

The influence of breathing-induced activation on the pre-decisional information search and strategy selection

Maša Iskra, Aalim Makani, Laura Voigt, Florian Loffing, Lisa Musculus, Sylvain Laborde, Markus Raab, and Julia Spaniol

Introduction

The **arousal-biased competition (ABC) theory** proposes that high arousal biases information search by enhancing the processing of the most relevant or salient information regardless of the valence¹.

Empirically, **high psychophysiological activation** has led to more **heuristic, non-compensatory strategy** use in multi-attribute decision tasks².

Respiration offers a novel approach to manipulating activation level while reducing reliance on external materials.

Studies show that **slow-paced breathing** (SPB) reduces activation by increasing cardiac vagal activity³, while the activating effects of **fast-paced breathing** (FPB) have been attributed to cardiac vagal withdrawal and increased sympathetic activity⁴.

Research gap

How does a breathing-induced activation manipulation influence the pre-decisional information search and strategy selection in a multi-attribute decision task?

Hypotheses

H1: Psychophysiological activation is expected to be increased through FPB and decreased through SPB. Indices collected were heart rate variability, skin conductance response, and self-reported arousal.

H2: More selective search is predicted after FPB than SPB.

H3: More frequent use of heuristic decision strategies is predicted after FPB than SPB.

Methods

- sample: 63 participants ($M_{age} = 22.46$, $SD = 3.39$); 36 women, 24 men, two non-binary, and one trans woman
- psychophysiological activation manipulated by increasing and decreasing the breathing pace (FPB at 55 cpm and SPB at 6 cpm)
- a within-subject design with two conditions: in each condition, one minute of paced breathing is followed by three decision trials, repeated six times (18 trials/condition)

- methodologies and parameters:

Physiological: ECG (index - RMSSD), EDA (tonic and phasic), respiration

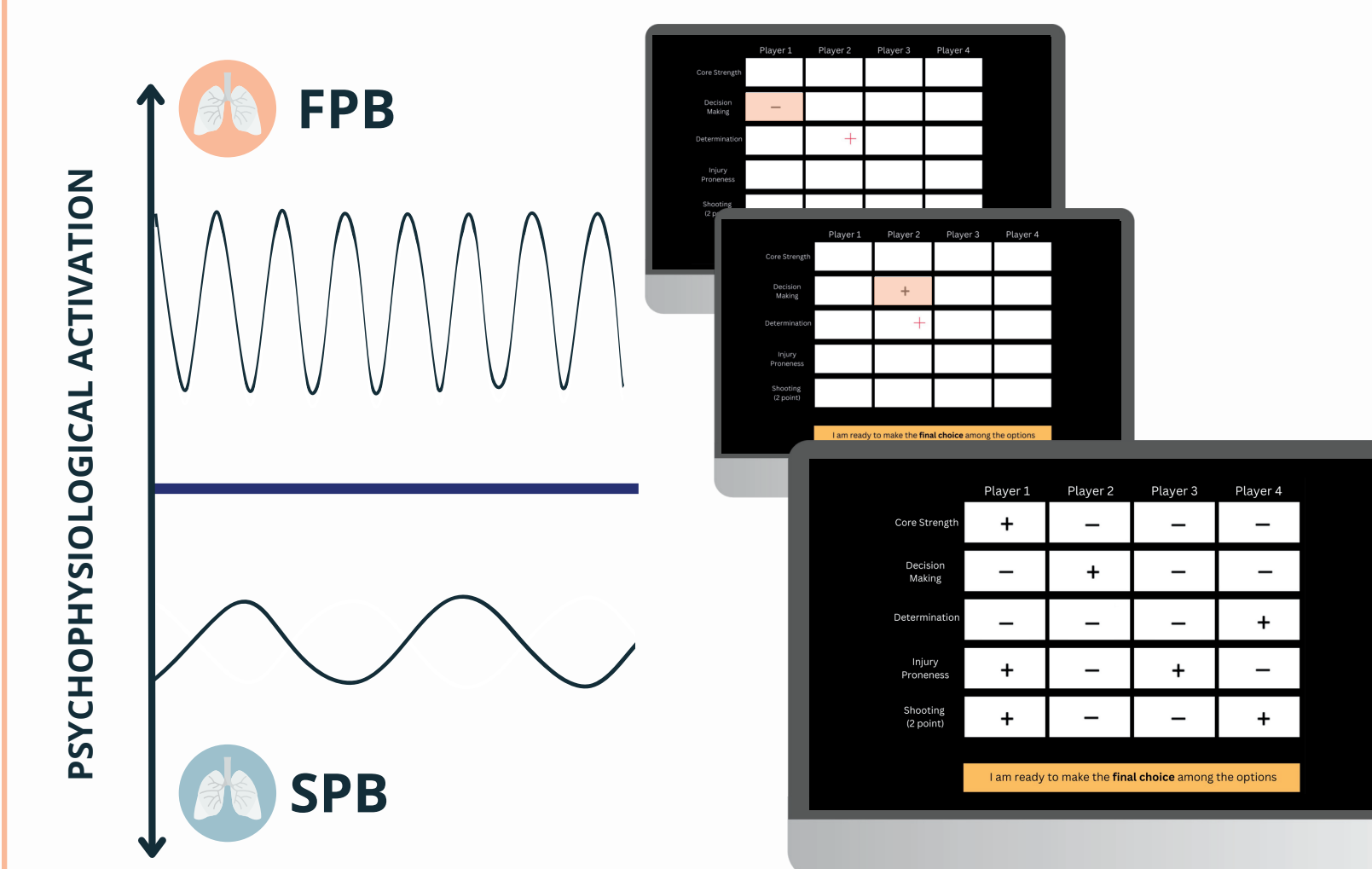
Behavioral: a multi-attribute decision task (search and choice behavior)

