# Meditation-Induced Changes in Subjective Time Are Mediated by Heart-Rate Variability and Breathing Rate

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Related to conceptualizations of a relationship between meditation, subjective time, and psychophysiology, we conducted a study probing for changes in temporal integration after meditation. We employed three psychophysical tasks related to perception of sequence in the milliseconds range, the integration of metronome beats, and the perception of alternations in the ambiguous Necker cube. The tasks were administered before and after the intervention. The 91 participants were experienced mindfulness meditators who in three separate 10 minute sessions either meditated by following a meditation session ($n = 44$) or listened to an audio play ($n = 47$), the three counterbalanced sessions conducted on three separate days. During the intervention heart-rate and breathing rate was recorded and compared to a resting-state condition. Applying path analyses, we found several mediating and moderating effects. Regarding subjective scales, those meditators who were less aware of the passage of time felt less emotional arousal. Regarding psychophysiology and switching of the Necker cube, breathing rate significantly mediated the effect of meditation across all participants, that is, the slower breathing during meditation the slower the switching of the two aspects in the Necker cube. Additionally, a moderator effect showed that trait-mindfulness leads to slower switching times in meditators. Regarding the metronome task, and over all frequencies meditation in more experienced meditators ($n > 100$ hours) lead to a decrease of integration intervals. However, for the fastest (ISI = 0.3 s) and slowest (ISI = 3 s) metronome frequencies an opposite effect occurred: the larger RMSSD during meditation the larger the integration interval. Overall, these findings add evidence to meditation-induced changes in subjective time and the general notion of embodiment of mental functioning.

**Keywords**

Mindfulness meditation, temporal integration, Necker cube, metronome, sequencing

*Acknowledgements*
This work was sponsored by the FUNDAÇÃO Bial, Portugal, through a grant to Marc Wittmann, Stefan Schmidt, and Karin Meissner: "Changes in subjective time as indication of increased mindfulness after meditation".

# The Effect of Focused-Attention Meditation Dosage on Time Perception

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Kramer, Weger and Sharma (2013) have shown that mindfulness-based focused-attention meditation can alter time perception. Using the temporal-bisection task their study showed that an 8-minute meditation intervention led to an overestimate of time compared to a control group listening to an audio clip. The current study was designed to replicate this research and extend it by looking at the effect of different meditation dosages. The length of the meditation intervention was varied in which identical instructions were heard but the duration of the self-practice elements were of 20 seconds, 6 minutes or 12 minutes in three different groups. As in Kramer et al., our study used the same temporal-bisection task where probe durations were compared to "short" (400 ms) or "long" (1600 ms) standard durations. The temporal-bisection task was completed before and after the meditation session. Results show that longer meditation practice times led to participants displaying greater overestimations of time. This supports the previous research and suggests that meditation self-practice is related to these overestimations of time. These results could have implications for the application of mindfulness-based meditative interventions, both in their efficacy and in their duration, for both clinical and everyday participants.

**Keywords**
Focused-attention meditation, meditation duration, mindfulness, temporal bisection

**Reference**

Kramer, R., Weger, U., & Sharma, D. (2013). The effect of mindfulness meditation on time perception. *Conscious. Cogn.*, *22*, 846–852.

# Time Estimation and Body Awareness

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