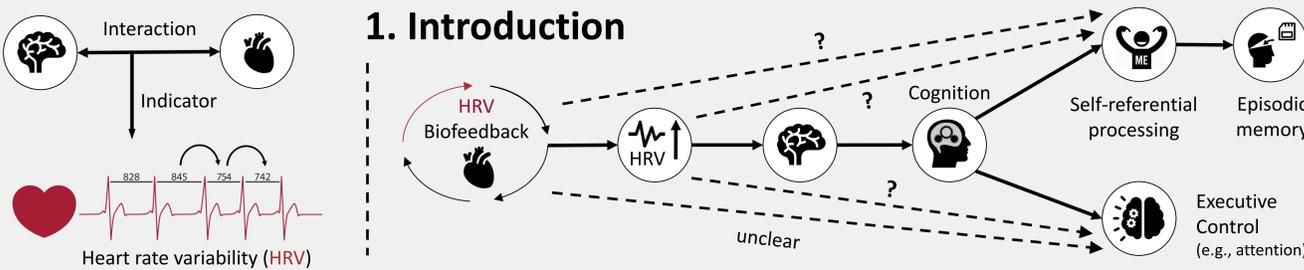# HRV-biofeedback in virtual reality enhances attention, short-term memory and self-referential episodic memory

Lukas Bögge[a], Itsaso Colás-Blanco[a], Pascale Piolino[a,b]

