

## Background

Children with autism have difficulty disengaging attention from one stimulus and shifting to another (Landry & Bryson, 2004) and have specific impairments in orienting to social as compared with nonsocial events (Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998). They have also shown impaired intersensory processing of synchronous auditory and visual stimulation (Bebko, Weis, Denmark, & Gomez, 2006). In typical development, these skills develop within the first half year of life and provide important building blocks for social and communicative functioning. Deficits in these basic skills may lead to further amplification of disturbances in more complex skills and associated neurodevelopment. Understanding the nature, basis, and development of these deficits is critical to earlier diagnosis and more effective interventions for autism. The present study investigated the nature of these attention skills for social and nonsocial events in typically developing (TD) children and children with autism (ASD) using methods adapted from studies of infant attention.

## Objectives

The overall objective of the current research is to more precisely characterize the nature of disturbances of attention in autism by assessing performance on a new Behavioral Attention Assessment Protocol (BAAP). The BAAP combines, in a single test, measures of four fundamental building blocks of attention (disengagement, orienting, maintenance, and amodal processing) to social vs. nonsocial events. The BAAP fosters a more integrated approach to the study of attention in autism, by allowing comparisons across four fundamental aspects of attention for the same individuals, permitting analyses of interactions not otherwise possible.

A second objective is to assess the attentional salience of two types of social events that vary in the degree of intersensory redundancy. Events that provide a great deal of redundant amodal information (audiovisual synchrony, intensity shifts, temporal patterning) are highly salient to infants and foster optimal perceptual development (Bahrack & Lickliter, 2002). We asked if social events high in redundancy would engage and maintain attention more effectively than social events with less redundancy, or nonsocial events.

## Methods

Eleven children with autism (ASD;  $M = 3.63$  yrs; range = 2.75 – 4.92) and 11 typically developing children (TD;  $M = 2.06$  yrs; range = 1.83 – 2.33), matched for functional age on the Adaptive Behavior Assessment Scale (TD;  $M = 2.11$  yrs;  $SD = .53$  and ASD;  $M = 2.12$ ,  $SD = .79$ ) were tested. Children were presented with a central stimulus for 3 s, followed by two peripheral events for an additional 10 s. One of the peripheral events was synchronous with a centrally projected soundtrack and the other was out of synchrony. On half the trials, the central stimulus remained on while the peripheral events were presented (disengage trials) and on the other half, the central stimulus was turned off as soon as the peripheral events were presented (orient trials). Three blocks of 20 trials were presented, with nonsocial (NS; objects impacting a surface), social neutral (SN; women speaking with neutral affect), and social positive (SP; women speaking using infant directed speech and positive affect) events (see Figure 1).

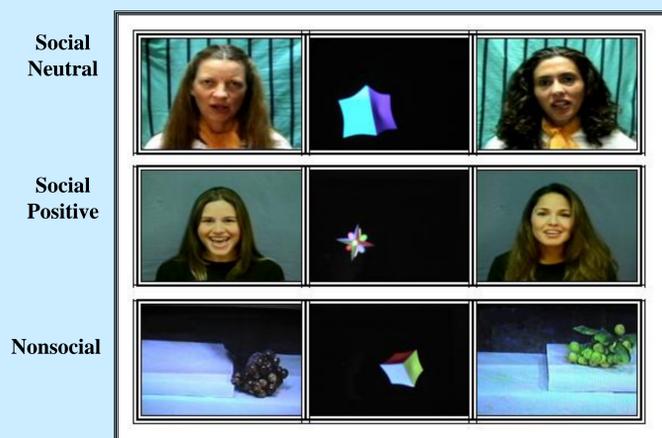


Figure 1. Still images of the central stimuli, social neutral, social positive, and nonsocial events.

## Measures

We assessed attention disengagement (latency to disengage from the central stimulus when it remained on, to view the peripheral events, RT Disengage), attention orienting (latency to shift attention from the central stimulus after it turned off, to view the peripheral events, RT Orient), attention maintenance (proportion of available looking time spent fixating the peripheral displays; PALT), and amodal processing (proportion of total looking time spent fixating the sound synchronous peripheral event, PTLT).

