

Playing for cognition: investigating the feasibility & user experience of a virtual reality serious game for cognitive assessment in children with congenital heart disease

C.L. van de Wouw, E. Bousché, M. J. van Schooneveld, J. M. P. Breur, H. P. Nijenhuis, H. Huygelier, & T.C.W. Nijboer

1. Introduction

To facilitate the **development & implementation of innovative technology in clinical practice**, it is necessary to understand the **user experience** of the **end-users** (i.e., **children with CHD**).

The overarching aim of the present study was to evaluate the **feasibility** of a **VR serious game** for **cognitive assessment** in **school-aged children with CHD**.

The sub-aims were twofold: (1) to objectively evaluate the **feasibility** of the VR serious game in children with CHD compared to TD children; & (2) to explore the **user experience** of both groups after their interaction with the VR serious game.

2. Methods

The study recruited children with **severe CHD** from two specialised CHD hospitals & via the *Hartekind* foundation. TD children were recruited from schools & sport associations. Data were collected between September 2021 to December 2022.

CHD children:

- 90-minute session at participating hospitals
- **Paper-&-pencil tests**
- **VR serious game**
- **User experience questionnaire**

TD children:

- 30-minute session at participating hospitals, schools, or sports associations
- **VR serious game**
- **User experience questionnaire**

User experience questionnaire

(15 items, comprising five categories)

1. **Engagement** (i.e., the feeling of active involvement & enjoyment of the content)
2. **Flow** (i.e., the mental state characterised by full immersion in an activity, intense focus, & a distorted perception of time)
3. **Presence*** (i.e., the feeling of full immersion within a virtual environment)
4. **Side effects**** (i.e., adverse physiological reactions, such as nausea)
5. **Transportation** (i.e., the feeling of being transported to an alternate world)

Each item was rated on a six-point Likert scale, ranging from negative (0) to positive (5).

*Presence was determined from two related items

**Higher scores indicated more side effects

VR serious game (Koji's Quest, NeuroReality)