Self-reported: the self-assessment manikin (valence and arousal)

- statistical analyses: repeated-measures ANOVA, paired samples t-test

The multi-attribute decision task

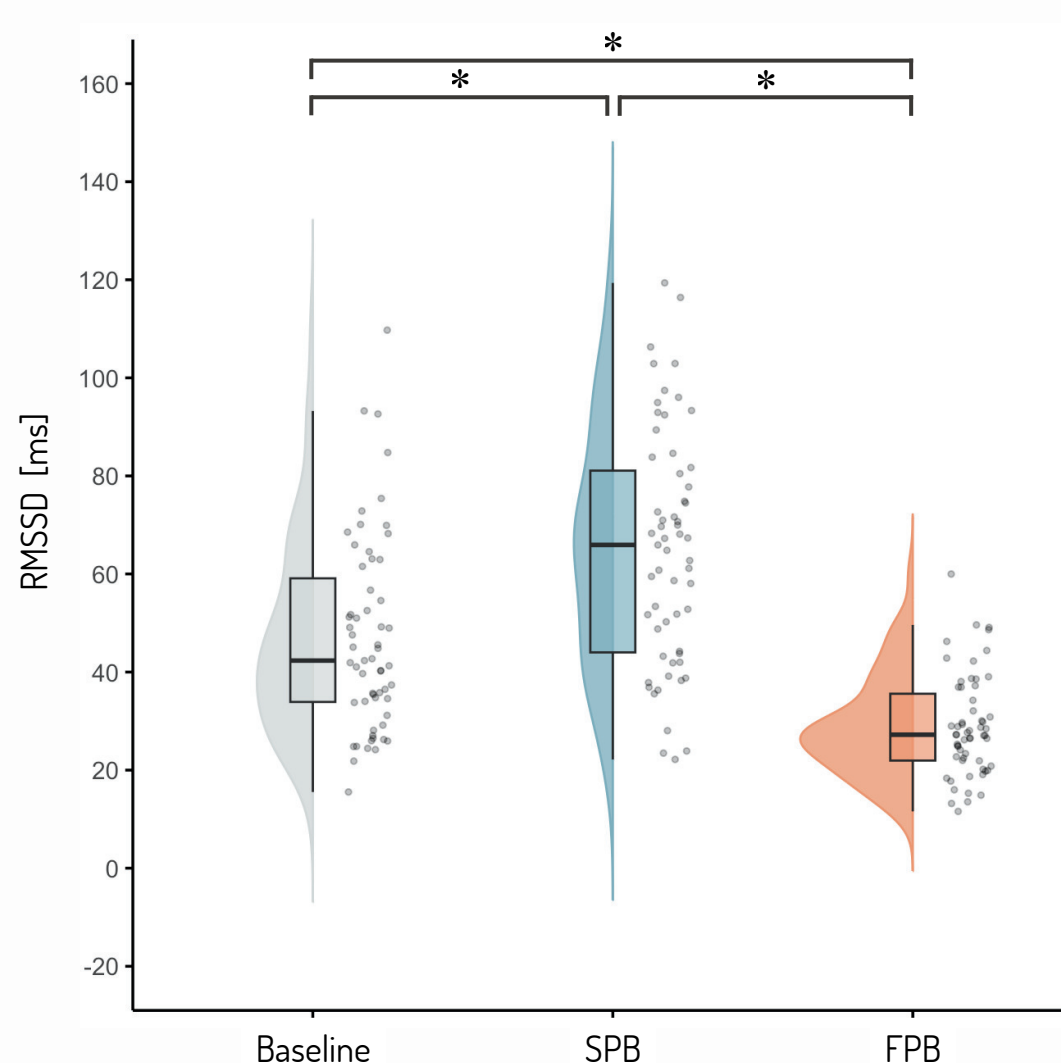
- a closed information board, 4x5 matrix
- choosing one of four options based on five attributes
- context: in the role of a basketball coach, choosing a player to substitute into the match
- low time pressure of 50s/trial



