitive to the prosodic properties of musical units/phrases within Mozart minuets (Krumhansl and Jusczyk, 1989). In Krumhansl and Jusczyk (1989), infants listened significantly longer to Mozart minuets that had artificial pauses inserted coincident with phrase boundaries than to minuets that had pauses inserted phrase-internally. In other words, these music results paralleled the results with the Polish stimuli. In the next study Jusczyk examined infants' performance on music with a different structure than western music, namely Japanese music. The stimuli used in this experiment were also different from those used in Krumhansl and Jusczyk (1989) in that they are songs (music with words) instead of minuets.

Methods

The method, design and procedure were identical to Experiment 1.

Subjects

Twenty-four (16 male, 8 female) 4.5-month-olds (mean age =20.4 weeks, range =22.1 to 17.3 weeks) completed the study. An additional 4 infants were tested, but failed to complete the procedure due to crying or fussiness.

Stimuli

The stimuli were recorded versions of eight Japanese songs.[2] These songs together with inserted pauses ranged from 22 s to 28 s in length with an average length of 25.35 s. In the Coincident versions of the stimuli the pauses were inserted before measures that followed either after a musical rest or a sustained note marking a phrase boundary. In the Noncoincident versions of the stimuli the pauses were inserted before measures as well, but not after rests or sustained notes, i.e., at non-phrase boundaries.

Results and Discussion

The mean orientation times were 11.9 s to the Coincident versions and 13.7 s to the Noncoincident versions. This difference was significant ($t(21)=-2.129$, $p<.045$). Thus, at 4.5 months of age the American infants displayed a reliable preference for the Noncoincident version of the Japanese music selections. We can conclude from these data that at an early stage of development familiarity with music is not a prerequisite for sensitivity to the prosodic markers of musical structure.

Interestingly, the infants in this experiment preferred the Noncoincident version to the Coincident version. This is not only the opposite of what was found by Krumhansl and Jusczyk (1989) in the study involving Mozart minuets, but also distinct from what was found with respect to the Polish language stimuli in Experiment 3. There are a few possible ways we might account for this finding. First, in order to explain this performance in contrast to the performance on the minuets, we must recognize that Japanese music is of course different in tone and rhythmic structure from Western music.

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[2] The songs in transliteration were: Zui Zui Zukkorobashi, Toryanse, Akatobo, Nunatsu No Ko, Shojoji No Tanuki Bayashi, Ureshii Ninamatsuri, Momiji, and Chiisaii Aki Mitsuketa.

Phrase boundaries in music may be marked both harmonically and rhythmically, while the rhythmic cues are roughly the same in this Japanese music as they are in Western music, the harmonic cues may be quite different. The pitch changes in the Japanese music are often of a different type than we would find in western music. Since these infants have no doubt been exposed to western music since birth, a greater familiarity with the type of music may have influenced their performance. Second, the Japanese music was quite a bit simpler in structure than the Mozart minuets played to infants in Krumhansl and Jusczyk (1989). The minuets had both melody and harmony, whereas the Japanese music had only melody and the minuets had much more complex cords. Either the simplicity of this music or its distinct pitch changes may have been contributing factors to infants' behavior in this experiment. Clearly though, more research is necessary in order to adjudicate between these alternatives.

General Discussion

An interesting fact that emerges from these studies is that the rhythmic class of the native language influences infants' sensitivity to the units of speech even as young as 4.5 months of age. Thus, 4.5-month-olds were sensitive to the units of speech in Polish (a language similar in rhythmic structure to English), but not sensitive to units in Japanese (a moraic language). Infants at this age were also shown to be sensitive to units in music stimuli, perhaps because the rhythmic properties marking phrases were similar to Western music, however, because this music had different pitch changes and less complexity than western music, infants' behavior or preferences were found to be distinct from their preferences with western music stimuli.

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