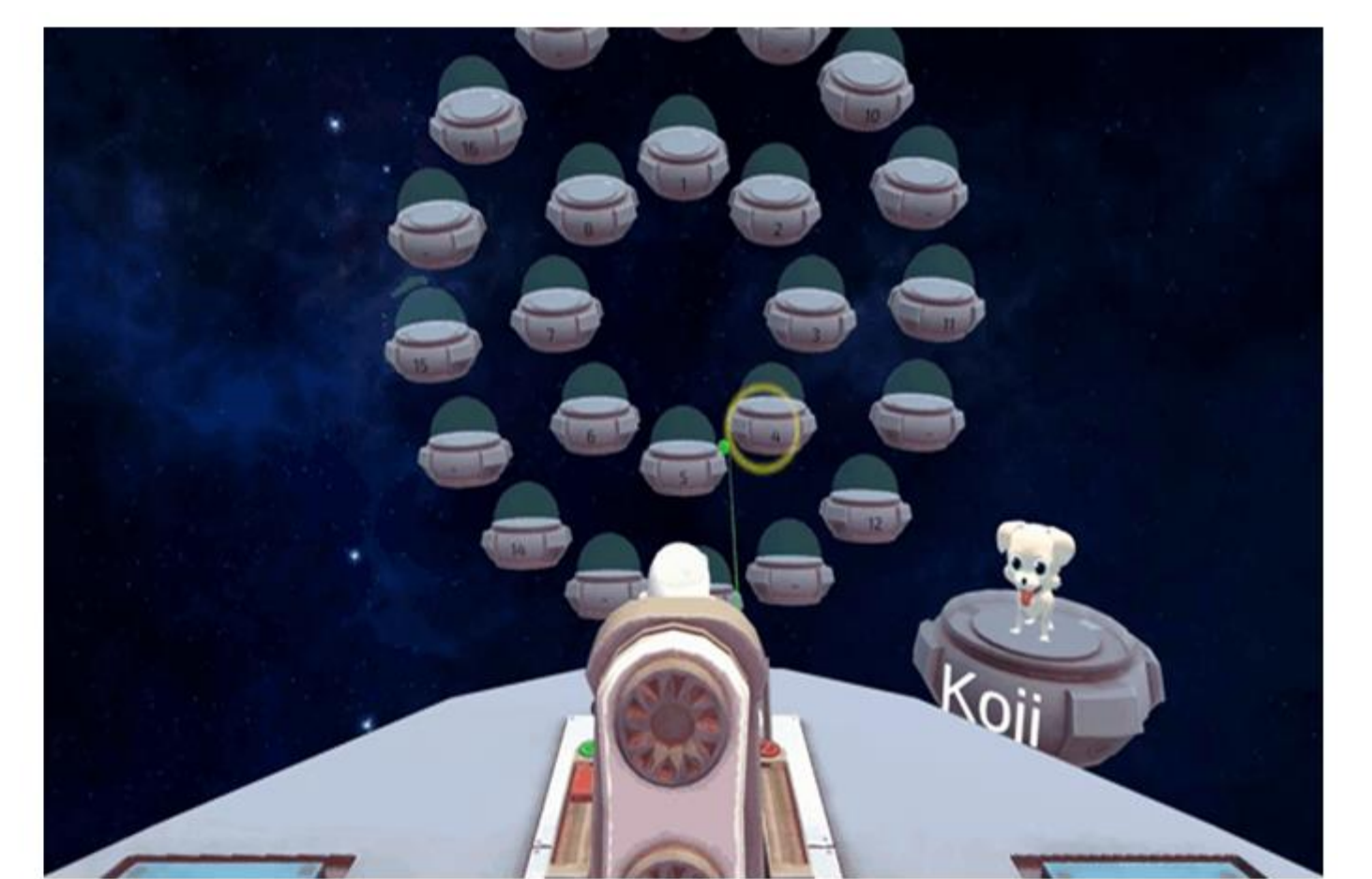
Executive functions



Memory



Selective attention



Divided attention

3. Results

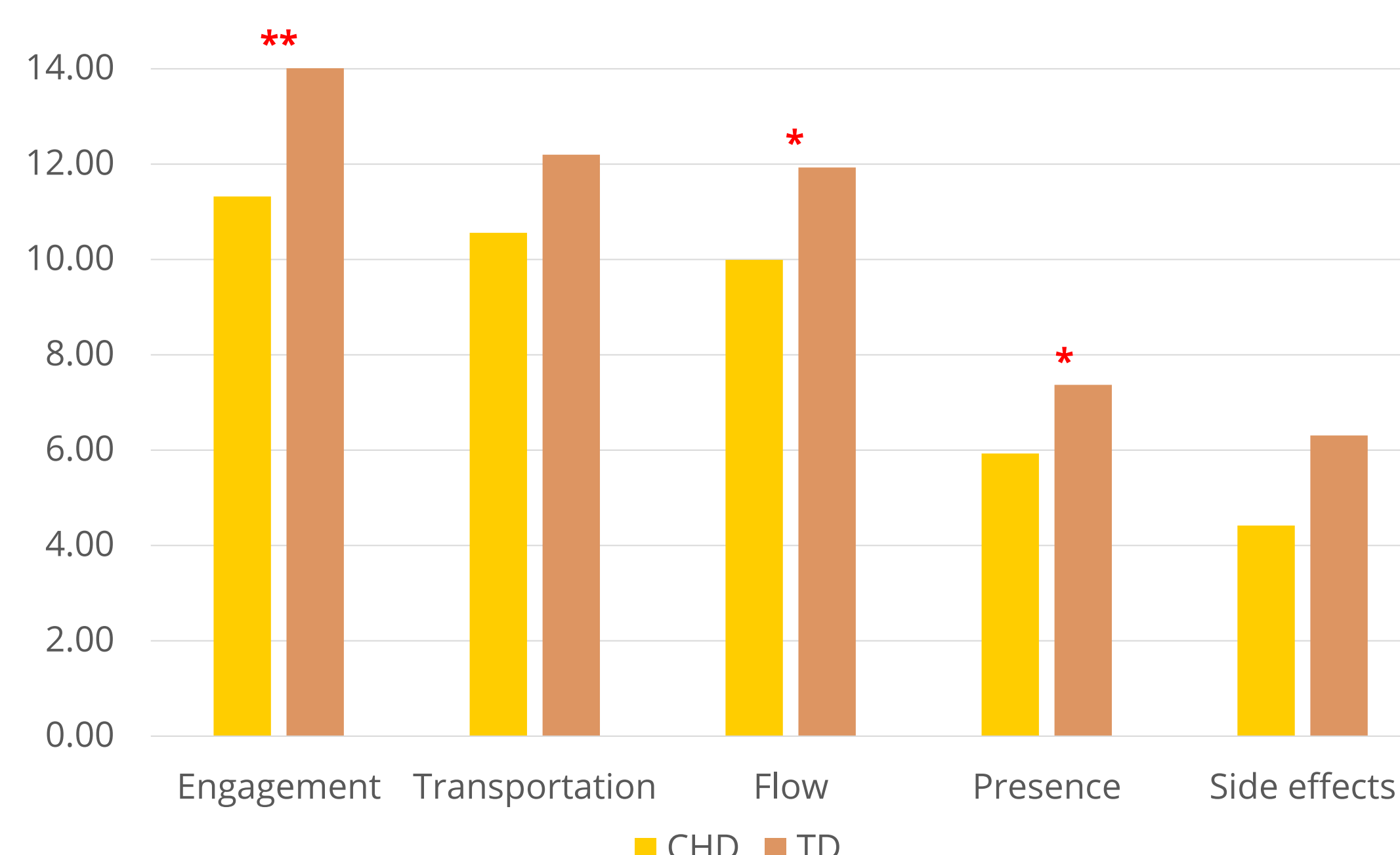
101 children participated; 98 children were included in the final analysis.

(CHD: n = 51; TD: n = 47)

Characteristics	CHD (n = 51)	TD (n = 47)
Age, years, Mean (SD)	11.20 (1.28)	11.00 (.72)
Sex, male (%)	64.7	38.3
Age first surgery, days, Median (IQR)	4, 61	
Number surgeries, Mean (SD)	2.41 (1.38)	
Diagnosis, N (%)		
Transposition of the Great Vessels	9 (20.0)	
+ Ventricular Septal Defect	3 (6.7)	
+ Pulmonary Stenosis	1 (2.2)	
Atrioventricular Septal Defect	5 (11.1)	
Tricuspid Atresia	5 (11.1)	
Hypoplastic Left Heart Syndrome	4 (8.9)	
Tetralogy of Fallot	4 (8.9)	
Other	14 (31.1)	

The VR serious game **appeared feasible** for both children with CHD & TD children, with **88%** children completing the VR assessment without encountering any issues.

Group (i.e., children with CHD or TD children; $p=0.389$) & **sex** (i.e., boy or girl; $p=0.127$) had **no significant effect** on the **likelihood of participants completing the innovative VR assessment**.



4. Conclusions

The **feasibility** of a VR serious game for children with CHD was **demonstrated**, with a **positive user experience**.

Future research should investigate the **effectiveness** of the **VR serious game** compared with a conventional or digital NPA, with a particular focus on the **development of novel outcome measures** that can better estimate & explain the impact of cognitive impairment on daily functioning.