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The Potential of Eye-Tracking as an Outcome Measure for Autism Intervention Studies

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DART development autism research technology

Conflict of Interest Declaration: the first author may receive royalty payments from the commercial version of the Findme app if sales exceed a certain threshold

Background

- The autism intervention research field is hampered by a lack of outcome measures which can provide objective and sensitive assessments of meaningful change[1,2]
- Research into technology-based support in particular is in need of measures which are specifically applicable to that context [3]
- Such measures should ideally capture signs of behavioural change which exist in the space between improvement within the technology itself (e.g. getting better at an iPad game with practice) and distant generalisation of that learning to a non-digital setting (e.g. change in interpersonal skills) [4]
- Eye-movements can provide an insight into underlying cognitive processes, are objectively measured and have the added benefit of being suitable for non-verbal and young children. [5,6]

This study explores the utility of eye-tracking as an outcome measure for use in trials of technology-based interventions, in a test with typical toddlers

FindMe

The FindMe app was co-designed with autistic children, parents and professionals to provide a motivating, enjoyable learning opportunity for pre-schoolers with autism.
The app provides an environment in which to practice two key building blocks of shared attention and learning:
1. Attention to people
2. Following social cues (i.e. pointing, looking)

A randomised controlled trial of the app failed to detect intervention effects measured at the distant-generalisation level of ratings of parent-child play using the BOSCC. This was despite children playing the app for substantial periods of time and showing good progress through the levels of complexity within the game. [4]

Figure 1: sample images from Part One of the FindMe app, where the player's task is to find and touch the person in order to collect a reward token and move to the next scene. Other items on screen are interactive, but do not link to reward tokens. Collecting five tokens triggers a longer, animated reward sequence featuring spinning shapes, jumping acrobats or a train.

Methods

We recruited typically-developing toddlers aged **20-26 months** at baseline. The final sample, after drop-out, was **n=39**. Children had no prior contact with the FindMe app.

The children were **group-wise matched** on age, vocabulary (MCDI scores), mean screentime per week, ethnicity, number of siblings, parental education, & days between baseline and outcome appointments.

Children viewed images on a computer screen while eye-movements were recorded with a Tobii X60 eye tracker. This was a **free-viewing task** with no instructions. Images are shown in Figure 2: there were 12 images in each category, a total of 48. Images within each category were selected at different **levels of complexity** (low, medium, high; just low & high for photos) based on the number of objects in the scene. Every scene contained just one person.

Children were alternately assigned to **Access (n=19) and Control (n=20) groups**. The Access group took home an iPad with the FindMe game, and were asked to play for around 5 minutes per day. Children then returned to the lab after a period of 14 days and repeated the eye-tracking assessment with the same images.

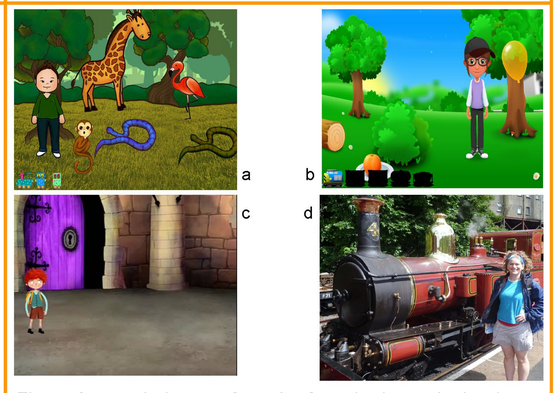

Figure 2: sample images from the free-viewing task showing a range of complexity levels
a) Direct-match: *images from the FindMe iPad app (high)*
b) Close-match: *images from the FindMe Android app (medium)*
c) Close-generalisation: *images from apps by Nosy Crow (low)*
d) Distant-generalisation: *photographs (high)*

Changes in looking at images from the FindMe app

Analysis focused on two areas of interest (AoIs): People and Rewards. These are the two areas of the stimuli used which we would expect to be affected by regular game play.

An initial ANOVA on Group (Access, Control) x Complexity (high, medium, low) x AoI (People, Rewards) x Time (Baseline, Outcome) indicated that the most interesting effects were for High Complexity images (Figure 3) where **looking-time to People was almost unchanged in the Control group but increased in the Access group**.

Other analyses revealed:
- Higher looking to People in Low and Medium Complexity images at baseline, which may indicate a 'ceiling' effect
- Minimal effect of Time or Group on looking to Rewards
- A correlation between game play and looking to Rewards for high complexity images only (r=.613, p=.005)

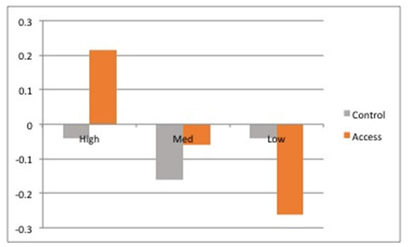

Figure 3: Change Scores (Outcome - Baseline) for fixation duration to People, FindMe images only, comparing 3 complexity levels.

Generalisation of effects to other image categories

Effects found in the FindMe direct-match stimuli are **closely replicated** in each of the three image categories, representing increasing degrees of generalisation (see Figure 4).

In each case, the Access group show increases in looking-time to People while the Control group decrease their looking time.

These differences are individually small but the **replicated pattern** is striking across the stimulus sets, and we interpret this finding as revealing a potential use for eye-tracking in outcome measurement.

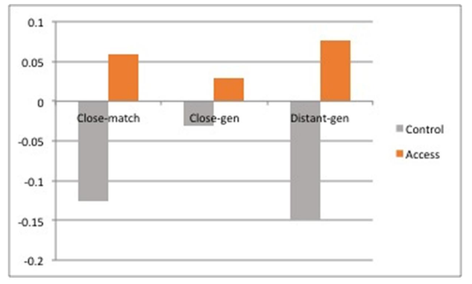

Figure 4: Change Scores (Outcome - Baseline) for fixation duration to People, High Complexity images only, comparing 3 generalisation categories

Conclusions

- For the most complex images, familiarity with the FindMe iPad app is associated with increased looking time to rewarded content (i.e. People), but not to Reward tokens themselves
- This pattern is replicated for stimuli at each level of generalisation, suggesting that this app may have a pervasive effect on distribution of attention to images
- The lack of effects for simpler images may reflect a ceiling effect in looking time to people, engendered by a lack of competing image content
- Much work remains to be done to extend this to intervention studies. This approach yields rich data which can be analysed in many ways. For example, we found a number of main effects and interactions not reported here. If using eye-tracking as an outcome measure it will be essential to have strong hypothesis-driven analysis plans defined *a priori*

With thanks to all of our participants

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