

Divergent thinking and Heart Rate Variability Biofeedback



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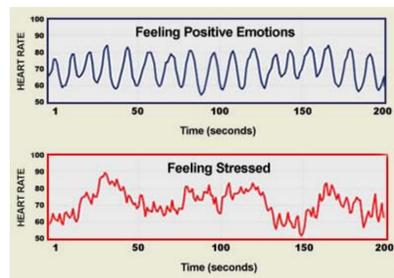
INTRODUCTION

Creativity

- Generating ideas, solutions, and insights that are both novel and useful is important for human survival and prosperity¹
- **Alternate Uses Test (AUT)** was the first paper-and-pencil task, proposed by Guilford, which measures creative ability²
- Assessed for **originality** (the less frequent the idea is being mentioned, the more original it is), **flexibility** (the more uses from different semantic categories, the more flexible someone is), and **fluency** (the more ideas, the more fluent)³
- **Originality (novelty)** measured by statistical originality (ORI)⁴
- **Divergent thinking (DT)** as a reliable indicator of creative potential

Heart rate variability (HRV)

- Change of time intervals between adjacent heartbeats
- Indicator of control over our health or psychological challenges
- High HRV - good health and well-being
- Low HRV - worse functioning of the organism



AIM OF STUDY/ HYPOTESIS

- Investigation of the influence of heart-brain interactions on DT.
- Heart Rate Variability biofeedback training improves divergent thinking.

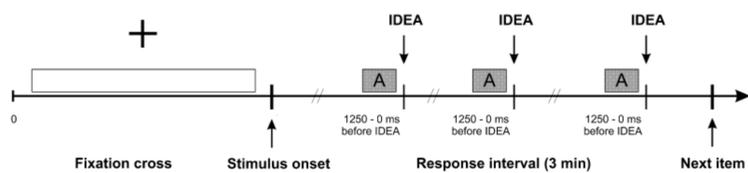
METHODS

1. Participants:

- Experimental group: 13 (9 female), age M = 20,3, SD = 2,4
- Control group: 8 (3 female), age M = 23.50, SD = 2,6)

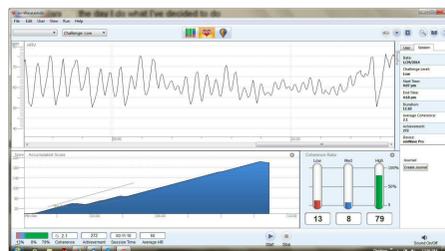
Alternative Uses task (AUT)

- AUT task: generate as many alternative uses for a common object as possible



- Participants were instructed to announce their idea (by pressing an 'idea button') and reported it – this procedure can help eliminate speech-related artifacts from EEG recordings

➤ Study design (HRV-BFB)



➤ Study design scheme

Inclusion into the study	Pretest	Sessions	Posttest	Additional sessions	Posttest
Psychometric testing	HRV + EEG + PANAS-S, STAI-S	HRV-BFB training/control	HRV + EEG + PANAS-S, STAI-S	HRV-BFB training/control	HRV + EEG + PANAS-S, STAI-S
Demographic, RPM(A), MEQ, IPAQ, FCB-TI, SUPIN-T, PSS-10, STAI-T, BDI, EHI	Baseline 5-min rest, IAUT, Short rest, ACOGNANT, Short rest, Auditory Oddball	1 2 3 4 5 6 7 8 9 10	Baseline 5-min rest, IAUT, Short rest, ACOGNANT, Short rest, Auditory Oddball	1 2 3 4 5 6 7 8 9 10	Baseline 5-min rest, IAUT, Short rest, ACOGNANT, Short rest, Auditory Oddball

