Episodic-like memory tested in virtual environment

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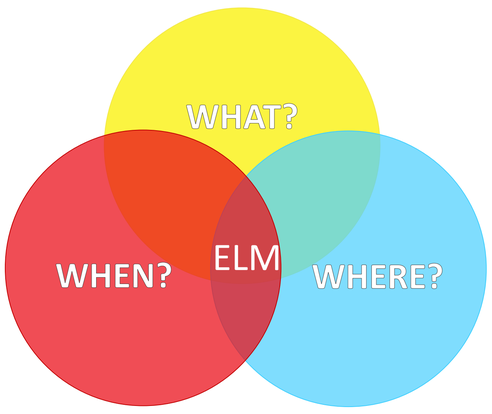
ABSTRACT

Episodic memory is a neurocognitive system – an ability to recall unique past events based on knowledge of "what", "when" and "where". These three parameters describe an individual characteristic of the event and form a model of **episodic-like memory (ELM)**, which is often tested also in animals. To study the ELM concept in humans, we designed in our pilot experiment the ELM task in two virtual environments and tested them in healthy volunteers.



INTRODUCTION

Episodic memory allows recollection of unique past events [1], demanding realization of three basic parameters: target information - "what" happened, temporal context - "when" it happened and spatial context - "where" the event took place [2]. Episodic-like memory (ELM) model is testable both in animals [3,4,5] and in humans [7]. Thus the ELM task could be therefore applied in translational models of neuropsychiatric disorders.

AIMS

The aim of this pilot study was to design virtual ELM task in three-dimensional virtual reality environments, applicable in later clinical studies. The task is based on the original two-dimensional version of the simple computer task previously designed by Kamil Vlček [7], aimed at spatial and temporal context of ELM.

MATERIAL AND METHODS

Healthy volunteers (n= 72; 21 females, 51 males; University education) were tested in two virtual environments (see Figure 1):

A) unstructured open space **OFFICE** (n= 41; average age: 26.9 years),

B) smaller structured **HOUSE** (n= 31; average age: 26.5 years).

In both environments subjects completed 5 trials with increasing difficulty (collection of objects: 3, 5, 7, 9 or 11), each requiring to remember temporal sequence and spatial positions of these objects. We collected also information about gaming experiences of participants and strategies they used during the task.

Statistical analysis: Position and order errors were evaluated. The effect of the task difficulty (trial as repeated measure variable) and environment (categorical variable) was analysed using ANOVA for repeated measures (Environment*Trial). The additional effect of continuous variables (age or gaming experiences) was analysed using GLM analysis.

