Effects of dynamic postural control on mathematical performance and heart rate variability

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Introduction

Several studies demonstrate a close connection between the cognitive and the postural control system, e.g. in dual-task performance (Dault, Frank, & Allard, 2001; Maki & McIllroy, 2007; Woollacott & Shumway-Cook, 2002). Severel studies have shown that mental arithmetic tasks have a decreasing effect on movement sway, with an increase in sympathetic activity (Yu & Zhang, 2012; Yu, Zhang, Xie, & Zhang, 2009; Zhang, Yu, & Xie, 2010). Ongoing research has demonstrated that postural control has a positive effect on attentional performance (Maus, Henz, & Schöllhorn, 2013), and mathematical performance (Henz, Schöllhorn, & Oldenburg, 2014).

Methods

Tasks and procedure

Subjects (*N* = 20) performed a 45 min mental math-test split in three parts (algebra, geometry, arithmetics) with three graduate difficulty levels under two different sitting conditions (static, dynamic). Electrocardiographic (ECG) data were recorded from seven electrodes before, during and after the mathematical test. Time-domain parameters as well as frequency-domain parameters of heart rate variability (mean HR, NN50, pNN50, LF, HF, LF/HF) were subjected to multivariate analyses of variance.

Figure 1: Induction of dynamic postural control by a dynamic stool (designed by MiShu).

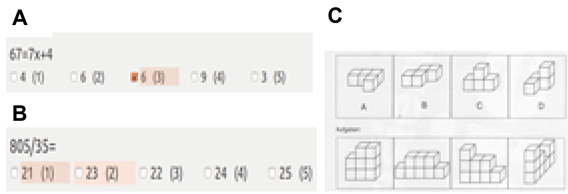

Figure 2: Mathematical tests. A Algebra. B Arithmetics. C Geometry.

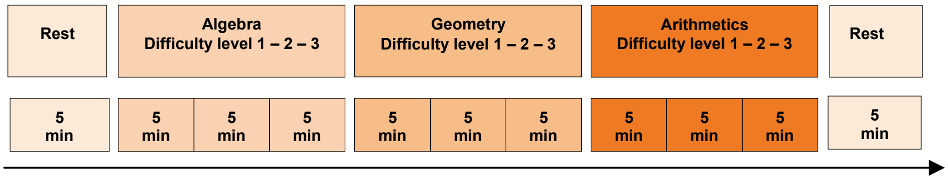

Figure 3: Experimental procedure.

Results and Discussion

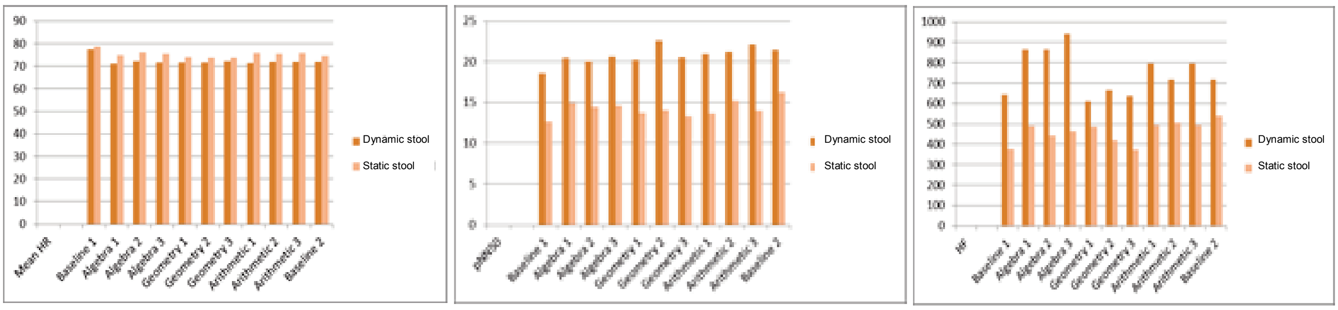

Figure 4: Means of time and frequency domain parameters of heart rate variability: mean HR, pNN50, HF.

Results indicate positive effects of dynamic postural control on mathematical performance. Data show improvement of 8% in correctly answered items, and a general increase of 8% in answered items. ECG-data show a main effect for type of stool. Mean HR decreased under the condition of dynamic postural control, $F(1,19) = 6.93$, $p < .05$. In the same way, NN50, $F(1,19) = 5.00$, $p < .05$, pNN50, $F(1,19) = 6.13$, $p < .05$, and HF, $F(1,19) = 5.57$, $p < .05$, reflect changes in autonomous regulation: they increased under the condition of dynamic postural control. Results indicate positive effects of dynamic postural control on mathematic performance and modulation of the cardiovascular system.

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