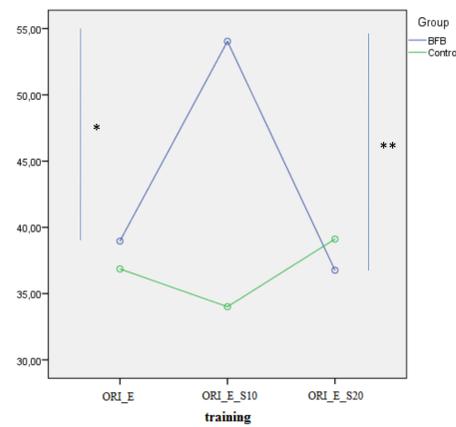
RESULTS

Paired Sample Test^a

		Paired Differences			95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	ORI_E - ORI_E_S10	-15,07537	17,81710	4,94158	-25,84214	-4,30861	-3,051	12	,010
Pair 2	ORI_E_S10 - ORI_E_S20	17,27230	16,27214	4,51308	7,43915	27,10546	3,827	12	,002
Pair 3	ORI_E - ORI_E_S20	2,19693	16,00195	4,43814	-7,47295	11,86681	,495	12	,630

a. Group = BFB

Table 1. Experimental group: T-student 's paired samples test (statistical significance p<0,05) for originality in the EASY task condition between the pretest and first posttest (S10), and between the first posttest (S10) and upon finishing the last training session (S20).



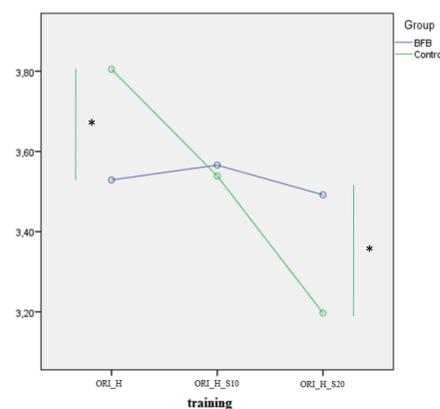
- Originality of the ideas at the beginning of training in the EASY (ORI_E) task conditions
- Originality of the ideas after 10 sessions in the EASY (ORI_E_S10) task conditions
- Originality of the ideas after 20 sessions in the EASY (ORI_E_S20) task conditions

Paired Sample Test^a

		Paired Differences			95% Confidence Interval of the Difference		t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper			
Pair 1	ORI_H_In - ORI_H_S10_In	,26584	,58507	,20685	-,22329	,75497	1,285	7	,240
Pair 2	ORI_H_S10_In - ORI_H_S20_In	,34175	,37496	,13257	,02827	,65523	2,578	7	,037
Pair 3	ORI_H_In - ORI_H_S20_In	,60759	,54921	,19417	,14844	1,06674	3,129	7	,017

a. Group = Control

Table 2. Control group: T-student paired samples test (statistical significance p<0,05) for originality in the HARD task condition between the pretest and first posttest (S10), and between the first posttest (S10) and upon finishing the last training session (S20).



- Originality of the ideas at the beginning of training in the HARD (ORI_H_In) task conditions
- Originality of the ideas after 10 sessions in the HARD (ORI_H_S10_In) task conditions
- Originality of the ideas after 20 sessions in the HARD (ORI_H_S20_In) task conditions

LITERATURE

1. Sternberg, R.J. and Lubart, T.I., 1999. The Concept of Creativity: Prospects and Paradigms in Handbook of Creativity, R.J. Sternberg, Editor, Cambridge University Press, New York.
2. Fink, A., Benedek, M., Grabner, R.H., Staudt B., Neubauer A.C., 2006, Creativity meets neuroscience: Experimental tasks for the neuroscientiWc study of creative thinking. ScienceDirect. Methods 42 (2007) 68–76
3. Fink, A., Grabner, R.H., Benedek, M., Neubauer, A.C., 2006. Divergent thinking training is related to frontal electroencephalogram alpha synchronization. Eur. J. Neurosci. 23, 2241–2246.
4. Dekker, J.M., Crow, R.S., Folsom, A.R., Hannan, P.J., Liao, D., Swenne, C.A., Schouten, E.G., 2000, Low heart rate variability in a 2-minute rhythm strip predicts risk of coronary heart disease and mortality from several causes: the ARIC Study. Atherosclerosis Risk In Communities. Circulation.
5. Wells, R., Outhred, T., Heathers, J.A., Quintana, D.S., Kemp, A.H., 2012. Matter over mind: a randomised-controlled trial of single-session biofeedback training on performance anxiety and heart rate variability in musicians. PlosOne .

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