Eye Tracking Speaking Faces: Predictions from the Intersensory Redundancy Hypothesis

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Introduction

Eye tracking measures are ideal for testing theories of selective attention, including predictions of the Intersensory Redundancy Hypothesis (IRH). The IRH posits that multimodal stimulation is salient because it makes the same information, redundant amodal information, simultaneously available across two senses, causing redundant information to become "foreground" and other aspects of the event to become "background" (Bahrick & Lickliter, 2000, 2004, in press; Bahrick, Lickliter, & Flom, 2004). For example, in social stimulation, the concurrent movements of the face with speech sounds creates highly salient intersensory redundancy, which highlights available amodal properties such as affect and the prosody of speech (Bahrick, Castellanos, & Argumosa, 2011; Castellanos, 2007; Flom & Bahrick, 2007). Infants will be tested with dynamic presentations of a female actress speaking in either a redundant audiovisual or a nonredundant unimodal visual condition. Infants who receive redundant audiovisual speech, as compared to nonredundant unimodal visual speech, are predicted to look significantly more frequently to areas of the face (e.g., eyebrows, eyes, and mouth) that promote detection of affect and prosody. Conversely, infants who receive nonredundant unimodal visual speech are predicted to display more dispersed looking patterns.

Methods

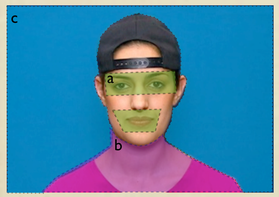
Stimulus Events

The stimulus events consist of dynamic color videotaped recordings of two female adults. Actresses were filmed wearing a baseball cap to mask external features (e.g., hair color and hairline). The redundant audiovisual displays depict a videotaped recording of the actress producing natural and synchronous infant-directed speech. The nonredundant unimodal visual displays were visually identical to the redundant audiovisual displays, however, no speech was audible.

Apparatus and Procedure

Three-month-old infants will sit on their parent's lap facing a color computer monitor approximately 70 cm away. Infants will view dynamic films of a woman speaking in infant-directed speech under one of two conditions: 1) redundant audiovisual versus 2) nonredundant unimodal visual, in a between-subjects design consisting of twelve 15-s exposures for each condition. The stimulus events will be presented using Tobii Studio 2.1.14 software on a 46-inch flat panel widescreen LCD computer monitor (NEC MultiSync P461) with a resolution of 1920 x 1080 pixels. Video soundtracks will be presented from matching stereo speakers (M Audio Studiophile Bx5a) placed centrally underneath the monitor so that the sound cannot be localized at one side of the screen or the other. The eye tracker will be placed centrally underneath the computer monitor and directly in front of infants to measure visual scanning patterns.

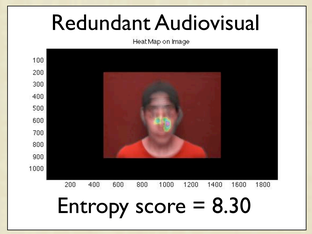
Figure 1: Illustration of Areas of Interest (AOIs) that will be analyzed as a function of condition (redundant audiovisual, nonredundant unimodal visual) and time. Area a: features of the face which promote affect and prosody discrimination including the eyebrows, eyes, and mouth; Area b: neck and body area; Area c: background.

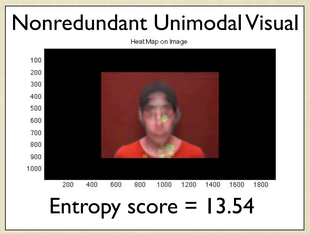


Predicted Results

Several dependent variables will be calculated to characterize the scan paths, including measures of entropy (scan path randomness or uncertainty), proportion of fixation time in AOIs (eyes, brows, mouth), and overall scan path length. According to the IRH, intersensory redundancy guides and constrains infants' selective attention to amodal properties (e.g., affect, prosody of speech) at the expense of other properties (e.g., facial configuration) available for exploration. If intersensory redundancy serves to focus infants' selective attention on amodal properties, then face scanning should be significantly more focused and constrained to the AOIs when intersensory redundancy is available versus when it is not available. A significant main effect of condition is predicted in which infants in the redundant audiovisual condition, as compared to infants in the nonredundant unimodal visual condition, are predicted to display more constrained scanning of the face as evidenced by shorter distances between fixations, lower entropy, and a greater proportion of fixations within the AOIs. Infants in the nonredundant unimodal visual condition, as compared to infants in the redundant audiovisual condition, are predicted to display more dispersed visual scanning as evidenced by longer distances between fixations, higher entropy, and a lower proportion of fixations within the AOIs, due to a lack of intersensory redundancy constraining attention to amodal properties.

Figure 2: Results of entropy analyses for the first two subjects in the experiment. An entropy heatmap was overlaid on an average image of the video. The image was averaged to depict the actresses' movements.





Discussion

Eye tracking measures provide specific information about what features of events infants attend to under different conditions. Further, they provide new and detailed information about infant attention to various aspects of dynamic faces in naturalistic audiovisual speech and unimodal visual speech. The current study will contribute to the understanding of the nature of infants' selective attention and processing of social events as a function of intersensory redundancy. The data collected from the eye tracker will allow for exploratory analyses of frame-by-frame micro-structural change in looking patterns across time that may give rise to information on how selective attention influences visual information gathering.

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