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Mindfulness meditation and relaxation training increases time sensitivity

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ABSTRACT

Two experiments examined the effect of mindfulness meditation and relaxation on time perception using a temporal bisection task. In Experiment 1, the participants performed a temporal task before and after exercises of mindfulness meditation or relaxation. In Experiment 2, the procedure was similar than that used in Experiment 1, except that the participants were trained to mediate or relax every day over a period of several weeks. The results showed that mindfulness meditation exercises increased sensitivity to time and lengthened perceived time. However, this temporal improvement with meditation exercises was primarily observed in the experienced meditators. Our results also showed the experienced meditators were less anxious than the novice participants, and that the sensitivity to time increased when the level of anxiety decreased. Our results were explained by the practice of mindfulness technique that had developed individuals' abilities in devoting more attention resources to temporal information processing.

1. Introduction

Time and consciousness are intimately entwined (James, 1890). However, few studies have examined the effect on time perception of meditation as a practice that alters the "stream" of consciousness. Some studies suggest that the practice of meditation changes our subjective experience of time, i.e., our attention to the passage of time (Block, 1979; Glicksohn, 2001). However, does it fundamentally modify our perception of time?

There are a wide variety of different meditation techniques. Mindfulness-based meditation is one of the most widely used techniques (Kabat-Zinn, 2003). In the practice of mindfulness, individuals must focus their attention on a chosen object (one-pointed attention), usually on the sensation of breathing. Mindfulness training has two major goals. The first is to access a deep state of calm. The second is to focus attention and awareness on what is happening in one's own body and mind as it happens, that is, in the present moment. Mindfulness therefore changes the relationship with time by focusing individuals' attention on the present moment, by encouraging them to live in the now. Using magneto-encephalography (MEG) recordings, Berkovich-Ohana, Dor-Ziderman, Glicksohn, and Goldstein (2013) recently showed that the change in the sense of time in meditators attempting to be outside of time ("timeless") is associated with a high level of theta activity in the brain (4–13 Hz). This slow cortical activity has often been observed during meditative states (Shapiro, 1980). It is characteristic of a state of deep relaxation, such as a period of light sleep. Individuals' feeling of being outside of time when meditating

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is thus explained by the reduction in arousal level (hypo-arousal). However, the cortical oscillation found in the brain depends on the meditation technique used. When meditators use a mindfulness technique, which consists in concentrating attention on a single object (internal state) while resisting distractors (irrelevant stimuli, anxious memories, negative moods) (Cahn & Polich, 2006), some high-amplitude gamma oscillations (25–42 Hz) are found over the frontal and parietal areas of the brain (e.g., Berkovich-Ohana, Glicksohn, & Goldstein, 2012; Lutz, Greischar, Rawlings, Ricard, & Davidson, 2004). These modulations in gamma activity are interpreted as reflecting an increase in selective attention (Fries, Reynolds, Rorie, & Desimone, 2001). The practice of the mindfulness technique has indeed been shown to improve individuals' attentional control skills, with meditators performing better on different attentional tasks than other participants who have never experienced meditation (e.g., attentional blink paradigm, d2) (e.g., Jha, Krompinger, & Baime, 2007; Moore & Malinowski, 2009; Sauer et al., 2012; Slagter et al., 2007). The question that we need to answer is therefore that of the real nature of the mechanisms (arousal or attention) underlying the effects of meditation on the perception of time.

