Comparing spontaneous cross-modal magnitude matching in infants and adults

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Abstract

It has been proposed that young infants, in contrast to adults, base similarities in stimuli across modalities on quantitative aspects rather than on qualitative aspects. To investigate the spontaneous quantitative matching across modalities in adults and infants, 12 adults and 32 infants watched film sequences while their looking behavior was recorded using an eye-tracker. The film sequences depicted three objects that changed in size (visual magnitude) over time while brown noise was played, with intensity matching the size envelope of the objects to different degrees. The results show that adults to a greater extent attend to visual prominence than do the infants.

Background

Broadly speaking, perception can be either amodal or modality specific. Modality specific properties (e.g. pitch and color) can be perceived through one sensory channel only, while amodal features can be perceived in different modalities, e.g. intensity can be perceived both through auditory and visual modality channels (Lewcowiz & Turkewitz, 1980).

It has been proposed that the individual's attention to different properties of an event differ at different stages of development (e.g. Schneirla, 1966). According to Schneirla's ecological Approach-Withdrawal theory, early in development, organisms respond to stimuli based primarily on their quantitative characteristics like their intensity. Through the interaction of maturation and experience, organisms later start to respond to qualitative modality-specific aspects such as pitch and color, with low intensity stimuli leading to approach behavior and high intensity stimuli leading to withdrawal behavior (Schneirla, 1966).

While adults are able to tell the difference and find similarities in modality specific events, evidence supports that young infants mainly find similarities based on quantitative aspects of stimulation (e.g. Lewkowicz, 1985a, 1985b; Lewkowicz & Turkewitz, 1980, McGuire & Turkewitz, 1978; Ruff & Turkewitz, 1975). Infants perceive the intensity of a light as similar to a noise presented in an intensity corresponding to that of the light (amodal event), rather than perceive a dim light as similar to a bright light (modality specific event) (Lewcowiz & Turkewitz, 1980).

When testing 3.5-month-old infants in their discrimination between amodal and modality specific events, Bahrik (1992) presented infants with audio-visual stimuli consisting of films depicting moving objects of different materials making sounds when striking a surface. Results showed that amodal mismatching between object and sound, either in terms of synchronization or of temporal microstructure, was detected prior to modality specific mismatching in terms of color of the object, or pitch of the sound.

Infant's tendency to spontaneously match amodal events in terms of magnitude prominence has also been suggested to be a mediating precursor to speech perception (Marklund et al., 2010; Lacerda et al., 2005).

Taken together, this suggests that sensory perceptual functioning may be mediated by different mechanisms at different developmental stages, indicating that perception of cross-modal equivalence may differ at different developmental stages.

The Present Study

If infants and adult differ in terms of attention to different aspects of stimuli, it is expected that adults and children will exhibit different looking behavior when presented with the same visual stimuli.

Participants are visually exposed to three similar looking objects changing in magnitude over time. The objects match, do not match, or partly match the magnitude of

the simultaneously presented noise. If participants spontaneously match amodal properties across modalities in a quantitative manner, they are expected to look more at the target (the object whose magnitude alternation matches the noise pattern). Adults on the other hand are not expected to spontaneously look more towards target based on these similarities.

Method

Participants watched film-sequences depicting three animated suns lined up next to each other. All suns were shrinking and growing at different paces. Brown noise was played with increasing and decreasing intensity, matching the suns to different degrees. The looking behavior of the participants was recorded using an eye-tracker.

Participants

Participants were 32 infants (13 male and 19 female, mean age 11 months, age range 10 to 13 months) and 12 adults (5 male and 7 female, mean age 25 years, age range 19 to 35 years). Infant participants were recruited through a letter sent to parents of infants born between selected dates and residing within the Stockholm area. Neither the infants nor their parents were compensated for participating in the study. Adult participants were given a cinema ticket for their participation.