a) Memory, Brain & Cognition Laboratory (MC2Lab), Institute of Psychology, University of Paris, France
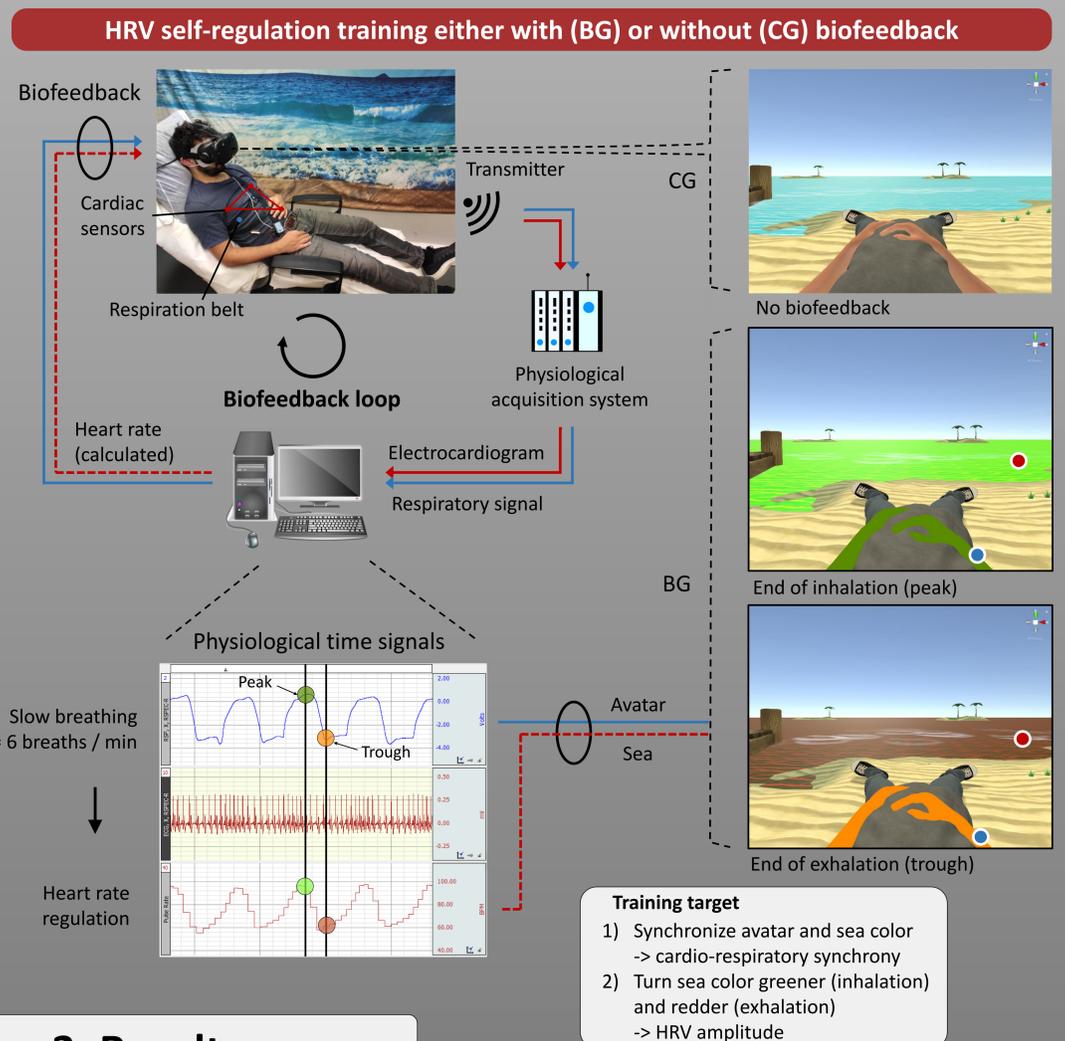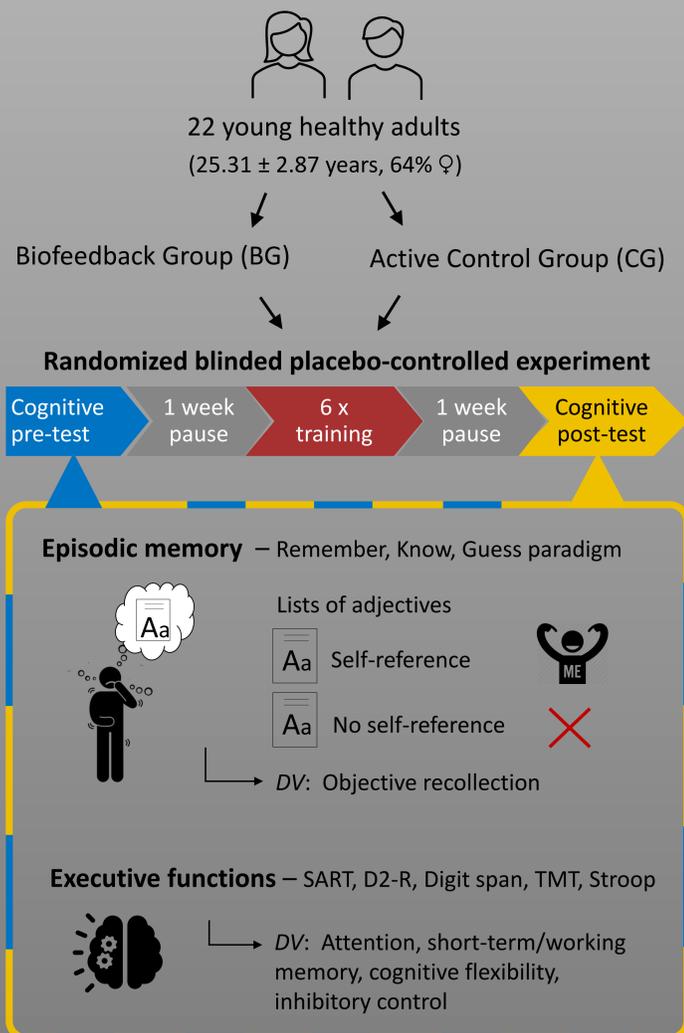b) Institut Universitaire de France (IUF), France

1. Introduction

Hypotheses

H1) HRV-biofeedback persistently improves self-referential episodic memory and cognitive control.

H2) Improvements correlate with biofeedback-evoked changes in HRV.

2. Methodology

22 young healthy adults
(25.31 ± 2.87 years, 64% ♀)

Biofeedback Group (BG) — Active Control Group (CG)

Randomized blinded placebo-controlled experiment

Cognitive pre-test → 1 week pause → 6 x training → 1 week pause → Cognitive post-test

Episodic memory – Remember, Know, Guess paradigm

Lists of adjectives
- Self-reference
- No self-reference

DV: Objective recollection

Executive functions – SART, D2-R, Digit span, TMT, Stroop

DV: Attention, short-term/working memory, cognitive flexibility, inhibitory control

HRV self-regulation training either with (BG) or without (CG) biofeedback

Biofeedback loop

Physiological time signals

Slow breathing ≈ 6 breaths / min → Heart rate regulation

Training target
1) Synchronize avatar and sea color -> cardio-respiratory synchrony
2) Turn sea color greener (inhalation) and redder (exhalation) -> HRV amplitude

3. Results

Linear mixed effect models verified significant or near significant group by test interaction effects for measures of self-referential episodic memory (Fig. 1), attention and short-term memory (Fig. 2). Cognitive improvements correlated moderately to strongly (Spearman) with changes in HRV (Tbl. 1).