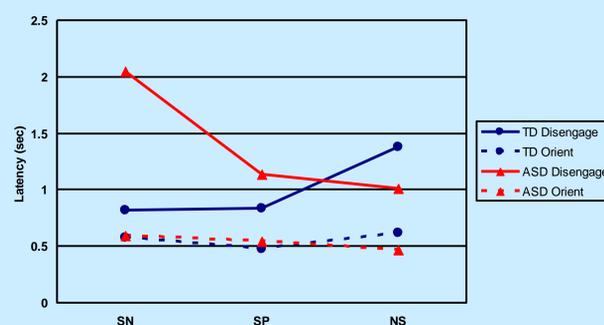


Figure 2. Latency to shift attention from the central to the peripheral events for typically developing children (TD) and children with autism (ASD) as a function of event type, social neutral (SN), social positive, (SP), and nonsocial (NS) and as a function of trial type (orient versus disengage).

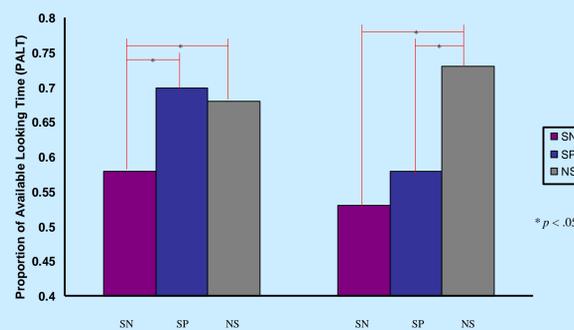


Figure 3. Proportion of available looking time for typically developing children (TD) and children with autism (ASD) as a function of trial type, social neutral (SN), social positive (SP), and nonsocial (NS).

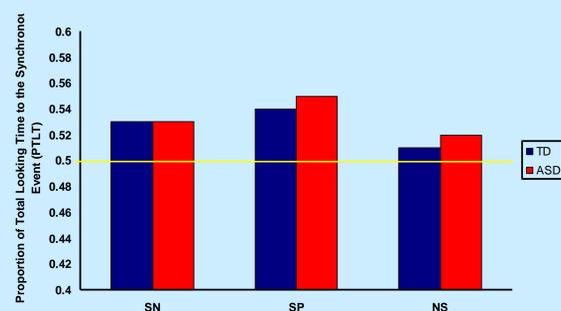


Figure 4. Proportion of total looking time to the sound synchronized events for typically developing children (TD) and children with autism (ASD) as a function of event type, social neutral (SN), social positive (SP), and nonsocial (NS).

## Results

**Disengagement and Orienting (see Figure 2):** A 3-way group (TD, ASD) x trial type (disengage, orient) x event type (SN, SP, NS) repeated measures ANOVA on the RT data revealed a main effect of trial type ( $F(1,20) = 13.05$ ,  $p < .005$ ), a significant group x event type interaction ( $F(2,40) = 4.30$ ,  $p < .05$ ), and a significant group x event type x trial type interaction for latency to look at the peripheral events ( $F(2, 40) = 3.80$ ,  $p < .05$ ).

- There was slower attention shifting for the disengage ( $M = 1.21$ ,  $SE = .19$ ) than orient trials ( $M = .55$ ,  $SE = .03$ ). This difference was especially pronounced for children with autism ( $p < .005$ ).
- Children with autism were slower to shift attention to the SN events ( $M = 1.32$ ,  $SE = .24$ ) than to either the SP ( $M = .84$ ,  $SE = .14$ ,  $p < .05$ ) or the NS ( $M = .74$ ,  $SE = .15$ ,  $p < .05$ ) events. TD children showed no differences as a function of event type ( $ps > .10$ ).
- Children with autism were slower to disengage than to orient for all event types (SN,  $p < .005$ ; SP,  $p < .05$ ; NS,  $p < .1$ ) and were particularly impaired in their disengagement to look at SN events as compared with typical controls ( $p < .1$ ). In contrast, the typically developing children were slower to disengage than to orient to the NS events ( $p < .01$ ) but showed no difference in latency to disengage vs. orient to either type of social event.