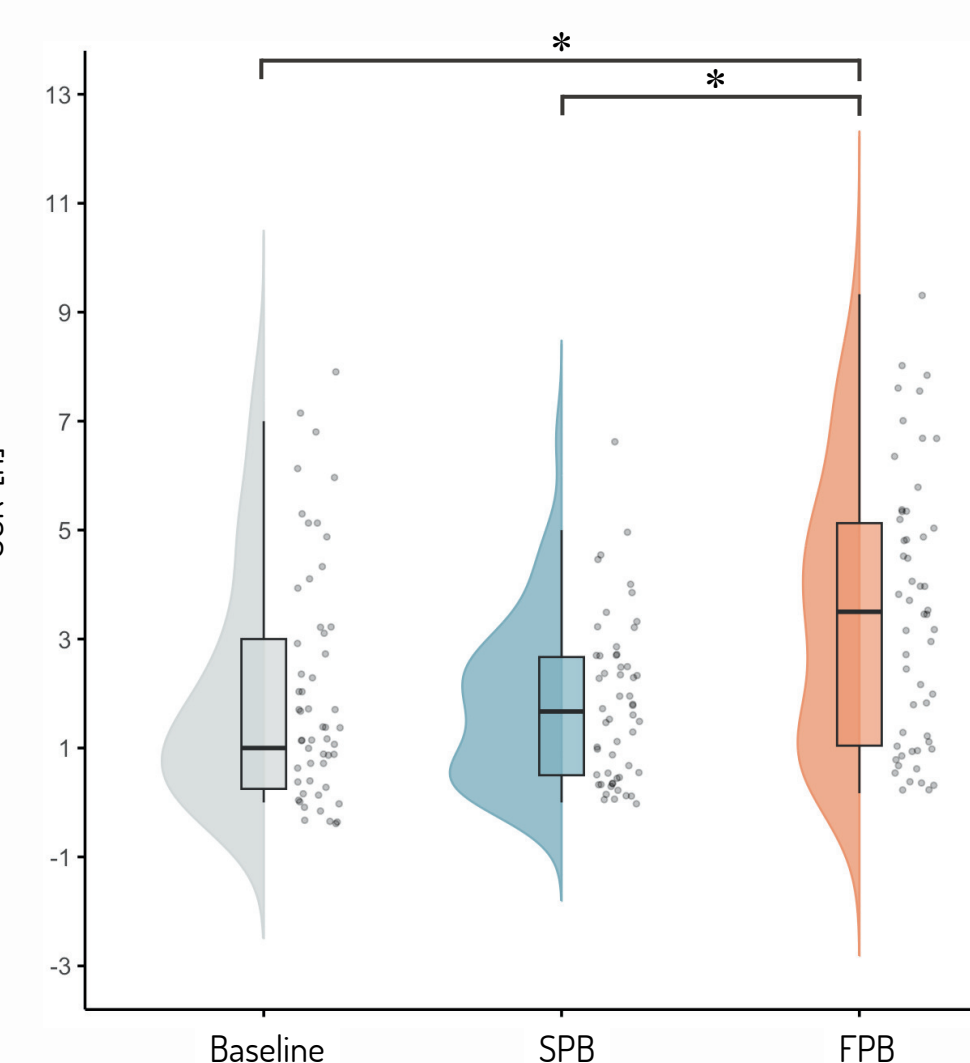
Results

Physiological changes during breath manipulation

A. Heart rate variability

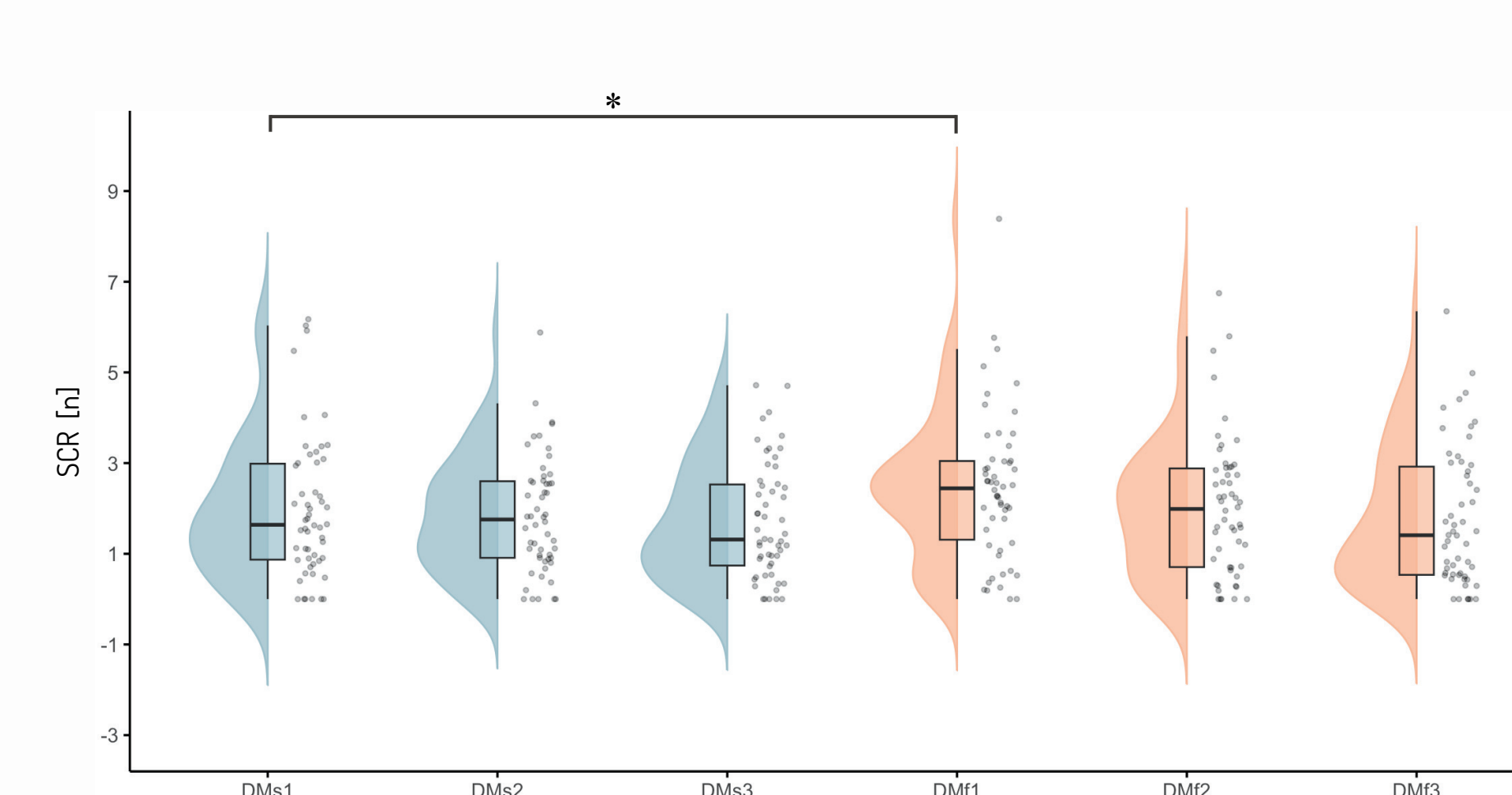


B. Skin conductance response



Physiological changes during decision trials

C. Skin conductance response

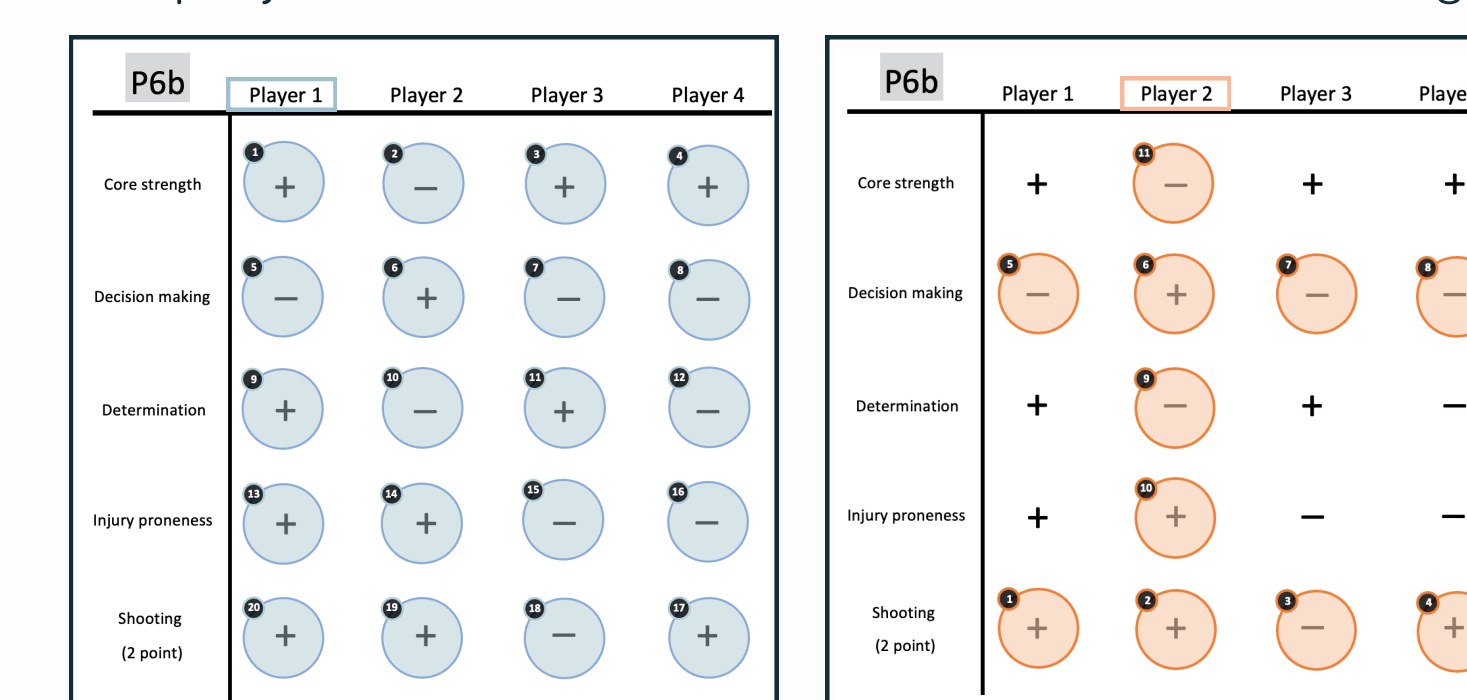


Arousal and valence: Self-reported arousal level was significantly higher in FPB ($M = 5.98$, $SD = 1.98$) than SPB ($M = 2.67$, $SD = 1.49$) condition. $W = 38.50$, $p < .001$, $r_{fb} = 0.95$, 95% CI [0.92, 0.97]. Valence was assessed as neutral to mildly positive, with significantly different values in FPB ($M = 5.56$, $SD = 1.99$) compared to SPB ($M = 6.29$, $SD = 1.82$) condition. $W = 344.50$, $p = .012$, $r_{fb} = 0.41$, 95% CI [0.12, 0.64].

