A not-so-narrow spotlight: Infants can encode information about objects into VSTM that were not fixated

Zsuzsa Kaldy, PhD, Sangya Dhungana, & Erik Blaser, PhD
Developmental and Brain Sciences Program, University of Massachusetts Boston

Motivation

It is well-established that adults use attention to selectively process information outside of fixation. Can infants similarly attend to, and usefully encode, information beyond their gaze?

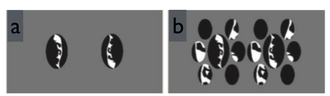
Goal

To test whether infants can encode information about objects that they did not fixate into their visual short-term memory (VSTM).

Introduction

Covert attention has been demonstrated behaviorally in infants as young as 3-4 months of age (Richards, 2005; Robertson et al., 2012) and its neural substrates have been identified (Xie & Richards, 2017). This allows infants at a very early age to plan saccades to peripheral targets.

Work on attentional resolution revealed an attentional spotlight twice as coarse as that of adults. Farzin et al. (2010) found that flankers reduced infants' face discrimination for stimuli as close as 3° of eccentricity.



Mooney faces: (a) uncrowded and (b) crowded

Farzin, Rivera, & Whitney (2010): crowding in infants

Other studies have demonstrated that 8-month-olds can use spatial cues to 'zoom' attention (Ronconi et al., 2016).

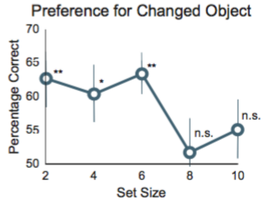
So, while the early development of attentional orienting is relatively well-studied, basic questions related to infants' attentional gating have not been explicitly investigated. Can infants use covert attention to *encode* information for further cognitive processing; in the present case, into visual short-term memory?

Estimating memory capacity

Participants: Twenty-five 6-month-old infants (age range: 5;0-7;5, 10 f) participated in a free-viewing eye-tracking study.

Materials: We used a Tobii T120 eye tracking system for display and recording.

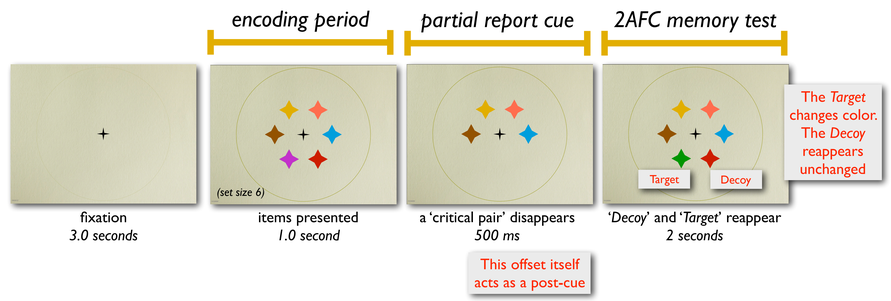
Procedure: Infants were presented with one block of 18 test trials. A set of 4 or 6 identically-shaped, but differently-colored items appeared, spaced symmetrically around central fixation. (Each infant was tested with only one set size). After a 1 second exposure, a randomly chosen 'critical' pair of neighboring items disappeared. After a 500 ms delay the two items reappeared, always with one changed to a new color (*Target*) and the other unchanged (*Decoy*). The sudden offset of the critical pair itself was the partial report post-cue Since the critical pair was chosen randomly, any differential treatment of *Target* vs. *Decoy* is a sign that the elements were in memory prior to offset. Preference for the Target (based on looking time) was measured.



6-m-olds' estimated capacity ~5 items

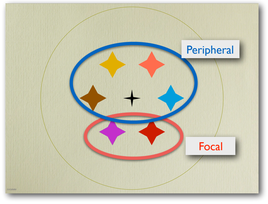
Blaser & Kaldy, 2010, *Psych Sci*

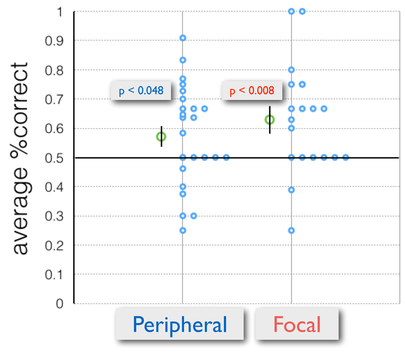
A partial report, 2AFC test of visual short-term memory in 6-month-olds



Current study

Here, we contrasted infants' performance (preference for the *target*) on trials where, during the encoding period, they fixated the two neighboring critical items that subsequently became the *target* and *decoy* ('focal look'), versus trials where they did not ('peripheral look').





Infant participants' average performance (percent of trials where the Changed item (target) was preferred) in 'peripheral' vs. 'focal' look' trials. Blue dots represent individual infants' performance, green dots are the group's average ± 1 SE.

In 'focal look' trials, infants' performance was 62.9±19.1%, which was significantly above chance ($t(18)=2.95$, $p<0.008$, $d=0.68$).

In 'peripheral look' trials, performance was 57.1±17.0%, which, importantly, is also significantly above chance ($t(24)=2.09$, $p<0.048$, $d=0.42$).

Conclusions

In a prior study, we used a partial report test to estimate 6-month-old infants' iconic memory capacity and found it to be around 5 items (Blaser & Kaldy, 2010).

Here we tested whether infants were able to encode and use information (in visual short-term memory) about objects that they did not fixate in this paradigm (*peripheral looks*). While performance was lower than when infants fixated the critical items during encoding (*focal looks*), it was still significantly above chance.

This study is one of the first to show that young infants can extract useful information - for more than just orienting - beyond the target of fixation. This means that tracking eye movements is not sufficient to understand what infants can attend to and encode in a visual scene.

Apparatus

Tobii T120

References

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contact: erik.blaser@umb.edu or zsuzsa.kaldy@umb.edu