Pip and the Brain Explorers:
An adaptive touch-screen battery to assess preschoolers with Autism Spectrum Disorder across six bio-behavioural domains

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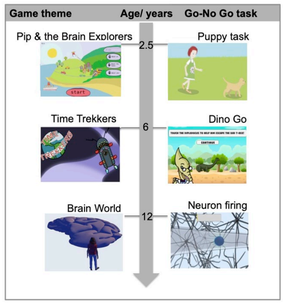
INTRODUCTION

Increasing evidence suggests that neurodevelopmental conditions, including autism spectrum disorder, involve developmental differences in social, emotional, cognitive, reward-related and/ or sensory processing [1]. Individual bio-behavioural profiles across domains may be used to assess specific therapeutic needs, or to measure treatment efficacy objectively [2]. Currently, a standardised suite of tests tapping these domains across the life-span is missing. Challenges include comparability of tasks across age/ ability levels, and inherent difficulties in testing young autistic children with developmental delay.

OBJECTIVES

- To create and validate three comparable touch screen batteries for **preschoolers**, **children** and **adolescents**.
- Tasks measure the same processes, but vary in theme and complexity to match the abilities and interest of children in given age-groups.

A. Project Overview



Left panel: **Pip** uses six characters as cartoons or puppets. **Time trekkers** visit dinosaurs, pirates and kings and queens. **Brain world** games take place in the brain or real-world. Social tasks are acted out by real actors. **Right panel:** Example of the same Go-No Go task for different age groups.

PIP: CONCEPT AND TASK DEVELOPMENT

- Created 14 subtests embedded in child-friendly games using animated cartoons or puppet videos (see **B-G**), built in Unity Game Engine.
- Most tasks tap multiple processes in addition to target process (see **E**)
- Procedure (see **H**, including interactive component):
  - Animations to engage child.
  - Clear in-built instructions for parents to increase standardisation.
  - Demonstration of task components by "Scientist" character.
  - Pre-tests and practice trials to test for comprehension.
  - Bayesian Optimisation uses responses to adapt task difficulty.
  - Remote testing: Parents can download app from app stores.
- Each task records all tablet/smartphone interactions in addition to main dependent variable (e.g. attention, categorisation, motor, re-engagements)
- 5 different versions were tested iteratively with ~20-50 children per version.

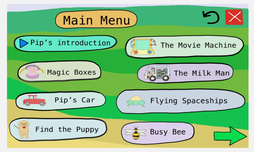
CONCLUSION AND NEXT STEPS

We created the first touch-screen test battery of six key domains for pre-schoolers with neurodevelopmental conditions. Acquisition rates are already high through use of child-friendly cartoon animations and building-up step-by-step procedure. Validation and standardisation in children with typical development and neurodevelopmental conditions are planned, including AIMS-2-TRIALS Preschool Imaging (PIP, N=600) and Safe Passage projects (N=1,500).

OVERVIEW: "Pip and the Brain Explorers"

