Serious Gaming: What are the Possibilities for Innovative Cognitive Assessment in Children with Congenital Heart Disease?

(Protocol)

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Background

Children undergoing (open) cardiac surgery in early life:

- Vulnerable to risks compromising neurodevelopment.
- **Cognitive impairment.**
- Phenomenon of '**Growing into deficits**'.
- Challenged in academic attainments, cognitive function and social integration.

Conventional Neuropsychological Assessment:

- **Does not reflect the dynamics of daily life** with additional time pressure and distraction.
- Not easily translated into everyday life.
- **Difficult to predict consequences at the levels of activity and participation.**
- **Not sensitive enough to detect mild cognitive impairment**.

Urgent need for more sophisticated tests measuring **subtle cognitive impairment** and the **complexities and dynamics of daily life.**

Innovative Technology:
Paper-and-pencil ⇨ Virtual Reality

Virtual Reality:

- Computer-generated, 3D environment.
- Allows development of **ecologically valid environments**.
- **Precise control** over stimulus presentation.
- **Large amount of sensitive performance data**.
  - **Novel performance outcome measures** (e.g., performance stability).

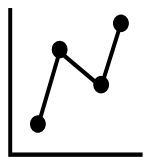
Research Objectives

1. Determine the **feasibility** and of a **Virtual Reality Serious Game** for **cognitive assessment.**
2. Gain insight into the **sensitivity** of a **Virtual Reality Serious Game** (dynamic difficulty progression and novel outcome measures, e.g., performance stability) in **detecting cognitive deficits** (vs. conventional outcome measures, e.g., accuracy, final score, and total time).

Feasibility	Sensitivity in detecting cognitive deficits
Measured by: • **User-experience questionnaire** administed post-assessment.	Measured by: • **Cognitive assessment** (e.g., subtests from BADS-C, NEPSY, TEA-Ch, WISC). • **Game performance** (e.g., novel outcome measures vs. conventional scores).

Novel Outcome Measure: Performance Stability

- **"How"** a patient obtained final outcome
  - **"Number of fluctuations in pace"**
- Inconsistent pace = Low stability in test performance.
  - Underlying processes:
    - **Fluctuating attention or cognitive effort**.



Innovative Measures:
Conventional scores ⇨ Novel cognitive biomarkers

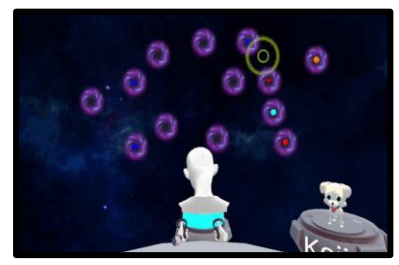
Spreij et al. (2021)

Virtual Reality Serious Game – Koji's Quest (NeuroReality)

Memory

Visual-spatial

Executive function



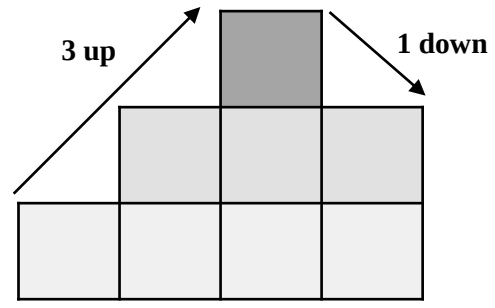
Selective attention

Divided attention

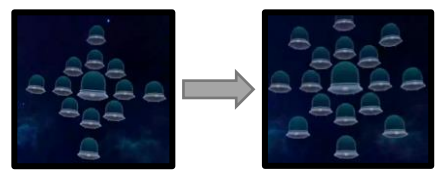
Mathematics

Innovative Method:
Static stimuli ⇨ Dynamic stimuli

Staircase Procedure:



- **Tailored** to a patient's **individual level of functioning** using **dynamic difficulty progression** (i.e., **no ceiling or floor effects**).
- Determines a threshold level of individual cognitive demand per test (Spreij et al., 2020).
  - Patient remains continuously **challenged** and **motivated** (Huygelier et al., 2020).
- E.g., Additional stimuli:



Methods

Design:

- Experimental, independent groups.
- Primary outcome variables: Attention (selective and divided), executive functions, memory, processing Speed, and visuospatial functions.

Participants:

- **150 CHD children and 100 HC**.

Protocol:

NPA → **VR Serious Game** → **User-experience questionnaire**