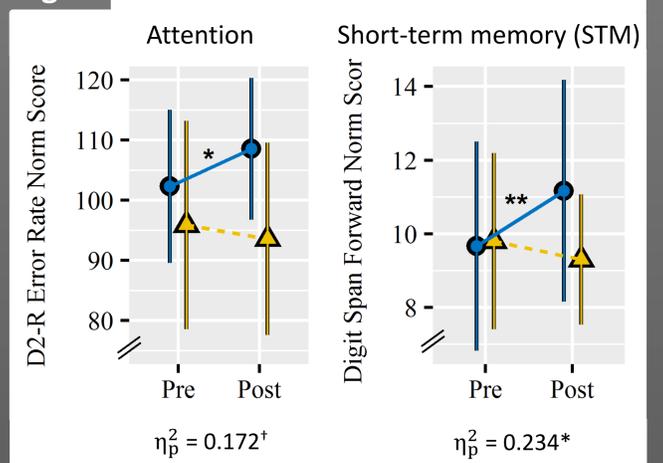Fig. 1 — Objective episodic memory recollection

Legend

Group
- BG
- CG
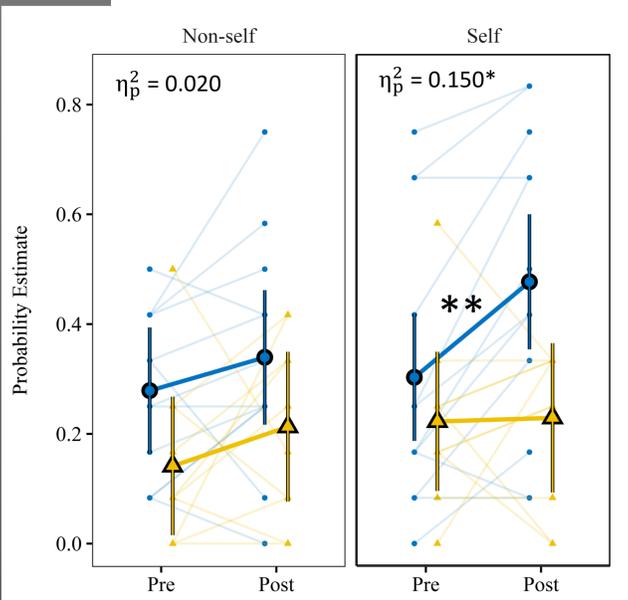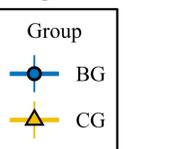
Error bars indicate 95% CI.
$**p < .01$. $*p < .05$, $†p < .06$.

Tbl. 1

Variable	r
Non-self	-.09
Self	.52*
Attention	.54*
STM	.42†

Fig. 2 — Executive functions

4. Discussion

vmPFC = ventromedial prefrontal cortex
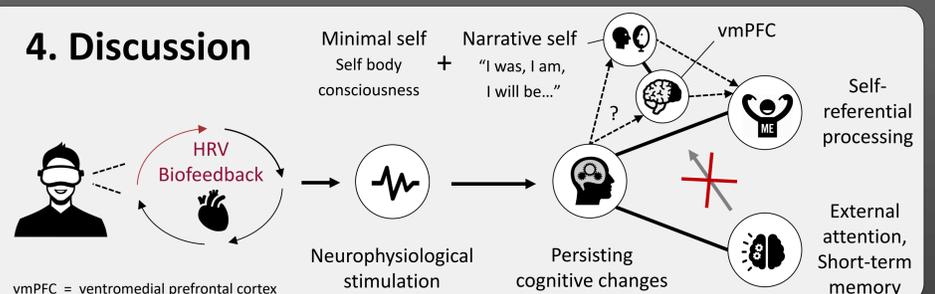
References
[1] Thayer et al., 2000 J Affec Disorders
[2] Thayer et al., 2009, Ann Behav Med
[3] Dessy et al. 2017, J Cogn Enhanc
[4] Symons & Johnson 1997, Psychol Bull

LUKAS BÖGGE
✉ Lukas.bogge@u-paris.fr