Confronted with Mathematics: The Impact of Pre-Service Elementary School Teachers' Self-Concept on Emotional and Physiological Responses to Mathematics Exposure

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Supplementary Information

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Validation Protocol for EDA Responsiveness

A validation protocol was used to identify and exclude the electrodermal activity (EDA) signals of non-responders—those individuals who do not exhibit any reactions in their EDA to stimuli (see, for example, Ikezawa et al., 2012; Venables & Mitchell, 1996 for information on non-responders). The validation protocol comprised two stimuli: first, the participants watched a short anxiety-inducing video showing a person climbing a tall building. Second, the participants received the instruction to hold their breath for 10 seconds. Both the induced anxiety from watching the video and the physical action of holding their breath were expected to trigger a skin conductance response in participants (Kreibig, 2010). Therefore, individuals who did not display any skin conductance response to either stimulus were classified as non-responders, and their EDA measurements were excluded from all analyses.

2

Study Settings for the Extraction of the Psychophysiological Parameters

Table S1

Settings for iMotions Peak Detection Algorithm

Peak onset threshold	0.01 microSiemens
Peak offset threshold	0 microSiemens
Peak amplitude threshold	0.01 micro Siemens
Minimum peak duration	500 milliseconds

Table S2

Settings for Kubios Scientific HRV

Quality and beat correction	Medium
RR time series interpolation rate	4 Hz
RR interval detrending	Smoothness priors
Smoothing parameter	500
Cutoff frequency	0.035 Hz

3

Item Selection for the Algebraic Pattern Finding Task

We selected 20 items of the item pool provided by Loe et al. (2018). This item pool was originally designed for an adaptive testing situation. As our math task was not supposed to be designed as an adaptive test, but simply as a collection of a number of consecutive items with varying difficulty, we selected the 20 items from the pool by making sure the items were on average at a feasible difficulty level (by ensuring that the Rasch-scaled difficulty was centered around zero). We presented the items in a typical arrangement: For the first twelve items, the Rasch-scaled item difficulty was continuously increasing, then after the break, item difficulty started lower again with item 13, and increased again until the last item.

4

Baseline Correction

To control for baseline differences between individuals in psychophysiological measures, we used a two-step residual approach. First, we predicted the task-based PPM/BPM/RMSSD indices from their baseline values via simple linear regression (see Table S1). Second, we extracted the residuals for each psychophysiological indicator. These baseline-corrected indices were used in all further analyses.

Table S3

Baseline-Correction via Residual Extraction

Predictor	Task-based PPM/ BPM / RMSSD	
	Adj. R^2	β (*SE*)
PPM baseline	.60	.65 (.07)***
BPM baseline	.81	.84(.05) ***
RMSSD baseline	.80	.78 (.05)***

Note. All values are standardized. Significance is indicated via asterisks (* $p < .05$, ** $p < .01$, *** $p < .001$).

5

Descriptives and Correlations

Table S4

Descriptive Statistics

Variable	*M*	*SD*	Median	Min	Max	Range	Skew	Kurtosis
Self-concept	3.07	1.18	3.33	1.00	5.00	4.00	-.07	-1.23
Positive emotion composite score	2.68	.88	2.50	1.20	4.80	3.60	.34	-.73
Negative emotion composite score	2.47	.86	2.45	1.00	4.25	3.25	.23	-.73
Skin conductance response	.00	1.73	.18	-3.87	4.03	7.90	-.32	-.22
Heart rate	.00	4.68	-.60	-9.61	15.20	24.81	.59	.48
Heart rate variability	.00	8.94	.58	-21.70	22.74	44.44	-.22	.69
Task performance	9.74	3.55	10.00	2.00	17.00	15.00	-.24	-.86

Note. Skin conductance response was measured in peaks per minute (PPM), heart rate in beats per minute (BPM), and heart rate variability was measured via the root mean square of successive differences (RMSSD). All psychophysiological measures were corrected for baseline via residualization.

Table S5

Correlations Between Study Variables

Variable	1	2	3	4	5	6	7
1 Self-concept	1						
2 Pleasant emotion composite score	.52***	1					
3 Unpleasant emotion composite score	-.42 ***	-.58**	1				
4 Skin conductance response	.13	-.11	-.16	1			
5 Heart rate	.18	.10	-.01	.32**	1		
6 Heart rate variability	-.29**	-.27**	.37**	-.35**	-.52***	1	
7 Task performance	.35**	.45**	-.33**	-.06	.02	-.06	1

Note. Skin conductance response was measured in peaks per minute (PPM), heart rate in beats per minute (BPM), and heart rate variability was measured via the root mean square of successive differences (RMSSD). All psychophysiological measures were corrected for baseline via residualization. Significance is indicated via asterisks (* $p < .05$, ** $p < .01$, *** $p < .001$).

Declarations

Author Contributions Franziska Eckerskorn, Miriam Wünsch, and Anne C. Frenzel contributed to the study conception and design. Data collection and coding were performed by Franziska Eckerskorn and Miriam Wünsch. Analysis was performed by Franziska Eckerskorn. The original draft of the manuscript was written by Franziska Eckerskorn. Anne Frenzel, Reinhard Pekrun, Miriam Wünsch, Léon Brings, and Michael Kleine contributed to manuscript review and editing. All authors read and approved the final manuscript.

Conflict of Interest The authors have no conflicts of interest to declare.

Informed Consent Participation in the study required informed consent.

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