Individual Differences in Growth Rate of Intersensory Processing Are Related to Early Language Skills

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BACKGROUND & MOTIVATION

Intersensory perception (e. g., matching synchronized auditory and visual information) forms a building block for language development (Bahrick & Lickliter, 2012). Detecting intersensory redundancy (stimulation synchronized across the senses) guides selective attention to unitary multimodal events, such as the sights and sounds of a person speaking, and synchronous naming and labeling facilitates object-label mapping (Gogate & Bahrick, 2001).

To better characterize fine-grained differences underlying these intriguing group-level findings we developed a new method, the Intersensory Processing Efficiency Protocol (IPEP). This method assesses individual differences in the speed and accuracy of intersensory processing (Bahrick et al., 2013; Bahrick, Soska, Todd, Saunders, & Bein, 2014). Using this method, we found that 6-month intersensory processing skills predicted receptive language skills at 6 months (Soska et al., 2015).

In the current study, we asked whether the *growth rate* from 6 to 12 months in intersensory processing relates to language skills (assessed at 6 months). First, we documented longitudinal change in intersensory processing from 6 to 12 months (Aim 1). Next, we asked if and under what conditions receptive language status at 6 months explained individual differences in this 6- to 12-month growth rate (Aim 2).

METHOD

In the IPEP, participants must find an acoustically-synchronized visual target amidst five visual distractors, simulating the “noisiness” of natural environments. At 6 and again at 12 months, infants (*N*=42) viewed 48 8s trials depicting a 2x3 grid (Figure 1) of dynamic social events (six women speaking; 24 trials) and nonsocial events (six objects striking a surface; 24 trials). During each trial, the natural soundtrack was synchronous with one event (target) and asynchronous with the five other events.

Visual fixations were recorded using a Tobii X120 eye-tracker (useable data *M*=59.7% at 6 months, *M*=58.7% at 12 months). We indexed accuracy in intersensory matching as the proportion of trials on which the target was fixated (PTTF).

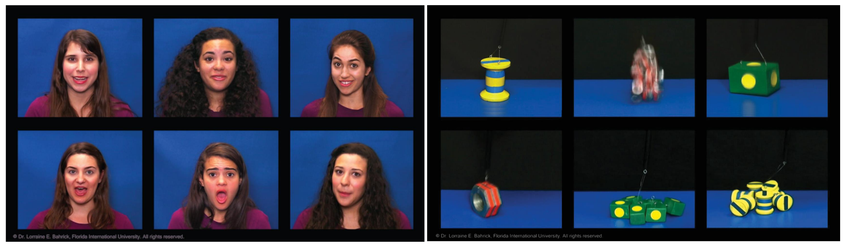

Figure 1. Static images of the dynamic social and nonsocial events in the IPEP.

Infants received the Mullen Scales of Early Learning (MSEL; Mullen, 1995) at 6 months to assess early receptive language skills (e. g., following social partners and responding to gestures). These early receptive language skills have been found to predict later language outcomes (Landa, Gross, Stuart, & Faherty, 2013).

RESULTS

AIM 1 RESULTS: DEVELOPMENTAL CHANGE IN INTERSENSORY ACCURACY

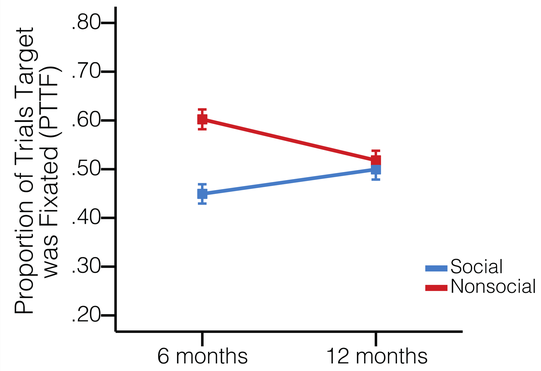

Figure 2. Developmental change in intersensory accuracy (PTTF) from 6 to 12 months of age for social and nonsocial events. Bars indicate standard errors of the mean.

We computed slopes to characterize individual infants’ rate of growth in intersensory accuracy (PTTF) from 6 to 12 months of age. Figure 2 shows the average change in intersensory accuracy from 6 to 12 months of age.

Social Events. PTTF to social events showed a marginally significant increase (R^2=.07, *p*=.086) from 6 to 12 months of age (*M*=5.03%; *SD*=18.53). Individual slopes reflected increases for 20 infants (47.6% of the sample), remained roughly flat (<2% monthly change) for 13 infants (31%), and decreased for 9 infants (21.4%).

Nonsocial Events. PTTF to nonsocial events at 6 months of age was higher than PTTF to social events (*t*(41)=5.82, *p*<.001). However, PTTF to nonsocial events showed a significant decrease (R^2=.196, *p*=.003) between 6 and 12 months (*M*=8.41%; *SD*=17.25), to a level similar to that of social events (*t*(41)=0.68, *p*=.5). Individual slopes showed decreases for 23 infants (54.8%), stayed flat for 10 infants (23.8%), and increased for 9 infants (21.4%).

AIM 2 RESULTS: INDIVIDUAL RELATIONS WITH LANGUAGE

	Baseline	Model 1	Model 2	Model 3
Intersensory Accuracy (6 mos)	b = -.69***	b = -.76***	b = -.78***	b = -.77***
Receptive Language (6 mos)	—	b =.27*	b = .22*	b = .22*
Speed & spread of scanning (12 mos)	—	—	b = .31**	b = .32**
Visual Reception (6 mos)	—	—	—	b = -.04
R^2 change	—	.07*	.10**	.001
Total R^2	.47***	.54***	.63***	.63***

Note: *p<.05, **p<.01, ***p<.001. Values represent standardized betas.

Table 1. Analyses of change in growth rate in intersensory accuracy to social events from 6 to 12 months of age

We conducted analyses of change (see Table 1) to examine relations between growth rates in intersensory processing for *social events* and receptive language.

First, we found that intersensory accuracy (PTTF) at 6 months predicted 6- to 12-month growth rates in intersensory accuracy (β=-.69, *p*<.001; *Baseline*). Infants with lower PTTFs at 6 months showed greater gains in PTTF by 12 months. Next, above their 6-month intersensory processing (PTTF) baseline, 6-month Receptive Language T-scores on the MSEL accounted for additional variance in growth rate (*p*=.023; *Model 1*). This positive relation held when controlling for number of events fixated per trial (speed and spread of scanning; *Model 2*) and Visual Reception T-scores on the MSEL (cognitive skills; *Model 3*) in the hierarchical regression (β=.22, *p*=.041).

We saw no significant association between growth rates in intersensory accuracy for *nonsocial events* and Receptive Language or Visual Reception on the MSEL (βs < .1, *p*s>.3).

CONCLUSIONS

Individual differences in the *growth* of intersensory processing *for social events* from 6 to 12 months of age are associated with early language-learning skills. These relations are independent of scanning speed and are evident when controlling for general cognitive skills (Visual Reception). Intersensory perception for *nonsocial events*, on the other hands, declined from 6 to 12 months and showed no relations with receptive language skills.

Future research will assess the nature of developmental pathways between intersensory perception of social events and early language skills (directionality of effects), as well as with later developing language skills, including vocabulary growth.

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