The effect of experience modality on individual learning characteristics

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The Neural Basis of Behavioral Change

Introduction

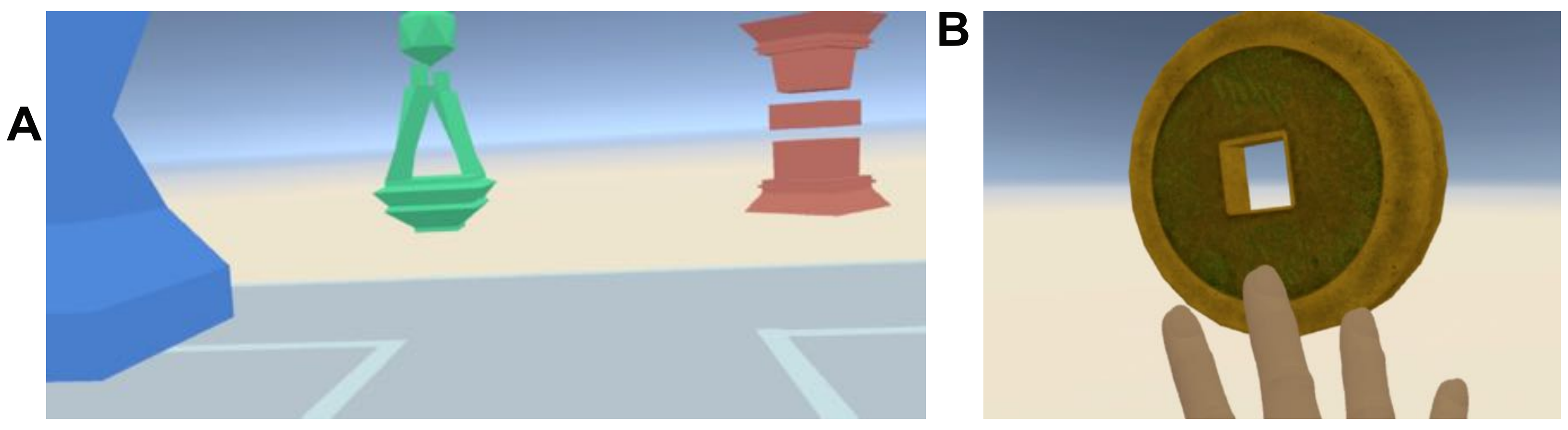
The technological utilization of immersive naturalistic virtual reality (VR)[1] is spreading in many applications[2–7] with specific interest arises in improving learning processes in education[8–10]. Identifying the impact of VR immersiveness on learning enhancement is a crucial step to optimize VR learning applications and is yet to be thoroughly assessed.

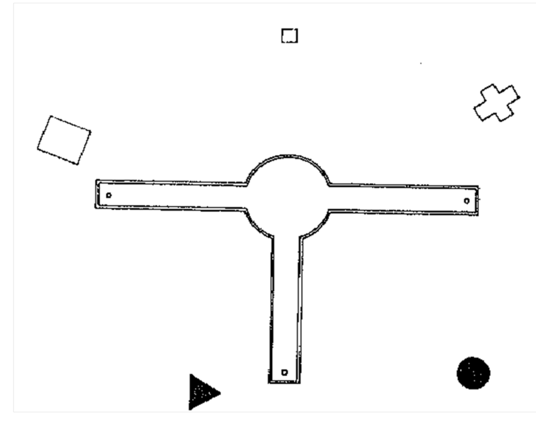
Research Aim

To test the effect of usage of VR modality of experience on cognitive processing and individual performance.

Methods

1. We translated a classic spatial learning task (Barnes et al.[11]) from animals to humans, where three spatial learning strategies were observed.



