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Do age differences affect performance in 2D sketching based on a first-person perspective (3D) route learning task in *differently-designed* virtual environments?

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Virtual environments (VEs) are widely used in navigational behavior studies. We examine VEs as assistive technologies that help people learn a route. We take a visualization perspective, as we believe the 'visualization design' of a VE affects how well people learn with them, and VEs can be optimized to specific tasks and audience. In this study, we primarily take a *visual realism* perspective, given that the mainstream VEs aspire to create realistic experiences [1]. Therefore, we examine the impact of three differently designed VEs on route learning, as expressed by the ability to produce correct sketches of the route from the memory. Specifically, we compare a RealisticVE (photorealistic) and an AbstractVE (non-photorealistic) to a "MixedVE", which we optimize for route learning. MixedVE is a result of 'mixing' the other two in terms of realism: We leave the photo-textures only on scene elements that are *relevant* for navigation (thus, highlight them), while we remove the photo-textures elsewhere in the scene [2]. Thus, the design of the MixedVE is optimized both regarding levels of realism, and regarding navigational memory (i.e., placement of the highlighted elements are informed by the knowledge on navigational attention/memory). Importantly, because there are individual differences in navigational performance [3] and memory abilities based on age [4]; we examine how age differences affect route learning performance. Specifically, 42 younger (25-35yo) and 39 older (65-75yo) participants learned a route in a fictional city in the three different VEs, and produced sketches of the route immediately after the experiment ("immediate"), and one week later ("delayed").

Here we report on participants' accuracy in sketching the route on 2D screenshots based on each VE. A 2 (age) x 2 (recall) x 3 (visualization) mixed-design ANOVA revealed statistically significant differences as follows: a) *age* $F(1, 79)= 17.04$, $p<.001$, $\eta_p^2=.15$ (young: 66.3%±31.7%, older: 40.5%±30.0%), b) *visualization* $F(2, 158)=11.69$, $p<.001$, $\eta_p^2=.01$ (Abstract: 53.6%±32.9%, Mixed: 57.6%±33.9%, Realistic: 50.5%±33.4%) and c) *age x visualization* $F(2, 158)=3.80$, $p<.05$, $\eta_p^2=.01$ (Fig. 1). The *age x visualization* interaction is explained by the significantly large difference in the sketching performance using the MixedVE and the RealisticVE for the younger and older participants (young: 11.0%±21.3%, older: 3.0%15.0%, $t(149.35)=2.77$, $p<.01$, $r=.22$; Fig 1d). Interestingly, the recall stage did not reveal statistically significant differences (immediate: 55.4%± 32.1%, delayed: 52.4%± 34.7%), neither did any other of the interactions.

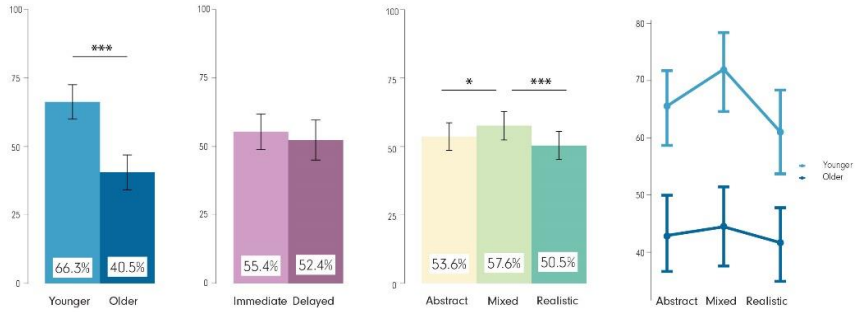

Fig. 1. Main effects of a) *age*, b) *recall stage*, c) *visualization type* on sketch task, and d) interactions between *age x visualization type* (irrespective of recall stage). *** p<.001, * p<.05. Error bars: SEM.

Besides the overall findings described above, we investigate the impact of different VEs on sketching performance with varying spatial and memory abilities (as measured by standardized tests). Overall, our results demonstrate that irrespective of age, participants learn routes better with the MixedVE.

References

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