There is now ample evidence that the perception of time changes as a function of the mechanisms involved, i.e. arousal or attention. According to the internal clock models (Gibbon, 1977; Gibbon, Church, & Meck, 1984; Treisman, 1963), the representation of time results from the number of time units (pulses, temporal oscillations) emitted by an internal clock system and accumulated during the stimulus duration. A slowing down of the internal clock system produced by a decrease in arousal level thus results in a temporal shortening effect. Indeed, when the clock run slower, fewer pulses are accumulated and time is judged shorter. This has been demonstrated in pharmacological studies in which sedatives (e.g., secobarbital, alcohol) have been administered to animals and human adults during time estimation tasks (for a review see Meck, 1996). In contrast, when the amount of attentional resources available for the processing of temporal information increases, time is judged longer and less variable (Brown, 2008; Zakay & Block, 1997). Numerous studies using the dual-task paradigm have demonstrated that time is indeed judged longer when the amount of attention allocated to time processing increases. Stimulus durations are thus judged longer in a single temporal task than in a dual-task, in which the participants must judge the duration of a stimulus while performing another non-temporal task (e.g., Macar, Grondin, & Casini, 1994). The attention-based models (Brown, 2008; Zakay & Block, 1997) explain this lengthening effect in terms of a reduction in the number of temporal units lost when attention is distracted away from time. In summary, an arousal-related slowing down of the clock and an increase in attention resources would have opposite effects on the perception of time.

Only three recent studies have examined the effect of meditation on the ability to process stimulus durations. Recently, Berkowitch-Ohana and her colleagues asked practitioners of mindfulness meditation and control participants to produce long durations (4, 8, 16 and 32 s) before and after a 15-min meditation session (Berkovich-Ohana, Glicksohn, & Goldstein, 2011; Berkovich-Ohana et al., 2012). The results showed that the meditators produced longer durations than the control participants. The authors therefore explained their findings in terms of a change in the meditators' subjective experience of "now" which was linked to a dilatation of the passage of time. However, in this study, there was no effect of the meditation exercise *per se*, thus suggesting that the difference between the temporal productions of the meditators and the other participants resulted from a "personality trait" specific to the meditators rather than from the activation of a meditative state during the session which would have affected the subsequent processing of time. However, if this is indeed the case, then the mechanisms underlying the production of longer durations in the meditators are far from clear. These results cannot be explained in terms of a lower rate of functioning of the meditators' internal clocks because the internal clock is recalibrated over time (Droit-Volet & Meck, 2007).

Other processes, probably related to consciousness, must therefore be considered as Glicksohn (2001) has argued. However, consciousness is closely linked to attentional processes. The practice of meditation has been shown to develop individuals' awareness, defined as an individual ability to voluntarily orient attention toward specific ongoing information (internal-oriented attention). Using a temporal bisection task, Kramer, Weger, and Sharma (2013) recently showed that the practice of a 10-min mindfulness exercise lengthened the perception of time in participants who had no prior experience of meditation. In their study, the participants were initially presented with a short (S) (0.4 s) and a long standard duration (L) (1.6 s). They then had to judge whether comparison durations of the same or of intermediate values were more similar to S or L. The participants performed this temporal bisection task before and after the mindfulness exercise. The results showed that the psychophysical function was shifted toward the left in the bisection task performed after the meditation exercise compared to that before the meditation exercise, thus lowering the point of subjective equality (Bisection Point) in a way which is consistent with a lengthening effect. The authors logically attributed their results to the meditation exercises which would have induced attentional control activities in their participants, who would consequently have paid more attention to time after than before the meditation exercise. The hypothesis is therefore that attention-related mechanisms account for the effects of meditation on the perception of time. To further test this hypothesis, we decided to examine the effect of a mindfulness exercise on the perception of time in a bisection task with longer durations (S = 4 s) than those used by Kramer et al. (2013) and whose processing requires a higher level of attention. In addition, we used a difficult temporal discrimination task, with a small ratio between S and L of 2:3 (S = 4, L = 6 s) as well as an easier temporal discrimination task with a larger ratio of 1:2 (S = 4, L = 8 s). Moreover, the mindfulness exercise was compared with a relaxation exercise in order to test the specificity of the effect of the mindfulness technique on the perception of time. The levels of arousal and anxiety induced by these two types of exercises were also assessed using self-reported scales at the beginning and the end of the experimental session. Our hypothesis was that the meditation exercise should lengthen time estimates and reduce their variability, especially in the difficult temporal discrimination condition.