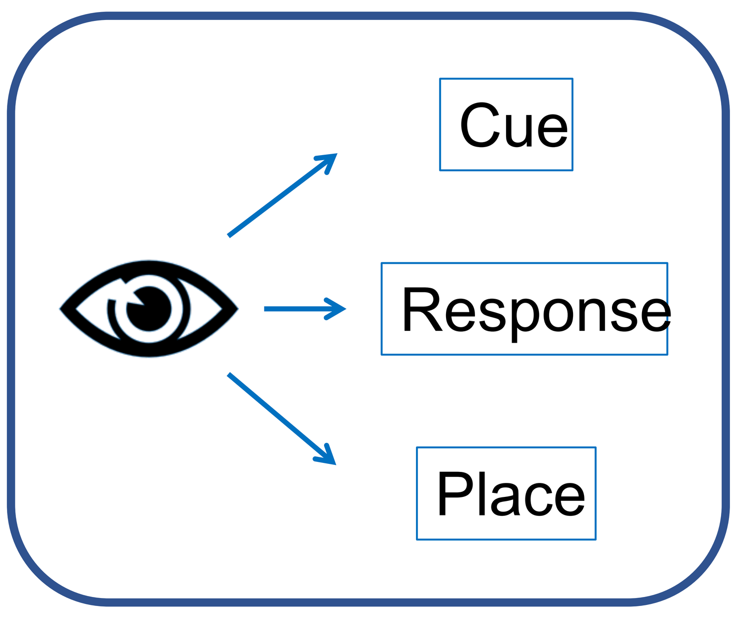


Task scheme. A: The view when entering the center of the T-maze from the start arm. **B:** Participant's hand represented reaching to collect the found coin (the task reward). **C:** The original T-maze task scheme from[11].

2. We will compare learning and experience traits in 3 conditions. In two of the settings participants will wear an head mounted display (HMD) VR headset with a built-in eye-tracker (ET) (HTC-Vive Pro) comparing walking physically vs. standing and using a controller, and in the 3[rd], the environment will be displayed on a regular 2D screen and navigated with a mouse and keyboard to control movement.

Experimental conditions. A: 3D HMD walking physically. **B:** 3D HMD standing and walking with controller. **C:** 2D screen display using the mouse and keyboard for movement.

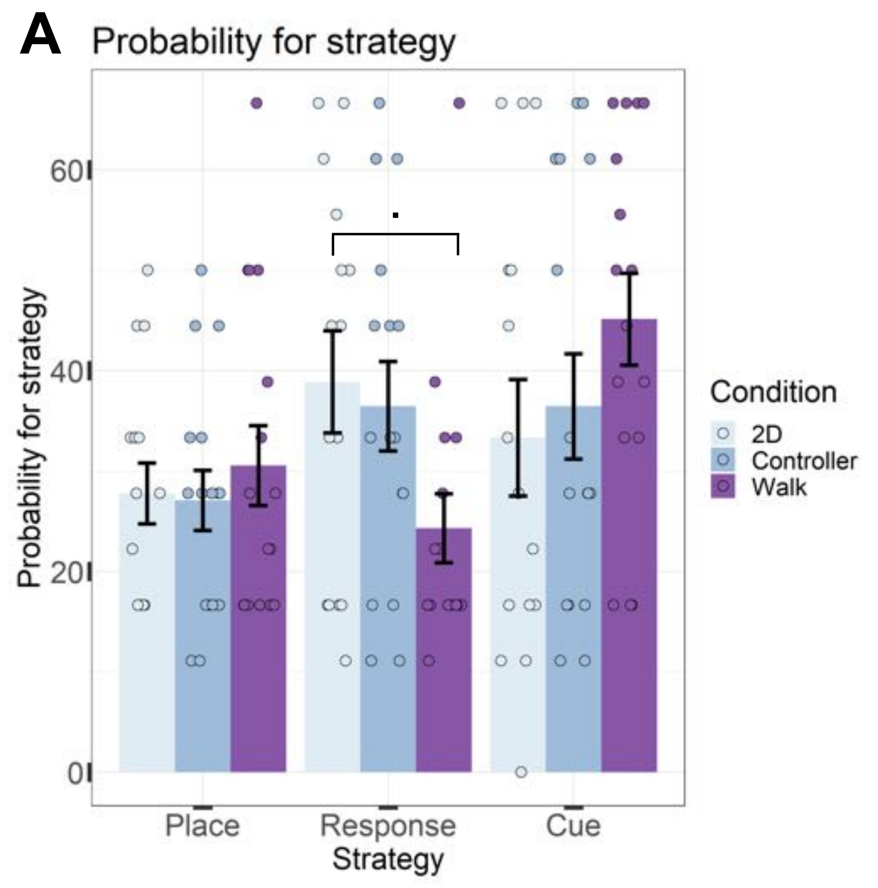
3. Learning properties such as navigational strategy used (place/cue/response), pace, success rate, and experience measures of presence, immersion, awareness of environment characteristics and of strategy used will be assessed using rich behavioral and ET data and presence questionnaires.

