The Development of Basic Indices of Attention to Bimodal and Unimodal Social Events Across Infancy

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Introduction

Research suggests that infant attention becomes more flexible and efficient across development with significant decreases in look length and processing time and concurrent improvements in disengaging from one stimulus and shifting to another (e.g., Ruff & Rothbart, 1996). Infants' ability to flexibly engage and disengage attention between stimuli has been linked to self-regulatory abilities (e.g., Rothbart, Posner, & Kieras, 2004) and the regulation of social interactions (Abelkop & Frick, 2002), and faster processing time has been linked to enhanced cognitive and perceptual skills (Colombo, 2004) and better developmental outcomes (e.g., Rose, Feldman, Jankowski, & Van Rossem, 2005). However, an integrated picture of developmental changes in disengagement and processing time across infancy, particularly for dynamic audiovisual events (such as social events), is not available, as prior studies have been characterized by diverse methods, measures, restricted age ranges, and a primary focus on static visual displays.

Research generated by the Intersensory Redundancy Hypothesis (IRH; Bahrick & Lickliter, 2002) suggests that attention and perceptual processing of multimodal events that provide intersensory redundancy (such as audiovisual speech) is enhanced relative to similar events that provide no redundancy (e.g., unimodal visual or unimodal auditory speech). This may be reflected by greater processing time and less disengagement from bimodal compared to unimodal stimulation. The present study provides the first systematic assessment of basic indices of attention to bimodal (redundant) versus unimodal (nonredundant) stimulation across multiple ages to address this question. Furthermore, as both social interaction and disengagement of attention are impaired in autism (e.g., Landry & Bryson, 2004), an integrated picture of developmental changes in engagement and disengagement to dynamic social events for typically developing infants may provide an important basis for identifying atypical development of attention and social orienting.

Method

To provide a systematic developmental picture of changes in attention to audiovisual social events across infancy, data from 315 infants at 2, 3, 4, and 6 months of age (N = 57, 94, 64, and 100, respectively) were analyzed from several unpublished infant control habituation studies from our lab. In all studies, infants were habituated (to a 50% criterion) to dynamic displays of faces of women speaking in infant-directed speech under one of two conditions, either bimodal audiovisual speech or unimodal (silent) visual speech. The mean number of looks away per minute (reflecting disengagement), mean time to habituation (reflecting total processing time), and mean look duration (reflecting attention maintenance) were calculated.

Results

Age (2 vs. 3 vs. 4 vs. 6 months) x condition (bimodal vs. unimodal) ANOVAs were performed on the three dependent measures, with all factors analyzed between subjects. Results indicated:

- Significant main effects of age for all variables, confirming trends in the literature, with looks away per minute increasing across age, $F(3, 307) = 8.26$, $p < .001$, mean processing time decreasing across age, $F(3, 311) = 7.63$, $p < .001$, and length of look decreasing across age, $F(3, 300) = 3.34$, $p = .02$.
- Main effects of condition indicating greater disengagement, $F(1, 307) = 7.03$, $p = .008$, shorter length of look, $F(1, 300) = 4.07$, $p = .05$, and shorter processing times, $F(1, 311) = 8.30$, $p = .004$, for unimodal visual speech than for bimodal, audiovisual speech.
- The main effects were qualified by significant age by condition interactions, indicating:
  - a greater number of looks away per minute for unimodal than for bimodal speech which was most pronounced for 6-month-olds and not apparent for the youngest infants, $F(3, 307) = 3.31$, $p = .02$, (see Figure 1).
  - greater total processing time for bimodal than unimodal speech for the 4- and 6-month-olds but not for the youngest infants, $F(3, 311) = 2.81$, $p = .04$, (see Figure 2).
  - a similar but nonsignificant interaction trend for length of look ($p = .096$; see Figure 3).
- Finally, analyses of simple effects revealed significant main effects of age for the unimodal visual condition for each of the measures (all $p < .01$), but no significant main effects of age for the bimodal synchronous condition for any of the measures (all $p > .10$; see Figures 1, 2, 3).

Figure 1. Looks Away Per Minute

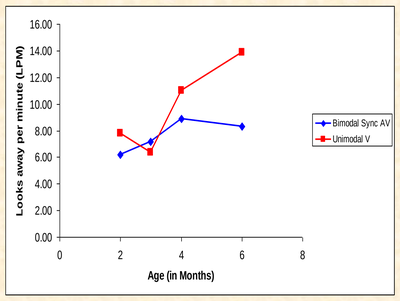


Figure 2. Average Length of Look

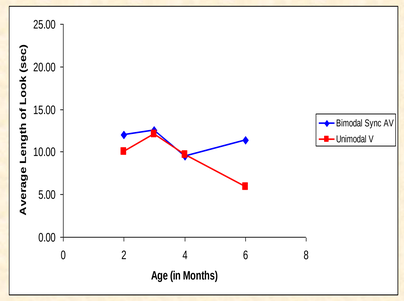
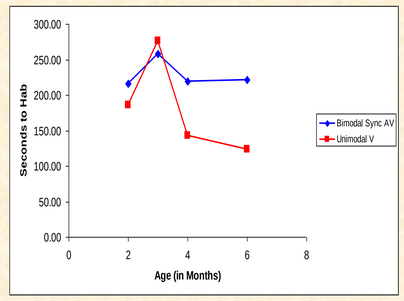


Figure 3. Seconds to Habituation



Figures: 1) Mean number of looks away per minute (disengagement), 2) average length of look (attention maintenance), and 3) mean number of seconds to habituation (processing time), as a function of age and condition (bimodal, synchronous audiovisual speech vs. unimodal silent visual speech).

Discussion

The present findings provide the first systematic picture of changes in disengagement, length of look, and processing times for dynamic audiovisual and unimodal visual events across infancy. Overall, these data converge with findings from the literature indicating increasing disengagement and decreasing length of look and processing times from 2 to 6 months of age. However, the developmental decline in look length and processing time and the increase in looking away was evident only for unimodal visual and not for bimodal audiovisual events.

These findings are consistent with predictions of the IRH indicating heightened attentional salience for events that provide intersensory redundancy (such as audiovisual speech) as compared with events that provide no intersensory redundancy (such as unimodal visual speech). Across age, look duration and processing time declined and disengagement increased for unimodal visual speech, but not for bimodal, synchronous audiovisual speech. Audiovisual speech, which provides intersensory redundancy, appears to engage and maintain attention and processing time across age during a time when attention to unimodal visual stimulation declines. Intersensory redundancy may thus be an important mechanism for promoting social orienting in infancy.

These findings also have important implications for identifying atypical patterns of attention to social events in infancy. They provide a developmental picture of changes in basic indices of attention in typically developing infants that may serve as a basis for identifying infants at risk for atypical development. In particular, children with autism show impaired social orienting and disengagement of attention, and these impairments are likely reflected by differences in attentional patterns in infancy.

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