



Tempo of Speech Discrimination in Preschool Children: The Roles of Intersensory Redundancy and Task Difficulty

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Abstract

The Intersensory Redundancy Hypothesis (IRH; Bahrick & Lickliter, 2000, 2002) posits that perceptual processing of amodal properties (e.g., tempo) is facilitated in redundant, bimodal stimulation and attenuated in nonredundant, unimodal stimulation (intersensory facilitation). This study extends the investigation of intersensory facilitation from infants to preschool-aged children (N=32; M=46.7 months) by assessing children's discrimination of tempo in redundant, audiovisual versus nonredundant, unimodal visual speech. We predicted intersensory facilitation would be evident in children and most apparent for difficult tasks. Children received four easy and four difficult tempo contrasts (large versus small difference in tempo) across trials depicting two women speaking sequentially. They pointed to the woman who spoke faster. As predicted, for difficult contrasts, children showed greater discrimination of tempo in the redundant than nonredundant conditions ($p < .001$). For easy contrasts, they discriminated under both conditions. Preschool children demonstrated intersensory facilitation for difficult tempo contrasts, extending findings of the IRH to children.

Introduction

The Intersensory Redundancy Hypothesis (IRH; Bahrick & Lickliter, 2000, 2002) posits that perceptual processing of amodal properties (e.g., tempo, rhythm, intensity) is facilitated in redundant, bimodal stimulation and attenuated in nonredundant, unimodal stimulation (intersensory facilitation). Evidence from infant studies of rhythm and tempo discrimination supports this hypothesis (Bahrick & Lickliter, 2000, 2004; Bahrick, Flom & Lickliter, 2002). The IRH also proposes that intersensory facilitation is not limited to early development. Rather, it extends across the life span and is most evident in tasks of high difficulty or high cognitive load. The role of task difficulty has been demonstrated in studies of tempo discrimination in infants (Bahrick, Lickliter, Castellanos, & Vaillant-Molina, 2010).

The present study extends the investigation of intersensory facilitation and the role of task difficulty from that of infants to preschool aged children by examining their sensitivity to changes in the tempo of speech for easy and difficult contrasts. According to predictions of the IRH, children should show enhanced discrimination of tempo changes in bimodal audiovisual speech (which provides intersensory redundancy) as compared with unimodal visual speech (which provides no redundancy), particularly if the task is relatively difficult.

Method

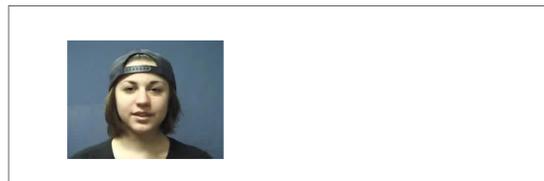
Thirty-two 3.5- to 4-year-old children (M=46.7 months; range = 42.2 to 49.4 months) participated. Children were randomly assigned to either the Unimodal Nonredundant (silent video of a woman speaking) or the Bimodal Redundant condition (audiovisual presentation of the woman speaking). Within each of these conditions, children received 2 blocks (4 trials each, with a different woman speaking in each block), with 2 easy and 2 difficult tempo contrast trials within each block, creating a 2 x 2 redundancy condition (unimodal, bimodal) by task difficulty (easy, difficult) mixed design. Order of task difficulty and pairing of actress with task difficulty were counterbalanced across subjects. Two standard rates of speech were used: 130 or 160 syllables per minute (spm). Easy contrasts depicted a difference of +/- 45 spm from the standard and difficult contrasts depicted a difference of +/- 30 spm.

Prior to the start of the study, children were asked to say something "fast" to gage their understanding of the term and then received 4 practice trials with feedback on their performance. The experimenter then explained that two "mommies" would be shown telling a story and children should pick which "mommy" spoke faster. Children then viewed 2 videos of the same woman speaking, presented sequentially, each on a different side of the screen (see Figure 1a), one at a faster rate of speech (i.e., tempo) than the other. The pairs of videos appeared one at a time on opposite sides of the screen (right or left), with lateral positioning counterbalanced. Children were asked to indicate which mommy spoke faster during the test phase in which 2 still frames of the woman, one on each side of the screen, appeared (see Figure 1b). Because the same woman and script were used for each video presentation within a block, the only basis for choosing a "mommy" was the rate of speech.