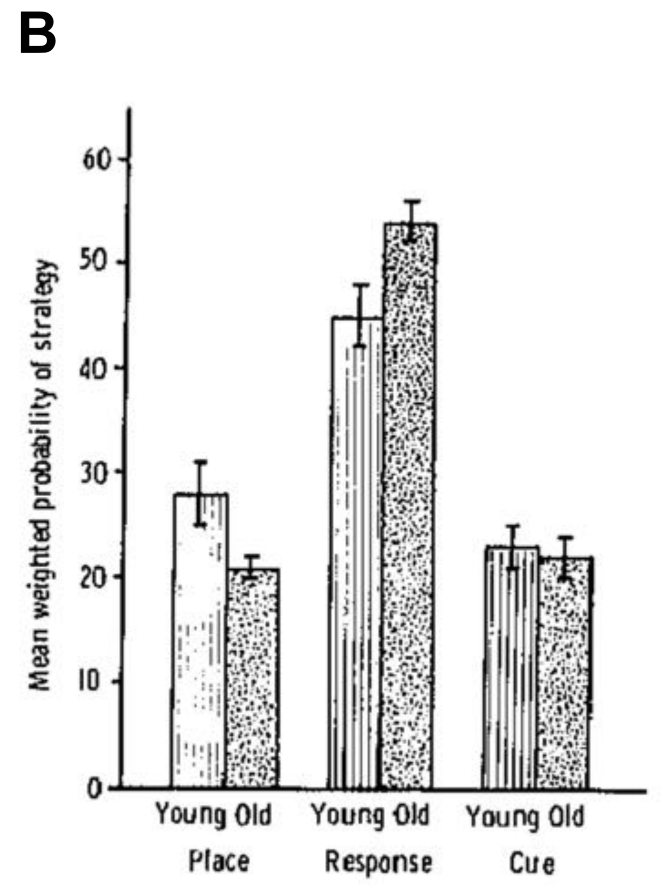


Results

We concluded data collection of a pilot sample of 48 participants, 16 in each of the 3 modality groups.

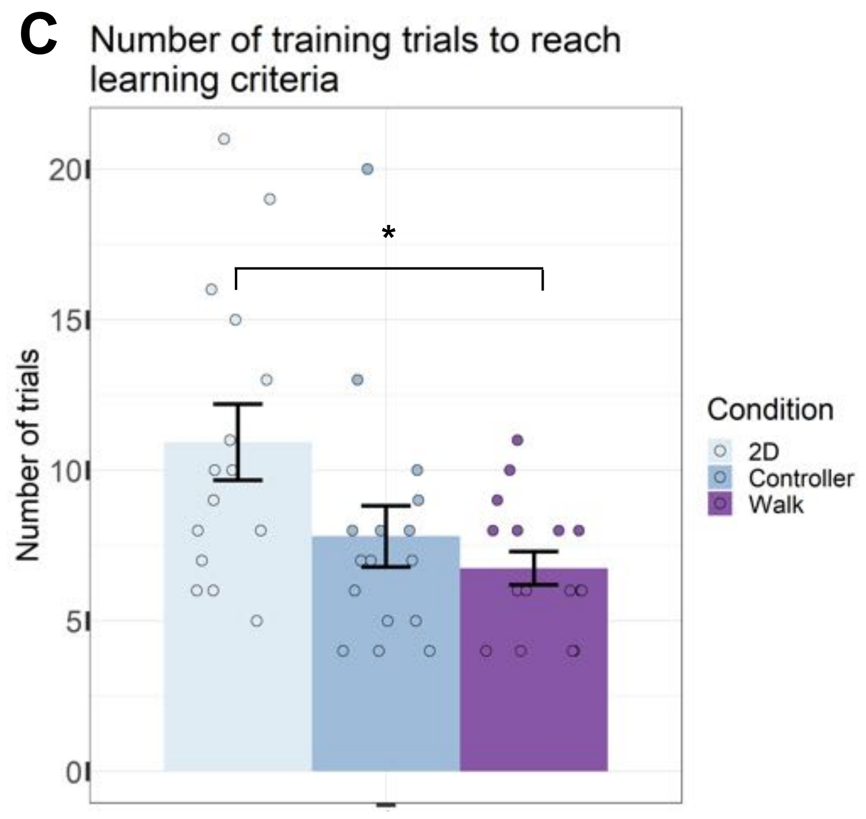
1.Our translation of the task to humans elicited usage in all three learning strategies in all experimental conditions, with a significant effect of modality on the probability for strategy. Nonetheless, all the three distributions of probability for strategy differed from the one obtained for rats.

