Virtual City system for cognitive training in elderly

Iveta fajnerová, Adéla plechatá, Václav sahula, jan hrdlička, jiří wild
NATIONAL INSTITUTE OF MENTAL HEALTH & 3dsense, CZECH REPUBLIC

AIMS & TARGET GROUP

The aim of the project is to create a complex training software in virtual reality (VR) city environment with high ecological validity. The program will be later applied in the day-care facilities for elderly, where it can serve in healthy aging programs as prevention of cognitive deficits. There is increasing necessity for the optimization of the daily care for elderly as the population is ageing (see Fig. 1). The complex virtual city environment was previously successfully applied in patients with traumatic brain injury, stroke or schizophrenia patients [1,2,3] using non-immersive technology. We believe that immersive VR provide more intuitive control system which can be more suitable for the elderly.

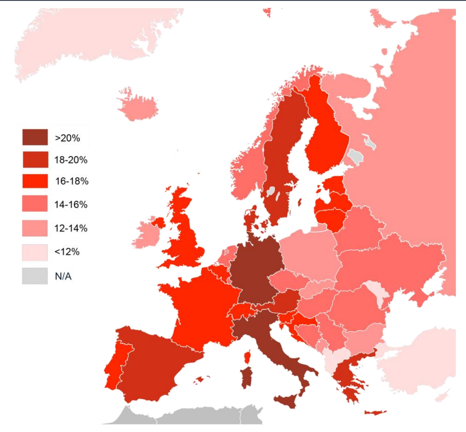

Fig.1 Percentage of the population over 65 years in Europe.

TECHNOLOGY (INVENTION) DESCRIPTION

Software: Game engine – Unity and the SteamVR (Valve VR system) Hardware: The application runs on HTC VIVE and Oculus Rift.

Immersive form of presentation using virtual glasses allows us to incorporate body movements into intuitive control of training games. The complex city environment simulates real-life situations, including the social context. This concept should facilitate the transfer of adopted strategies into real life.

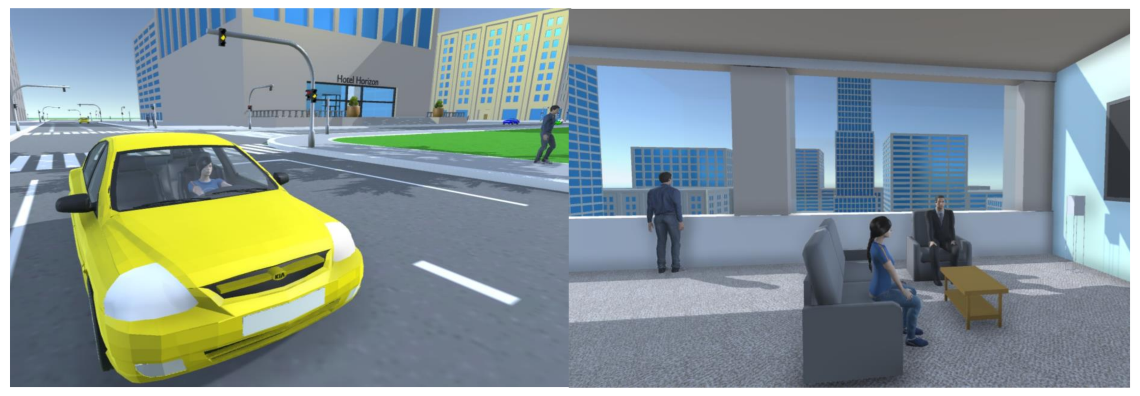

Fig.2 The illustration of the social aspects of the Virtual city.

CONCEPT OF THE VIRTUAL CITY

The game protypes are located in the complex VR city environment (see Fig.4). The VR environment is adapted according to the Czech region (city structure and street layout or local shopping products). The application enables us to freely change the weather and the VR scene according to the daytime (see Fig. 3).

Fig.3 The illustration of the weather and daytime changes in the Virtual city.

Fig.4 The layout of the Virtual city.

Serious games prototypes

Table 1. Design of individual training games with targeted cognitive functions.

