

Abstract

Research conducted on infant directed speech has primarily focused on infants' perception of unimodal auditory speech, even though natural speech is typically multimodal. According to the intersensory redundancy hypothesis (IRH), information presented redundantly and synchronously across two or more senses recruits attention and facilitates perceptual learning of amodal properties more successfully than information that is presented to only one sense (Bahrick & Lickliter, 2000, 2002). Multimodal presentations provide redundant information for amodal properties such as prosody, intonation, intensity, tempo and rhythm available in audiovisual speech which are important for conveying meaning. The present study tested predictions of the IRH and assessed whether 4 1/2-month-old infants could perceive a change in meaning from prohibition to approval or vice versa when unimodal auditory speech passages were presented (no redundancy) versus bimodal audiovisual speech passages (redundancy provided by the speaker's moving face). Consistent with predictions, results of an habituation procedure demonstrated that under the bimodal audiovisual speech condition, but not the unimodal auditory speech condition, infants detected a change in meaning across different speech passages. These findings demonstrate that at 4 1/2 months, infants are able to discriminate changes in prosody that convey prohibition and approval in the presence of intersensory redundancy provided by audiovisual speech, but not in auditory speech where there is no redundancy. Further, at 4 1/2 months, infants are able to generalize across different speech passages on the basis of prosody conveying approval or prohibition. These findings support predictions of the IRH and suggest that detection of meaning conveyed by prosody first emerges by detecting intersensory redundancy in audiovisual speech.

Introduction

When and under what conditions do infants detect meaning in speech? Research has shown that infant directed speech, or "motherese" (involving greater prosodic repetition, higher pitch and wider pitch range, longer pauses and shorter utterances), is important for maintaining infant attention and conveying intention and meaning in speech (e.g., Fernald, 1989). For example, infants of 6- but not 4-months were able to discriminate and categorize utterances of approval versus comfort in unimodal auditory speech based on non-linguistic prosodic features such as variations in frequency, rhythm, and intensity (Moore, Spence, & Katz, 1997; Spence and Moore, 2003). According to the intersensory redundancy hypothesis (IRH), information presented redundantly and synchronously across two or more senses recruits attention and facilitates perceptual learning of amodal properties more successfully than information that is presented to only one sense (Bahrick & Lickliter, 2000, 2002). Multimodal presentations provide redundant information for amodal properties such as prosody, intonation, intensity, tempo and rhythm available in audiovisual speech which are important for conveying meaning such as approval, comfort, and prohibition. In contrast, unimodal auditory presentations provide better information for modality specific properties such as timbre and pitch.

The present study evaluated predictions of the IRH by assessing whether infants would detect changes in the meaning of speech passages better in bimodal audiovisual than unimodal auditory speech. Infants of 4 1/2 months of age were tested in an habituation procedure to determine whether they could perceive a change in meaning from prohibition to approval or vice versa when unimodal auditory speech passages were presented (no redundancy) versus bimodal audiovisual speech passages (redundancy provided by the speaker's moving face). It was expected that detection of a change in meaning across different speech passages would be facilitated by bimodal, redundant speech and attenuated by auditory, nonredundant speech. Further, since redundancy is most helpful at younger ages and for difficult tasks (Bahrick & Lickliter 2002), it was expected that infants as young as 4 1/2 months would detect changes in meaning conveyed by prosody in audiovisual speech.

Method

The stimuli consisted of two passages, each comprised of three short phrases spoken by one of two women using infant directed speech (see Figure 1). One passage consisted of the phrases "Come over here by me! Where's the baby going? Look at you!" and the other consisted of "Gentle with the baby! Whose doggy is that? You did this!" Each passage was spoken with prosody characteristic of approval and prohibition. Forty-eight 4 1/2-month-old infants were randomly assigned to the bimodal, audiovisual speech condition ($N=24$) or the unimodal auditory speech condition ($N=24$). In the audiovisual condition infants received videos of a woman speaking (voice and synchronously moving face), whereas in the auditory condition infants received the auditory speech along with a static face of the speaker (no redundancy), allowing us to measure interest in the voice by the infant's visual fixations on the contingently presented visual display (see Bahrick & Lickliter, 2000). Infants in each condition were habituated in an infant-control procedure, to a woman reciting one of the two passages using prosody conveying approval or prohibition. Following habituation (and two no change posthabituation trials) infants received two test trials with the new passage under one of two conditions, meaning change (from approval to prohibition or vice versa) or no meaning change (from approval to approval or from prohibition to prohibition). Prosody chosen for habituation was counterbalanced across infants within each condition.