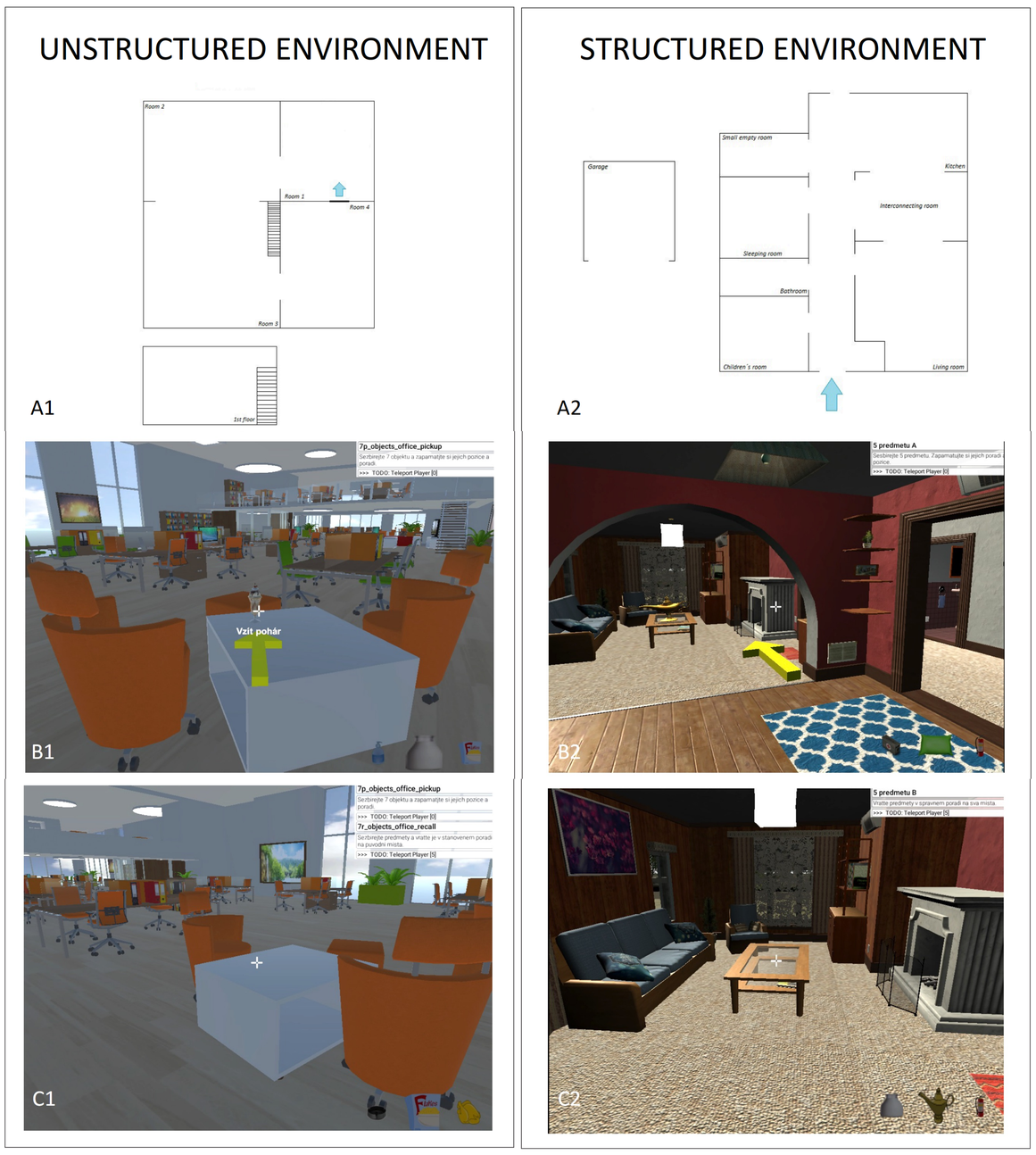


Figure 1. Illustration of both virtual environments: OFFICE (1) and HOUSE (2). A - Ground plan; B, C - each trial consisted of two consecutive phases: PRESENTATION (B1,2) - a yellow arrow showed direction to each object in a specific order and RECALL (C1,2) - required to return all objects to original positions in a correct sequence.

RESULTS

- The number of both types of errors increased with growing task difficulty in both environments (trial effect $p < 0.001$, see Figure 2).
- Participants showed superior ability to remember positions ($p < 0.001$), but not order of the objects ($p > 0.05$), in the well-structured "House" environment. Repeated measures ANOVA showed also significant Environment*Trial interaction in position error (post hoc Newman-Keuls test in difficulty level 11: $p < 0.05$).
- No effect of previous experiences with virtual games was found.
- The effect of age is significant in both types of errors, but more pronounced in order ($p < 0.001$) than in position errors ($p < 0.05$).

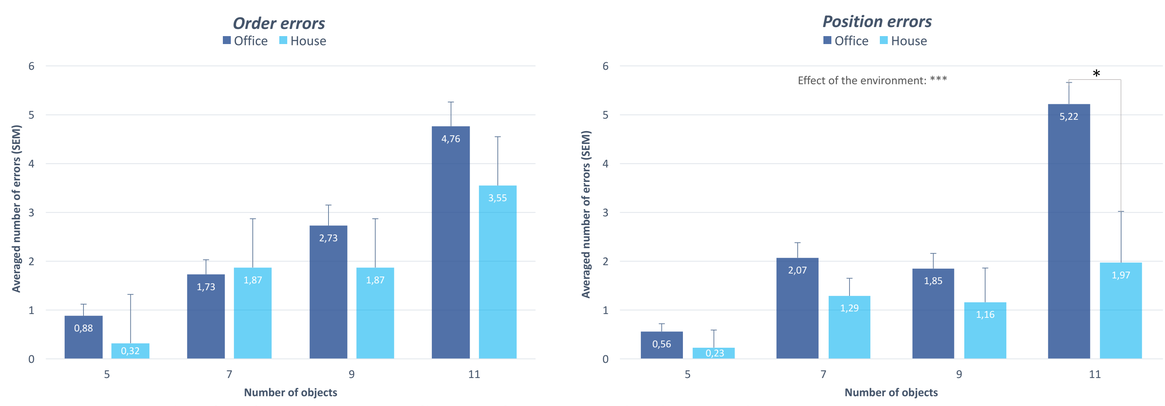


Figure 2. Order (top) and position (bottom) errors in both virtual environments. Results of the ANOVA repeated measures (errors averaged for the whole group) show comparison between structured and unstructured environment.

CONCLUSIONS & DISCUSSION

The pilot study demonstrated:

- Number of order and position errors increases with the task difficulty.
- Well-organized environment of family "House" is more suitable for recollection of unique past events, such as collection of objects.
- The ELM task performance is affected by age, but not by gaming experiences.

Debriefing of the participants helped us to identify variable strategies used to solve the task, e.g. story creating, mental repeating of order during objects collection.

Future directions:

- Current study deals with the 3rd ELM parameter "what" – requiring free recall of collected objects by their active selection from a set of additional objects.
- Comparative character of the ELM model suggests applicability of the novel virtual ELM task in future clinical studies in neuropsychiatric disorders affecting episodic memory, such as Alzheimer disease [7] and schizophrenia [6].

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