Stimuli

Stimuli consisted of 36 film sequences, each with duration 20 s. The sequences depicted three suns lined-up horizontally next to each other (Figure 1). The suns increased and decreased in size. The audio consisted of brown noise played with different intensity envelopes. In some cases, the size modulation of a sun (Target, T) matched the intensity modulation of the noise in terms of rate and direction. In other cases, the size modulation of a sun (Pseudo-Target, PT) matched the noise in terms of direction, but not in terms of rate. In a third case, the size modulation of a sun (Non-Target, NT) matched neither in terms of rate, nor direction. There were two types of film sequences. In the first type, one T-sun, one PT-sun and one NT-sun were present. In the second type of film sequence, one PT-sun and two NT-suns were present.

There were four different experiment versions, each consisting of six sequences of the first kind and three sequences of the second kind. The film sequences were presented in random order. Infant participants watched one experiment version each and adult participants watched all four versions, balancing for presentation order according to a Latin square design.

Procedure

Participants were placed in a sound attenuated room. Adults sat in a chair approximately 70 cm from the eye-tracking screen. Infants were placed in their parent's lap, also at a distance of approximately 70 cm from the screen. Before each experiment session, a short calibration was performed.

Apparatus and Software

Stimuli were created in Adobe Photoshop 7.0, Adobe Audition 2.0 and Adobe Premiere CS. A Tobii T120 eye-tracker integrated with a 17" TFT monitor and a set of Creative Inspire T5400 loudspeakers was used for stimuli presentation, which was controlled by the software Tobii Studio 2.2.7. Eye-tracking data was collected and pre-processed using Tobii Studio, and statistical analysis was performed in PASW Statistics 18.

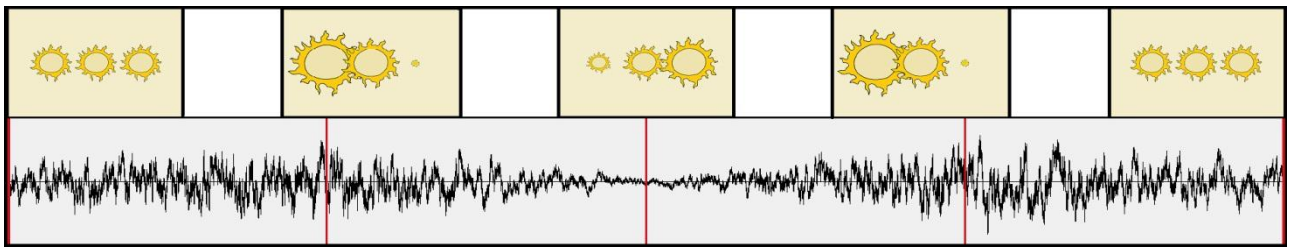

Figure 1: Example of a stimulus film sequence. The video (top) shows three suns varying in size over time, and the audio (bottom) plays brown noise varying in intensity. The screenshots of the video are taken from the corresponding points in the audio waveform (time axis from left to right). In the current example, the sun to the left is Target, the middle sun is P-Target and the right sun is N-Target.

Results

So far, only the film sequences of the first type have been analyzed, i.e. those in which there were one T-sun, one PT-sun and one NT-sun. The mean looking times towards the different kinds of suns were computed, and no difference was found for infants. Adults looked longer at NT-suns than any of the other suns.

For a more detailed analysis, the conditions were divided further, based on how big the size modulations of the suns were. There were, for example, two different settings in regard to T-suns, one in which the size modulations were big and one in which they were smaller, but in both cases, they matched the noise. Dividing the conditions into those sub-conditions, a pattern becomes apparent in the looking behavior for infants (Figure 1). They look longer at the suns with bigger size modulations, regardless if the size modulations match the noise or not. The same general pattern is found in adult participants (Figure 2), except in the case of NT-suns where there is no difference in looking time between suns with big or small size modulations.