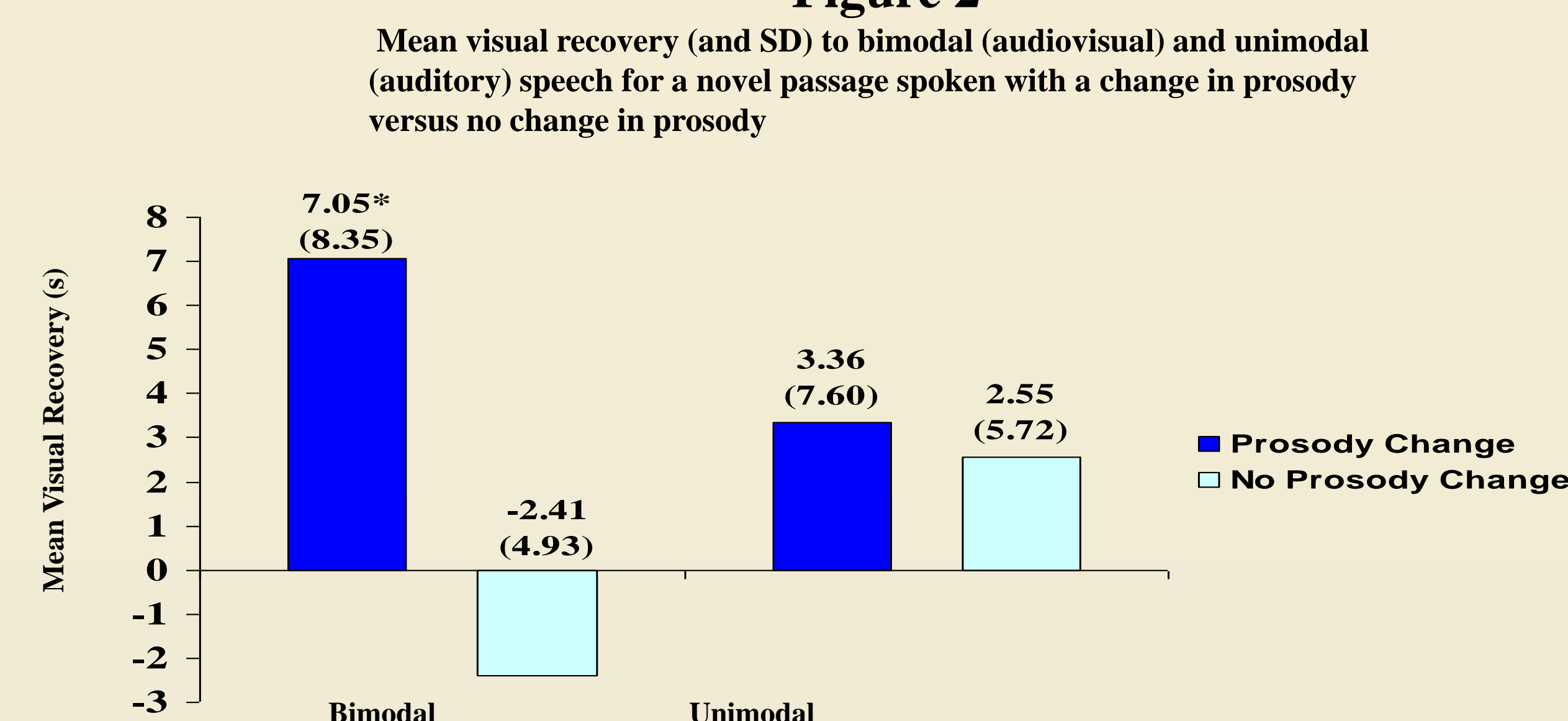
Figure 1



Results

Visual recovery (the increase in visual fixation from the two no change posthabituation trials to the two test trials) served as the measure of discrimination. Results (see Figure 2) indicated that infants in the bimodal audiovisual speech condition discriminated a change from one speech passage to the other when the novel passage was spoken using the novel prosody ($t(11) = 7.05, p=.014$) whereas infants showed no significant visual recovery when the novel passage was spoken in the familiar prosody ($t(11) = -2.41, p>.1$). In contrast, infants in the unimodal auditory speech condition failed to discriminate a change from one speech passage to another, even when it was spoken in the novel prosody ($ps>.1$). A two-way analysis of variance with condition (bimodal, unimodal) and prosody (change, no change) as between subjects factors revealed a significant interaction ($F(1,44) = 4.86, p=.03$), indicating that infants showed greater visual recovery to the new passage when there was a change in prosody than when there was no change in prosody in the bimodal condition, but not in the unimodal condition.

Figure 2



Conclusions

These findings demonstrate that infants of 4 1/2 months are able to discriminate between intonations conveying approval versus prohibition across two passages when they are presented under bimodal, audiovisual speech conditions, but not when they are presented under unimodal auditory speech conditions. Audiovisual speech provides redundancy for amodal properties such as prosody, intensity, rhythm, and tempo, which are important for conveying meaning in speech. Further, infants of 4 1/2 months generalized across two unfamiliar speech passages with the same prosody and showed discrimination only to passages with changes in prosody in audiovisual infant-directed speech. These findings extend those of prior research (e.g., Spence & Moore, 2003) and suggest that sensitivity to prosodic features of speech can be found developmentally earlier in bimodal, audiovisual than unimodal speech. These results also support predictions of the IRH and suggest that detection of meaning conveyed by prosodic features of speech likely first emerges by detecting intersensory redundancy in audiovisual

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