Search: Participants searched quicker through the information board after FPB than SPB, $t(61) = 2.05$, $p = .045$, $d = 0.26$, 95% CI [0.01, 0.51], but opened a similar number of boxes in both conditions, $p = .387$.

Strategy: Participants used heuristic strategies significantly more often after FPB than SPB, $W = 170.50$, $p = .017$, $r_{fb} = 0.46$, 95% CI [0.12, 0.70].

Exemplary search and final choice after SPB (left) and FPB (right)



Discussion

Main findings

- Psychophysiological activation was increased through FPB and decreased through SPB (H1). FPB was evaluated as a **neutral and moderately arousing** stimulus, while SPB was evaluated as a **mildly positive stimulus of low arousal level**.
- Breathing-induced effects were reflected in a higher skin conductance response during the first decision trial that followed FPB compared to SPB.
- Partial support for the ABC predictions¹: while participants did not search more selectively (H2), they did so **faster after FPB**.
→ low time pressure and lack of penalty for exploration
- In line with previous findings², **high psychophysiological activation** led to **increased use of heuristic strategies** (H3).

Limitations

- physiological activation assessed using peripheral measures, lack of data regarding the neural response
- indirect estimation of the search (benefits of adding gaze behavior data)

Future implications

- specifying the mechanism(s) of the respiration-cognition relationship
- clarifying the temporal dynamics of psychophysiological activation
- investigating the activating effects at the motor-cognitive level⁴

Conclusion

Breathing-induced changes in psychophysiological activation influenced the search and choice behavior in a multi-attribute decision task. Fast-paced breathing led to a faster search through the cues and a more frequent use of heuristic strategies compared to slow-paced breathing.

References

- Mather, M., & Sutherland, M. R. (2011). Arousal-biased competition in perception and memory. *Perspectives on Psychological Science*, 6(2), 114-133.
- Wichary, S., Mata, R., & Rieskamp, J. (2016). Probabilistic inferences under emotional stress: how arousal affects decision processes. *Journal of Behavioral Decision Making*, 29(5), 525-538.
- Laborde, S., Allen, M. S., Borges, U., Dosseville, F., Hosang, T. J., Iskra, M., ... & Javelle, F. (2022). Effects of voluntary slow breathing on heart rate and heart rate variability: A systematic review and a meta-analysis. *Neuroscience & Biobehavioral Reviews*, 138, 104711.
- Buchanan, T. L., & Janelle, C. M. (2021). Fast breathing facilitates reaction time and movement time of a memory-guided force pulse. *Human Movement Science*, 76, 102762.