Figure 1a. Sample trial: Children viewed 2 dynamic videos of the same woman speaking, presented sequentially, each on a different side of the screen.



"Look at the mommy."



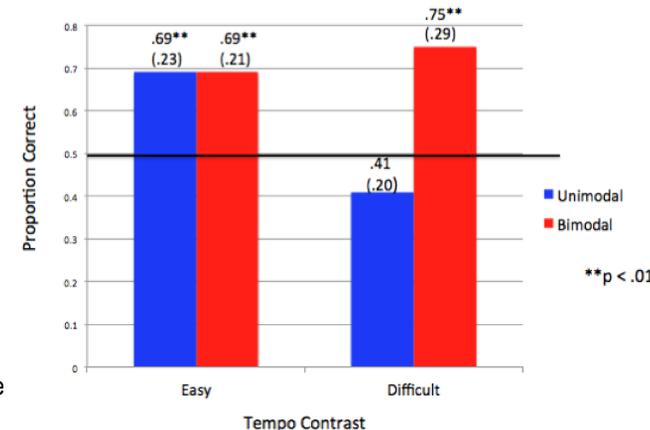
"Look at the mommy."

Figure 1b. Sample test trial featuring 2 still frames of the woman, one on each side of the screen. Children were asked to indicate which mommy spoke faster by pointing.



"Which mommy spoke faster?"

Figure 2. The proportion of correct responses during test trials as a function of redundancy condition and task difficulty



Results

Single sample t-tests against the chance value of 50% were conducted to assess the conditions under which children showed a significant proportion of correct responses (see Figure 2). For the easy tempo contrasts, children in the Bimodal Redundant condition, $t(15) = 3.22$, $p < .01$, and the Unimodal Nonredundant condition, $t(15) = 3.5$, $p < .01$, both selected the target person who had spoken at a faster tempo at above chance rates. For the difficult tempo contrasts, children in the Bimodal Redundant condition showed significant evidence of selecting the target persons who had spoken faster, $t(15) = 3.46$, $p < .01$, however, children in the Unimodal Nonredundant condition did not, $t(15) = -1.86$, $n.s.$

A repeated measures ANOVA examining the proportion of correct responses, with tempo contrast (easy vs. difficult) as the within-subjects factor and redundancy condition (Unimodal Nonredundant vs. Bimodal Redundant) as the between-subjects factor, revealed a marginally significant main effect of tempo contrast, $F(1,30)=3.48$, $p = .07$, and a significant interaction of redundancy condition and tempo contrast, $F(1,30)=8.60$, $p < .01$. For easy tempo contrasts, the performance of children in the Unimodal and Bimodal conditions did not differ from one another, $t(30)= .00$, $n.s.$ In contrast, for the difficult tempo contrasts, children in the Bimodal condition showed significantly greater discrimination of tempo changes than children in the Unimodal condition, $t(30)= -3.91$, $p < .001$, demonstrating intersensory facilitation.

Discussion

The results of this study indicate that intersensory facilitation of attention to amodal properties in a social event is evident in preschool-aged children under conditions of relatively high, but not low, task difficulty. Children discriminated a change in the tempo of speech when the task was difficult (i.e., a small tempo contrast) for redundant audiovisual speech but not for nonredundant unimodal visual speech, demonstrating intersensory facilitation of tempo perception. In contrast, when the task was easy (i.e., a large tempo contrast), children discriminated a change in the tempo of speech in both redundant audiovisual and nonredundant unimodal visual speech (no intersensory facilitation). These findings are consistent with predictions of the IRH and are the first to find evidence of intersensory facilitation and the role of task difficulty in preschool-aged children. Together, these findings suggest that predictions of the Intersensory Redundancy Hypothesis extend across the lifespan from infancy through early childhood

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