Discussion

In this study, spontaneous amodal magnitude matching was tested in adults and infants. The results of the infants failed to indicate that infants found similarities between sounds and object alternations. The reason why infants failed to detect a resemblance between noise and object might be due to their age. Ruff and Turkewitz (1975) found that when comparing 11-24 weeks old infants with infants 10 weeks or younger, the younger tended to find equivalence in regard to qualitative properties rather than quantitative properties as opposed to the older infants. This finding would in turn implicate that infants at 11 months of age have may no longer mainly focus on quantitative amodal aspects.

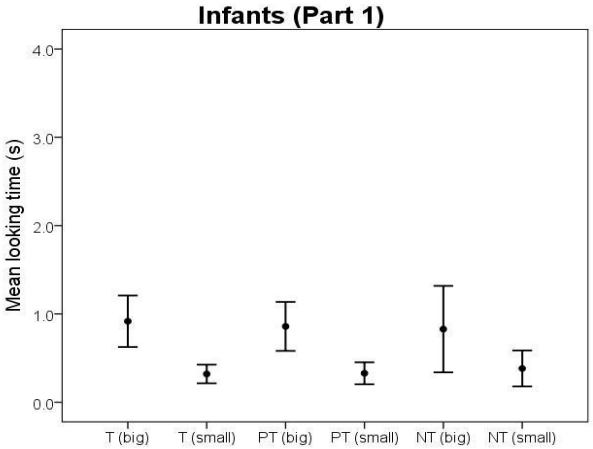

Figure 1: Infants' mean looking time towards the conditions taking the big and small size modulations of the objects into account. The bars depict the 95% confidence interval.

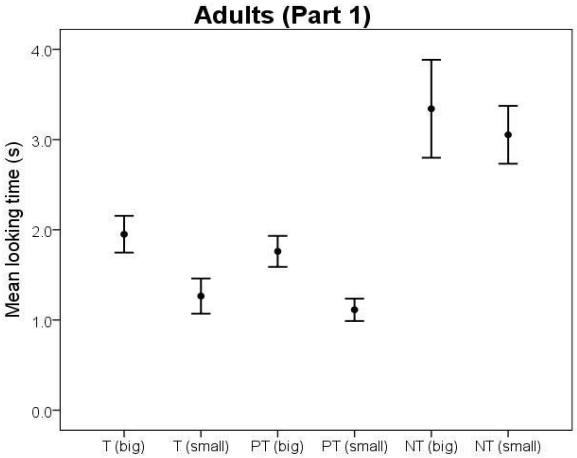

Figure 2: Adults' mean looking time towards the conditions taking the big and small size modulations of the objects into account. The bars depict the 95% confidence interval.

Adults looked longer at the one object that did not match the auditory stimulus in any way terms of magnitude. This may have been because they were affected by its visual odd-ball status. The N-sun, shrinking when the other two objects were growing and vice versa, may have visually become the most prominent object. This would then indicate that adults do not take the noise into consideration when attending to the objects, instead looking more at the visual stimulus that was the exception to the norm. Infants on the other hand seemed not to be affected by this odd-ball status of the N-sun.

The fact that neither adults nor infants seem to base their looking behavior on what they heard may also be due to the experimental design, in that the noise may not have been distinct enough.

Regarding the sub-conditions, the looking behavior may also be a result of a tendency to look at the more visually prominent object, regardless of the noise, since both infants and adults look longer at the objects with bigger size modulations.

In conclusion, neither the adults nor the infants seemed to match the occurring targets with the noise, although the results indicate that infants, 10-13 months of age, were not as affected by the visual prominence of the conditions as were the adults, in terms of odd-ball status. The different results between adults and infants although suggest that infants find similarities based on other aspects of stimulation than do adults. Further studies should preferably be conducted to investigate these disparities more thoroughly.

Acknowledgements

The study was funded by the Bank of Sweden Tercentenary Foundation (K2003-0867). The authors would like to thank Johannes Bjerva for help with data collection and Klara Marklund with help with stimuli preparation.

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