TRAINING GAME	TARGETED COGNITIVE FUNCTIONS	DESCRIPTION
A - TRAINING	-	requires the practice of the movement in VR
B- ACTIVITY PLANNING	decision-making and planning	requires multimodal information processing in order to schedule a daily program
C - NAVIGATION	spatial memory & orientation	requires pointing and navigation to city locations
D - OBJECTS	episodic-like memory (what, when, where)	requires memorizing the spatial position & order of objects
E- FLIES	attention, psychomotor speed & visuo-motor control	requires to find and hit a sitting fly
F - SUPERMARKET	verbal & visual declarative memory	requires to remember & locate items from a shopping list
G - SHOOTING RANGE	selective attention, psychomotor speed & inhibition control	demands differentiation of targets from non-targets (Go/Nogo paradigm)
H - CAROUSEL	mental flexibility & spatial working memory	requires orientation in separate spatial frames while searching for hidden targets

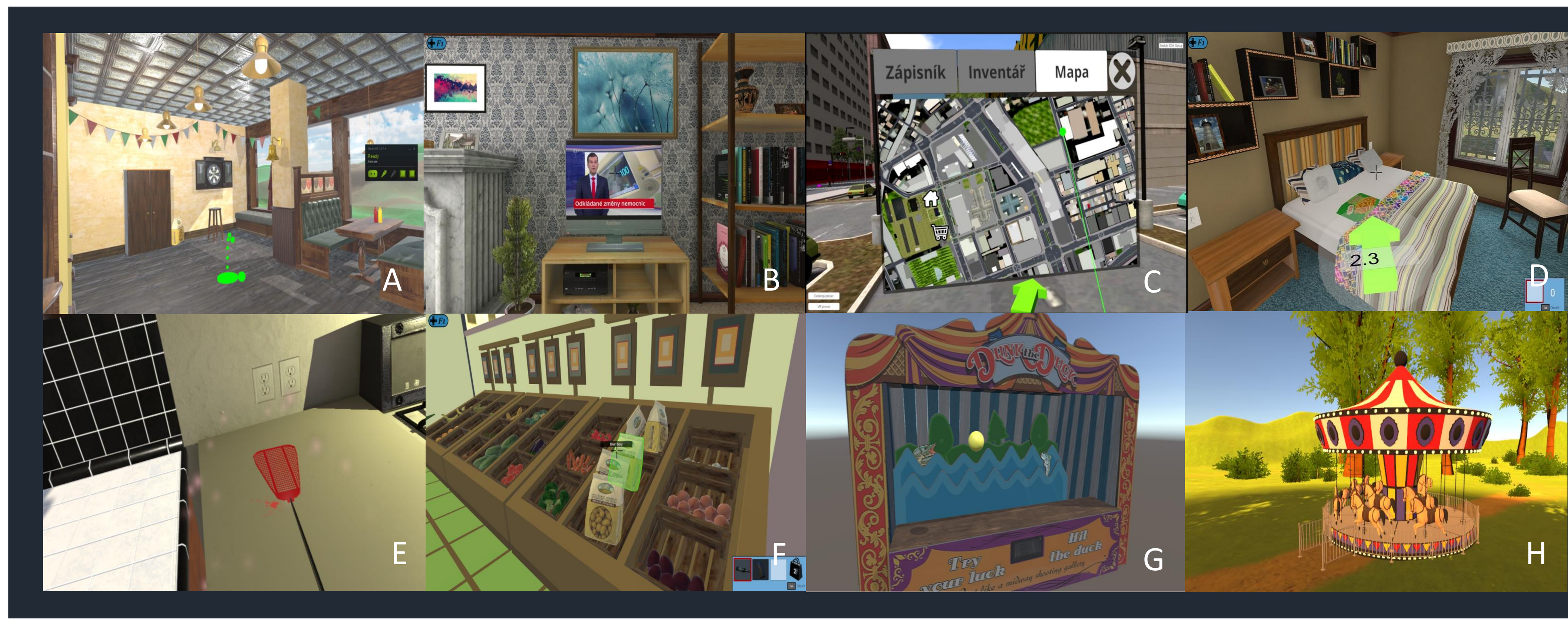

Fig.5 The illustration of the prepared prototype serious games: Training (A), Planning (B), Navigation (C), Objects (D), Flies (E), Supermarket (F), Shooting range (G), Carousel (H)

NORMATIVE DATA and feasibility

We have started to collect normative data for two prototype games – Supermarket [4] and Objects (see Fig. 7 and 8.). The seniors scored in both games more poorly than the young adults. For the feasibility data see Fig 6.

