Putting ‘effort’ in a usable way: Using eye movements and pupillometry to uncover the role of focused attention in Visual Working Memory

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Motivation

Focused attention / cognitive effort, deployed purposefully, is a critical component of Executive Function, and supports the active processing of information.

The integration of memory and attention occurs between 6- to 15-month of age, as a result of the maturation of frontal circuitry (Colombo & Cheatham, 2006).

However, the link between focused attention and Visual Working Memory has not been well-studied in infants.

Questions

Can focused attention (as indexed by pupillometry) predict VWM performance?

Higher attention during encoding has been shown to correlate with phasic pupil diameter (task-evoked pupil responses; TEPRs) and better subsequent WM performance in adults and older children (Kahneman, 1973; Unsworth & Robison, 2015; Johnson et al., 2014), but what about infants?

Does the familiarity of the to-be-remembered objects affect their memorability, or the allocation of focused attention?

VWM capacity in adults is greater for familiar, real-world objects than for unfamiliar abstract shapes (Brady et al., 2016). Here, instead of abstract shapes we used up-side down versions of the objects (to control low-level information).

Method

Participants

- Familiar Objects (Exp. 1): N = 22
- Upside Down (Exp. 2): N = 21

M_age = 13.4 months
Range = 11-15 months

Stimuli

- Familiar Objects (Exp. 1)
- Upside Down (Exp. 2)

Procedure

Fly-in 0.5 s
Each card revealed for 1.5 s, sequentially
After 1 s, Sample is revealed
Response 2 s
Feedback and reward 1 s

Task-evoked pupil responses (TEPRs)

Familiar Objects (Exp. 1)
Upside Down (Exp. 2)

VWM performance

Split by group
- Above median performance
- Below median performance

Split by trial
- Correct trials
- Incorrect trials

Results

13-month-olds performed significantly above chance in our VWM task, but only when the to-be-remembered objects were familiar (Exp. 1).

In Exp. 1, we found a significant correlation (r = 0.52, p = 0.018) between infants’ pupil response (TEPR) at the end of encoding and their VWM performance. This was not present in Exp. 2 (as performance was at chance).

Conclusions

- Infants have better memory for familiar objects.
- Focused attention (as indexed by the pupil), during memory encoding, predicted better VWM performance.
- Pupillometry is a promising tool to measure focused attention with high temporal resolution in infants.

Exp. 1: Cheng, Kaldy, & Blaser, under review