**Attention Maintenance (see Figure 3):** A 3-way group (TD, ASD) x trial type (disengage, orient) x event type (SN, SP, NS) repeated measures ANOVA assessing attention maintenance (overall interest; PALT) indicated a significant main effect of trial type ( $F(1, 20) = 31.14$ ,  $p < .001$ ), a significant main effect of event type ( $F(2, 40) = 11.65$ ,  $p < .001$ ), and a significant group x event type interaction ( $F(2, 40) = 3.88$ ,  $p < .05$ ).

- Overall, there was longer looking to the peripheral events during the orient trials than the disengage trials.
- Overall, there was most looking to the NS events ( $M = .71$ ,  $SE = .03$ ) and least to the SN events ( $M = .56$ ,  $SE = .03$ ).
- However, children with autism spent longer viewing the NS events than either of the social events (SN;  $p < .001$ ; SP;  $p < .01$ ), whereas typically developing children spent longer viewing the SP and NS events than the SN events ( $p < .005$ ,  $p < .05$ , respectively). The typically developing children showed more interest in the SP events than did the children with autism ( $p < .10$ ).

**Amodal Processing (see Figure 4):** Analyses of PTLTs were evaluated against the chance value of .50 to assess evidence of amodal processing.

- Results demonstrated significant intersensory matching on the basis of synchrony for all participants taken together ( $t(21) = 2.35$ ,  $p < .05$ ) and no differences between groups. More sensitive measures of amodal processing are currently being explored.
- The intersensory matching was carried by the orient trials ( $t(21) = 2.49$ ,  $p < .05$ ) and was not significant for the disengage trials where more competing stimulation was present ( $p > .1$ ).
- Analyses of event type revealed significant matching for the SP event alone ( $t(21) = 2.86$ ,  $p < .01$ ).

## Conclusions

By assessing four basic attention skills in a single test, the BAAP revealed interactions between diagnostic group (TD, ASD), event type (social neutral, social positive, nonsocial) and trial type (orient, disengage) not previously seen for measures of RT and attention maintenance. These interactions suggest that children with autism are particularly impaired in shifting and maintaining attention to events when there is interference from concurrent stimuli (disengage trials), and this is particularly pronounced for affectively neutral social events (as compared with nonsocial events, or affectively positive, infant directed speech). In contrast, children with autism showed enhanced interest and faster disengagement to look at nonsocial as compared with social neutral events. These findings converge with those demonstrating social orienting impairments in children with autism (Dawson et al., 1998). In addition, they suggest important and complex differences in the attentional salience of different types of social events depending on their level of intersensory redundancy and affect. Social events that provide high levels of intersensory redundancy and affect, such as affectively positive, infant-directed speech, attract attention more quickly than neutral social events, but may not maintain attention longer. Finally, with respect to amodal processing, children with autism and typically developing children together showed significant intersensory matching with no group differences. Matching appears to be best when there is no competing stimulation and for affectively positive social events that provide high levels of amodal information. Thus, despite the fact that children with autism show less attention to social events, they may show amodal processing for social events that contain high levels of intersensory redundancy, once they attend to them. More sensitive measures of amodal processing (not yet analyzed) are needed and are expected to reveal group differences. Future data collection on this project will focus on this goal, in particular, by assessing the duration of first looks to synchronous events, in order to clarify these intriguing findings. Together, these findings may have potential implications for interventions and perhaps for attenuating social orienting deficits in children with autism.

## References

- Bahrack, L.E. & Lickliter, R. (2002). Intersensory redundancy guides early perceptual and cognitive development. In R. Kail (Ed.), *Advances in Child Development and Behavior*, 30 (pp. 153-187). New York: Academic Press.
- Bebko, J.M., Weiss, J.A., Demark, J.L., & Gomez, P. (2006). Discrimination of temporal synchrony in intermodal events by children with autism and children with developmental disabilities without autism. *Journal of Child Psychology and Psychiatry*, 47(1), 88-98.
- Dawson, G., Meltzoff, A.N., Osterling, J., Rinaldi, J., & Brown, E. (1998). Children with autism fail to orient to naturally occurring social stimuli. *Journal of Autism and Developmental Disorders*, 28(6), 479-485.
- Landry, R. & Bryson, S.E. (2004). Impaired disengagement of attention in young children with autism. *Journal of Child Psychology and Psychiatry*, 45(6), 1115-1122.