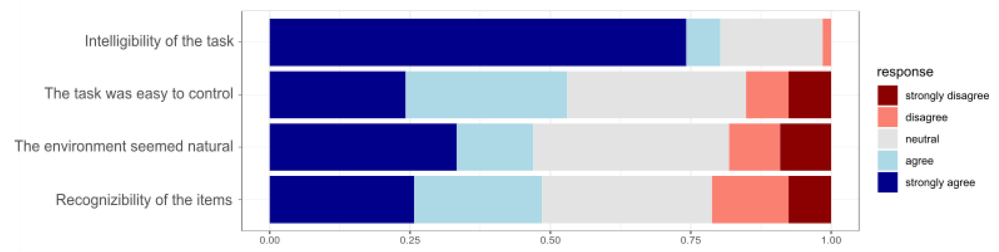

Fig.8. Feasibility evaluation of Supermarket.

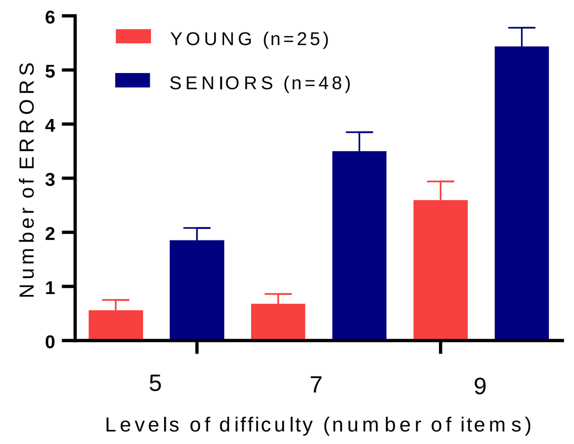

Fig.6. Mean number of errors (SEM) for Supermarket..

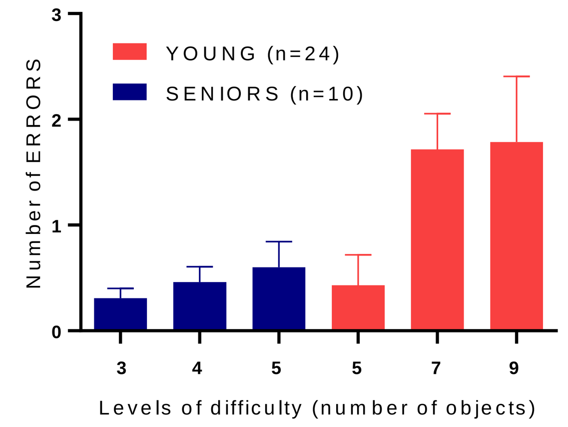

Fig.7. Mean number of position errors (SEM) for Objects..

Cognitive training - Pilot study

The 4 prototype games – Training, Supermarket, Objects and Flies were feasibility tested in a pilot cognitive training. The pilot study was administered in a group setting using one HTC VIVE headset and video projector, where the VR game view was mirrored. Seven cognitively healthy seniors with mean age 67.9 (SD=5.46) training completed the training.

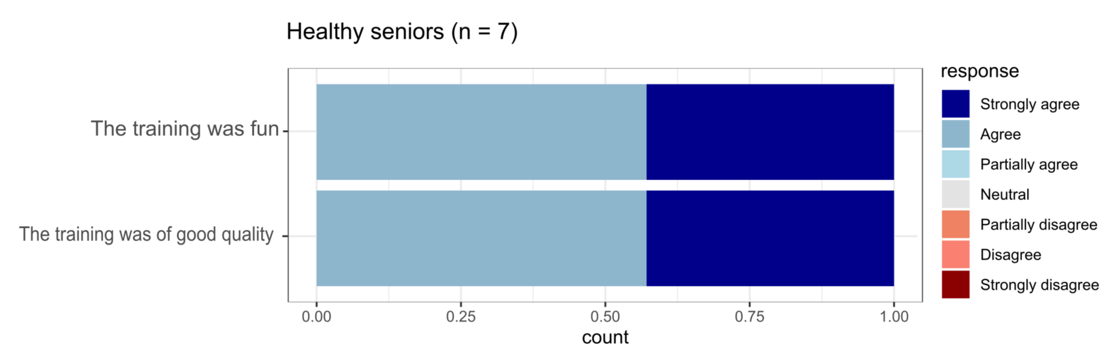

Fig.10. The results of the training evaluation.