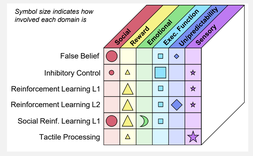
B. Landing Page

C. Main Menu



D. Intro video

E. Domains involved

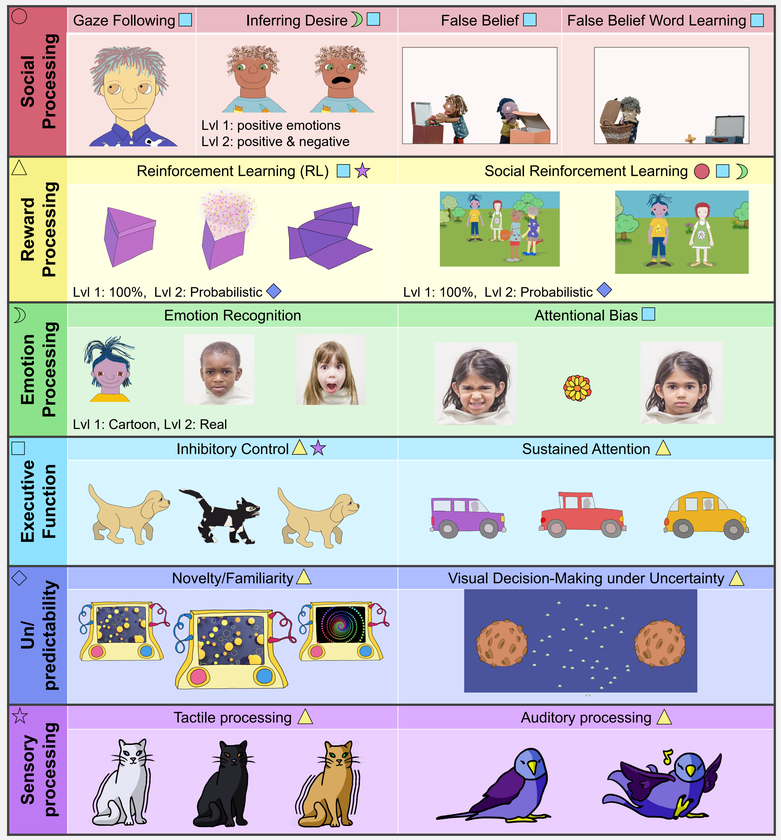


F. Acquisition rates V. 0.5

Task	Completion rate
Inhibitory Control*	85%
Gaze Following	58%
Reinforcement Learning*	83%
Social Reinforcement Learning*	90%
Attentional Bias	91%
Visual Decision-Making under Uncertainty*	50%
False Belief task	100%
False Belief Word Learning	91%
Novelty/Familiarity	80%

Note: Data from 2019 pilot with typically developing children (3-5 years). Tasks have since been further optimised for children with developmental delay. *Beta versions

G. Overview of different tasks, grouped by domain



Note: Symbols show examples of where tasks span multiple domains.

H. Example: Go-No Go "Catch the Puppy" task

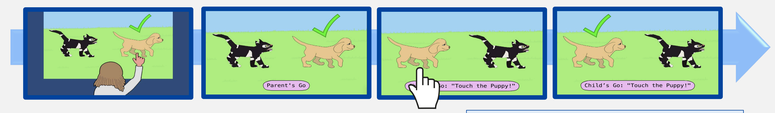
1. Pre-test: Motor response — Reward

DV: Use BO to determine for each child optimal speed

2. Animated Cartoon: Familiarisation, acts out task (non-verbally)

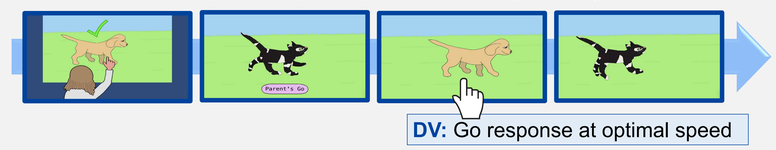
DV: Child's attention: Did s/he watch 30 sec movie?

3. Demo (Scientist) **Demo** (Parent) **4. Pre-test**: Categorisation



DV: Distinguish cat from dog

5. Demo (Scientist) **Demo** (Parent) **6. Practice** (10 trials)

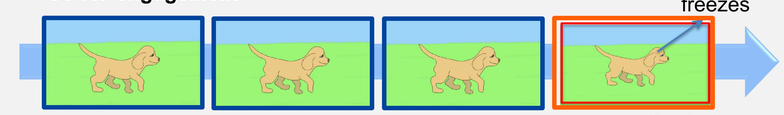


DV: Go response at optimal speed

7. Main task (40 trials). *barks*

DV: Go trials / No-go trials

8. Re-engagement freezes *barks*



DV: Attention: Re-engagement by social / non-social reward

Find and click this symbol for our interactive components.

Institutions involved in future data collection:

Radboud Universiteit Nijmegen · University of Cambridge · Zentralinstitut für Seelische Gesundheit · Ghent University · Stellenbosch University · Karolinska Institutet

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[1] Insel TR. The NIMH Research Domain Criteria (RDoC) Project: precision medicine for psychiatry. Am J Psychiatry. 2014;171(4):395-7.

[2] Loth E, Evans DW. Converting tests of fundamental social, cognitive, and affective processes into clinically useful bio-behavioral markers for neurodevelopmental conditions. Wiley Interdiscip Rev Cogn Sci. 2019;10(5):e1499.

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