Recently rewarded task-irrelevant stimuli do not distract 2-year-olds during visual search

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Background

Attentional control (also referred to as executive or cognitive control, or endogenous attention) is fundamental for goal-directed behavior.

The maturation of the attentional control network is an important developmental milestone^(1,2) that results in reduced distractibility^(3,4,5) and improved cognitive flexibility^(6,7,8).

While attentional control is well studied in older children, methodological factors have limited an understanding of the development of this ability in young children.

Traditional set-shifting paradigms require verbal instructions and selective attention to feature dimensions, raising the possibility that performance is conflated by factors other than attentional control ^(7,8).

Experiment

Here we present a novel reversal-learning visual search task for the eye-tracker. A similar paradigm has previously been used in adults to investigate reward based attentional capture^(9,10).

We asked whether children could selectively attend to a rewarded target, and, flexibly shift attention to a newly rewarded target.

<u>Participants</u>: 31 typically developing toddlers (17 females). Age range was 17.26 months - 36.64 months (M = 27.5, SE = 1.05).

Methods: Tobii T120 eye tracker measured eye movements.

Data processing: Participants with < 60% of samples, or participants who did not complete the experiment, were excluded. Valid trials were those where cumulative visit duration to screen > 1 secs, 1+ search array item was fixated, and latency to first item fixated was < 3 secs (86% of trials).



Children were tasked with learning which target would be rewarded, and reversing this rule following a change in cue-reward structure. Critically, no verbal instructions were given.

0 secs Cue Search period Reward animation ~ 2 secs ~ 4 secs ~ 2 secs

Results



Errors = Probability of fixating UR-target vs missing both (i.e. trials on which R- target was not fixated).

Accuracy = Probability of fixating R-target vs not fixating R-target

Cumulative fixation duration = Sum of length of fixations to each target.



Discussion

2

Baseline

Reversal 1

Reversal 2

Toddlers were sensitive to the change in cue-reward structure (cumulative fixation duration). Accuracy was unimpaired following the target reversal, suggesting the presence of a recently rewarded yet task-irrelevant target did not distract toddlers. Trial-by-trial analyses did not reveal an immediate switch cost. Correlation analyses revealed a significant positive relation between Age in Days and Reversal 1 accuracy.

We conclude that our reversal learning paradigm combined with eye-tracking provides a relatively more sensitive measure of attentional control. We believe this task is ideal for use with preverbal children (and populations with weak receptive language skills) as no verbal instructions are required. This task is also ideal for the assessment of the development of attentional control in both typical and atypical populations.



Posner, Rothbart, & Voelker, 2016¹; Rueda et al., 2004²; Fisher, Godwin, & Seltman, 2014³; Gaspelin, Margett-Jordan, & Ruthruff, 2014⁴; Jones, Rothbart, & Posner, 2003⁵; Blackwell & Munakata, 2014⁶; Hanania & Smith, 2010⁷; Hendry, Jones, & Charman, 2016⁸; Maljkovic & Nakayama, 1994⁹; Awh, Belopolsky, & Theeuwes, 2012¹⁰.

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Rewarded target

Unrewarded target