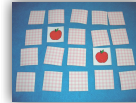


Goal

To test young infants' visual working memory capacity for objects in a scene, using a paradigm that could be 'scaled up' for older age groups (e.g. preschoolers).



Method

We developed a nonverbal, anticipation-based version of a *delayed match-to-sample* task. This measures a proactive response of infants' knowledge of *what is where*.

Introduction

VWM studies with infants vs. preschool age children use widely different paradigms and dependent variables (for a discussion of this problem, see e.g. Reznick, 2007; Simmering, 2012).

We developed a version of the card game “Memory” that can be used with infants, but easily 'scaled up' for older ages (e.g. by varying retention interval, number/similarity of cards, etc.)

This was meant as an engaging version of the classic delayed matching-to-sample paradigm, but able to test memory for location/identity bindings (*what is where*).

Here we present results of the first in a series of studies, tailoring parameters for infants.

Matching-to-sample

Our task is a version of the classic match-to-sample paradigm: a sample item is revealed, and participants must indicate which of two possible locations matches the sample.

We trained infants - implicitly - to make an anticipatory saccade to the match location.

We then measured the rate of match vs. non-match fixations.

This paradigm sidesteps some challenges of violation-of-expectation based tests (e.g. does poor performance in such tests reflect a failure to remember or use remembered information?) and measures a proactive response (anticipation), not a reactive one.

Apparatus



Tobii T120

Participants

Experiment 1

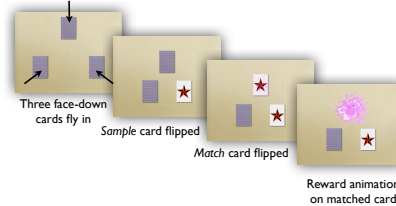
Fourteen 6-month-olds
 (6 females, average age: 5:24, range: 5:00-6:15)
 Eight 7.5-month-olds
 (3 females, average age: 7:14, range: 6:15-8:00)

Experiment 2

Fourteen 9-month-olds
 (4 females, average age: 8:29, range: 7:00-10:20)

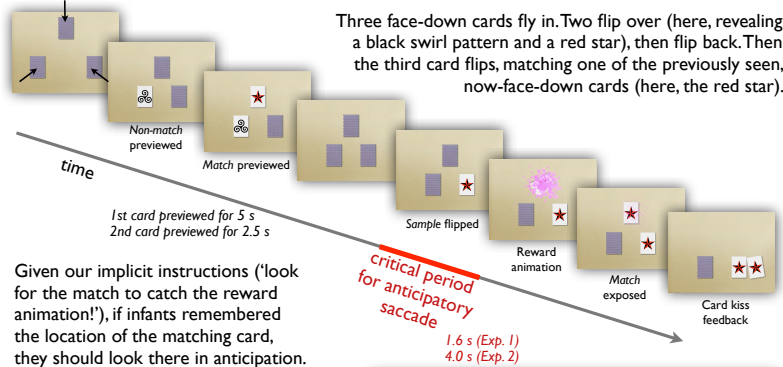
Methods

Teaching infants to match-to-sample



During training, infants are shown that the matching card will do something interesting: we are hoping they will come to anticipate this 'reward'. This reward is so short (167 ms) that infants would miss it unless their gaze was at the correct location already.

Testing delayed match-to-sample in infants



Given our implicit instructions ('look for the match to catch the reward animation!'), if infants remembered the location of the matching card, they should look there in anticipation.

In Exp. 1, the critical period for anticipation was 1.6 s. However, infants often did not move their eyes from the Sample card during this period: the interval seemed too short to allow for anticipatory saccades. The period was extended to 4.0 s in Exp. 2.

Procedure

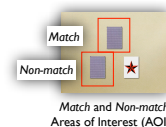
Calibration was done using Tobii's standard 5-point calibration. In each block of trials, infants were first shown 3 training trials, followed by 12 test trials. Two potential pairs of images were presented (see images to the right). Each event was accompanied by sound effects. After the training trials and following every four test trials, an attention-grabbing animation (where all four types of cards were shown jumping up and down) was presented. In test trials, the test object pairs, the position and the order of the Match and the Non-match and the identity of the Match were all randomized. Infants ran two blocks of trials.

Familiarization/training

Infants were familiarized to the three-card configuration as well as card identities, behaviors, and sound effects by virtue of the training trials that comprised the first three trials of the 15 trial block.

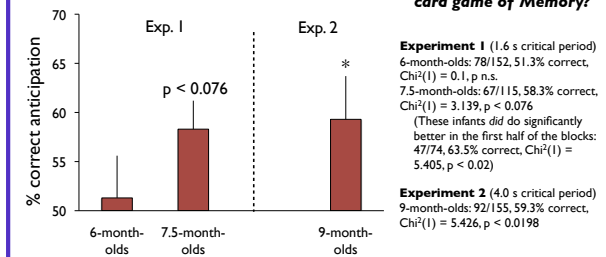
Data analysis

We analyzed the percent of anticipatory (first) looks to the (correct) 'match' AOI vs. total looks to match and non-match AOI's.



2AFC: First fixation within the Match AOI during the critical period is a correct response.

Results



Conclusions

We developed a novel, non-verbal, anticipation-based VWM paradigm - modeled on the game “Memory” - that can be used with a wide variety of age groups from infants to preschool-age children.

9-month-olds remembered the location/identity binding of at least one item in a delayed match-to-sample task (they can play the game Memory with 3 cards!) (7.5-month-olds can too, in the first half of the trials).

This overall pattern is consistent with previous studies of infants' VWM capacity (Oakes et al., 2006; Kaldy & Leslie, 2005).

Future research

- * maximize performance by using response-dependent rewards (gaze-contingent stimuli).
- * scale for older children by manipulating number of items, retention times, and/or object similarity.
- * use salience-calibrated stimuli (Kaldy & Blaser, 2009) to allow for fair comparisons of memory for different feature dimensions.

References

• Kaldy, Z. & Blaser, E. (2009). How to compare apples and oranges: Infants' object identification tested with equally salient shape, luminance and color changes. *Infancy*, 14, 222-43.
 • Kaldy, Z. & Leslie, A. (2005). A memory span of one? Object identification in 6.5-month-old infants. *Cognition*, 57, 153-177.
 • Oakes, L. M., Ross-Sheehy, S., & Luck, S. J. (2006). Rapid development of feature binding in visual short-term memory. *Psychological Science*, 17, 781-787.
 • Reznick, J. S. (2007). Working memory in infants and toddlers. In: L. M. Oakes & P. J. Bauer (Eds.). *Short- and long-term memory in infancy and early childhood*. pp. 3-26. Oxford: Oxford University Press.
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