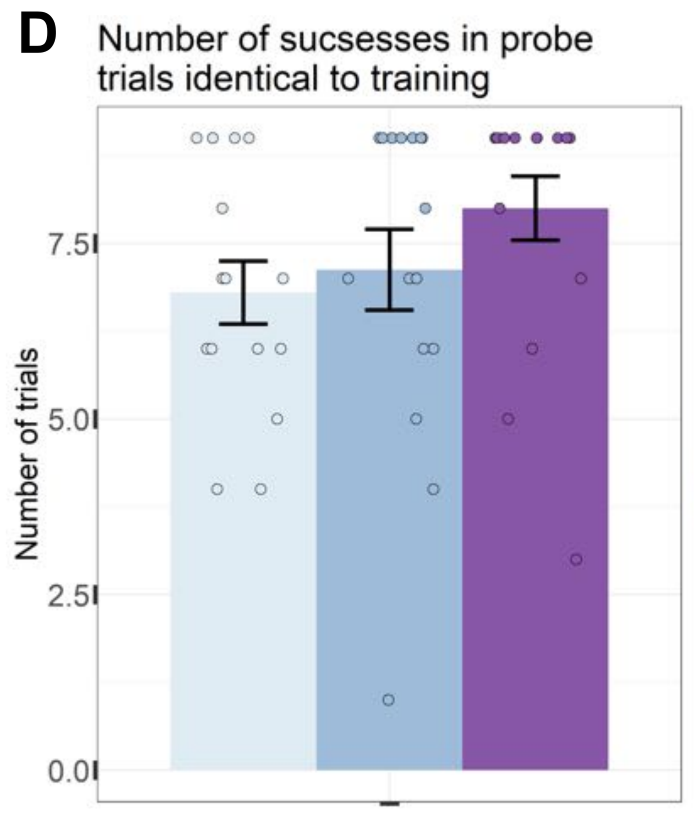




Probability for learning strategies. Bar graphs of the mean probability for strategy according to group. Error bars indicate standard errors. **A:** According to modality. A significant difference in the probability for response strategy between at least two conditions was obtained by a one-way ANOVA ($F(2, 44) = [3.246]$, $p = 0.048$). Tukey's HSD Test for multiple comparisons obtained marginally significant difference between 2D and walk ($p = 0.058$, 95% C.I. = [-0.296, 0.004]). **B:** According to age group as obtained in Barnes et al.[11].

2. Additional learning measures we extracted thus far are learning pace and learning success.





Learning measures. Bar graphs of the learning measures mean according to group. Error bars indicate standard errors. **C:** Learning pace was defined as the number of training trials to reach learning criteria. A significant difference in the learning pace between at least two conditions was obtained by a one-way ANOVA ($F(2, 44) = 4.883$, $p = 0.012$). Tukey's HSD Test for multiple comparisons obtained significant difference between 2D and walk ($p = 0.012$, 95% C.I. = [-7.545, -0.821]). **D:** Learning success was defined as the number of successful probe trials that were identical to training trials (with a maximum of 9 trials). Values with a greater distance than 2 SD's from the mean were treated as outliers and excluded from the analysis.

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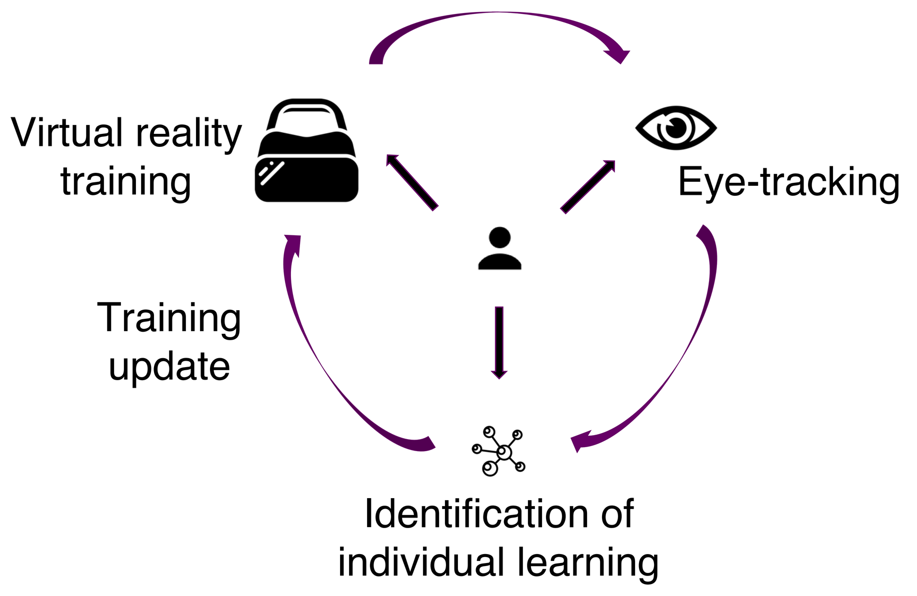
Summary and Future Directions

In this new era of the Metaverse there is expected to be greater usage of HMD devices also for learning. Our findings could shed light on the effect of using VR on individual experience, cognitive and learning processes, and their related physiological signals of ET.



This may serve for optimizing different learning tasks in education systems, professional training, and even for psychiatric diagnosis and treatment sessions, since spatial learning strategies studied in this project's task were found to be indicative of various disorders[12–14] and old age[11].

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