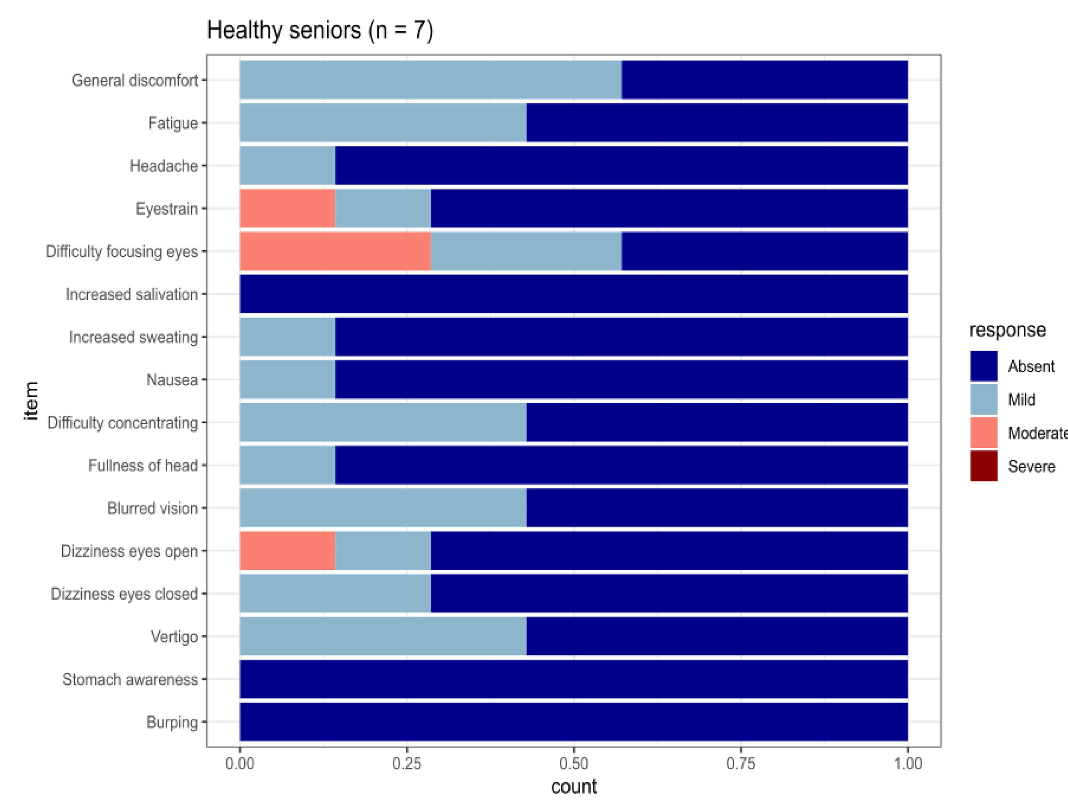

Fig.9. The results of the cybersickness questionnaire.

REFERENCES

[1] Costa, E M Da, L A V De Carvalho, and D F De Aragon. 2000. "Virtual City for Cognitive Rehabilitation." In *Proc. 3rd Intl Conf. Disability, Virtual Reality & Assoc. Tech., Alghero, Italy 2000*, edited by Paul Sharkey, A Cesarani, L Pugnetti, and A Rizzo, 299–304. UK: University of Reading.
[2] Faria, Ana Lúcia, Andreia Andrade, Luísa Soares, and Sergi Bermúdez i Badia. 2016. "Benefits of Virtual Reality Based Cognitive Rehabilitation through Simulated Activities of Daily Living: A Randomized Controlled Trial with Stroke Patients." *Journal of NeuroEngineering and Rehabilitation* 13 (1): 96. https://doi.org/10.1186/s12984-016-0204-z.
[3] Vourvopoulos, Athanasios, Ana Lúcia Faria, Kushal Ponnam, and Sergi Bermudez i Badia. 2014. "RehabCity: Design and Validation of a Cognitive Assessment and Rehabilitation Tool through Gamified Simulations of Activities of Daily Living." In *Proceedings of the 11th Conference on Advances in Computer Entertainment Technology - ACE '14*, 1–8. New York, New York, USA: ACM Press. https://doi.org/10.1145/2663806.2663852.
[4] Plechatá, Adéla, Václav Sahula, Dan Fayette, and Iveta Fajnerová. 2019. "Age-Related Differences With Immersive and Non-Immersive Virtual Reality in Memory Assessment." *Frontiers in Psychology* 10 (June): 1330. https://doi.org/10.3389/fpsyg.2019.01330.

T A
Č R
The project (no.L01000309) is co-financed with state support of the Technology Agency of the Czech Republic within the Program Éta.