Effects of pointing & tracing gestures on learning performance, eye movements and cognitive load

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The study was designed based on the study of Hu, Ginns, and Bobis (2015) that showed beneficial effects of finger tracing on mathematical problem-solving and Macken and Ginns' (2014) study which showed beneficial effects of tracing gestures on anatomy and physiological learning about the human heart. Cognitive load theory (Paas & Sweller, 2012) and theories of embodied cognition (Glenberg, Witt & Metcalf, 2013) provide explanations for the beneficial effects of tracing gestures. One explanation is that the finger functions as a cue to focus attention for visual processing, similar to the effects of hand gestures and position on attention direction (Cosman & Vecera, 2010; Reed, Grubb & Steele, 2006). The goal of the study was to examine the effect of pointing and tracing gestures on learning performance, visual information processing and cognitive load in a between-subjects design. The original paper-based learning instruction about the human heart (Macken & Ginns, 2014) was converted to a digital version and adapted for eye tracking on a 23"touch-screen monitor. The learning instruction, including pre- and post-tests, was translated into German and the original cognitive-load rating scale (Macken & Ginns, 2014) was replaced by a German version of an up-to-date scale for intrinsic and extraneous cognitive load (Leppink & Van den Heuvel, 2015). Eye movements were recorded with a Tobiix2-60-compact eye tracker and analyzed with Tobii-Studio software. Areas of Interest (AOIs) were set for the textual and the pictorial information on each slide. The tracing group (n=20) was instructed to use their hands to point and trace important elements of the learning instruction and to make relations between the corresponding textual and pictorial information. The control group (n=20) was instructed not to use their hands. As the study is still running the sample size will be expanded to N=60 participants within the next months. Preliminary results are reported here. Learning performance was assessed for the three subscales of identification, terminology, and comprehension. Results show a significant impact on identification, $F(1,39)=4.23, p<.05, ?^2=.10$, with higher learning performance for the tracing group (M=75.00%,SD=21.40%) in contrast to the control group (M=58.10%,SD=30.27%). The analysis of eye movements focused on the fixation duration on text and picture AOIs as well as on transitions between the corresponding text and picture AOIs across all slides of the learning instruction (Korbach, Brünken & Park 2016; Park, Korbach & Brünken, 2015). The tracing group showed significantly longer fixation duration on the picture AOIs (M=431.82s,SD=104.13s) compared to the control group (M=308.96s,SD=124.15s), $F(1,39)=11.73, p<.01, ?^2=.23$. In contrast, the control group showed significant longer fixation duration for the text AOIs (M=1103.30s,SD=135.31s) compared to the tracing group (M=952.10s,SD=129.60s), $F(1,39)=13.33, p<.01, ?^2=.26$. Concerning the transitions, the tracing group showed a significantly higher number of transitions (M=364.45s,SD=83.52s) compared to the control group (M=205.43s,SD=80.42s), $F(1,39)=38.58, p<.01, ?^2=.50$. The cognitive load measure shows no differences concerning the single cognitive load items or intrinsic and extraneous cognitive load measures. In sum, eye-tracking data indicates the tracing effect holds for students in higher education and seems to be grounded in a different focus of attention.