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Meditation-induced states predict attentional control over time

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ABSTRACT

Meditation is becoming an increasingly popular topic for scientific research and various effects of extensive meditation practice (ranging from weeks to several years) on cognitive processes have been demonstrated. Here we show that extensive practice may not be necessary to achieve those effects. Healthy adult non-meditators underwent a brief single session of either *focused attention meditation* (*FAM*), which is assumed to increase top-down control, or *open monitoring meditation* (*OMM*), which is assumed to weaken top-down control, before performing an Attentional Blink (AB) task – which assesses the efficiency of allocating attention over time. The size of the AB was considerably smaller after OMM than after FAM, which suggests that engaging in meditation immediately creates a cognitive-control state that has a specific impact on how people allocate their attention over time.

1. Introduction

Even though many people still view meditation as a technique primarily intended for relaxation and wellbeing, numerous studies have shown that meditation alters various affective and cognitive processes. Indeed, meditation has substantial effects on how people perceive and process their physical and social environment and how they regulate attention and emotion (for reviews, see Lippelt, Hommel, & Colzato, 2014; Lutz, Slagter, Dunne, & Davidson, 2008). Moreover, by reducing anxiety, meditation may enhance efficient functioning of the goal-directed attentional system and reduce the extent to which processing is influenced by the stimulus-driven attentional system (Eysenck, Derakshan, Santos, & Calvo, 2007). However, all meditation techniques are not equal – neither in terms of their goals nor in terms of their effects. Lutz et al. (2008) and more recently Lippelt et al. (2014) have distinguished between two general meditation practices: Focused attention meditation (FAM) and Open monitoring meditation (OMM), which are likely to exert differential effects on attentional control.

During FAM, practitioners are required to focus attention on a chosen object or event, such as a candle flame or breathing. To sustain this focus, the practitioner has to constantly monitor the concentration on the chosen event to avoid mind wandering (Tops, Boksem, Quirin, IJzerman, & Koole, 2014). During OMM, instead the focus of the meditation becomes the monitoring of awareness itself (Lutz et al., 2008; Vago & Silbersweig, 2012), and there is no internal or external object or event that the meditator has to focus on. These different aims of the two techniques have been found to be associated with different effects on cognitive, affective, and neural processing. For instance, OM meditators have been found to outperform FAM practitioners in a sustained attention task when the target stimulus was unexpected (Valentine & Sweet, 1999). This might indicate that the OMM practitioners had a wider attentional scope, even though the two practitioners groups did not differ in

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performance when the stimulus was expected. Electrophysiological evidence for meditation-induced improvements in attention comes from a recent study in which Vipassana (i.e., OMM-style) meditators performed an auditory oddball task before and after meditation (in one session) and random thinking (in another session) (Delgado-Pastor, Perakakis, Subramanya, Telles, & Vila, 2013). Meditators showed greater P3b amplitudes to target tones after meditation than either before meditation or after the no-meditation session, an effect that is thought to reflect enhanced attentional engagement during the task.

These and other differential effects of the two meditation types on information processing have motivated the hypothesis that they engage different cognitive-control styles (Lippelt et al., 2014): While FAM induces a single-channel processing mode that strengthens top-down support for relevant information and/or increases local competition between relevant and irrelevant information (Duncan, Humphreys, & Ward, 1997), OMM induces a more parallel processing mode in which top-down support and/or local competition are reduced. Consistent with this idea, while the size of the Simon effect (reflecting the efficiency of handling response conflict) was unaffected by type of meditation, the amount of dynamic behavioral adjustments (i.e., trial-to-trial variability of the Simon effect: the Gratton effect) were shown to be considerably smaller after OMM than after FAM (Colzato, Sellaro, Samara, & Hommel, 2015). In the present study, we will test the control style hypothesis in the context of visual attention.

So far, the literature has focused on long-term effects of meditation. In a seminal study, Slagter et al. (2007) investigated the effects of 3 months of intensive Vipassana (i.e., OMM-style) meditation training on the allocation of attention over time as indexed by the "attentional-blink (AB)" – when two target stimuli (T1 and T2) embedded in a rapid stream of events are presented in close temporal proximity, the second target stimulus is often not noticed. This effect is thought to result from competition between the two target stimuli for limited attentional resources (Raymond, Shapiro, & Arnell, 1992). After the training, participants showed a smaller AB, suggesting that they were more efficient in allocating their attentional resources to the processing of T1 and T2. The reduced AB was accompanied by a smaller T1-elicited P3b, the above-mentioned brain-potential thought to index attentional resource allocation. van Leeuwen, Müller, and Melloni (2009) found age-(and/or practice-)related effects of long-term meditation. In line with these results, only the older and very experienced meditators (on average 10,704 h of experience) showed a smaller AB during OMM than during FAM (van Vugt & Slagter, 2014). However, as the two kinds of meditations were performed in the same experimental session, the lack of an effect in less experienced meditators may be due to carry over effects or the failure to distinguish between FAM- and OMM-related activities.

While these observations provide evidence that meditation can affect attentional control, one can ask whether this impact really requires so much practice. In fact, if it is really the case that particular kinds of meditation engage specific cognitive-control styles (Lippelt et al., 2014), it should be possible to demonstrate that meditation immediately induces control states that immediately impact behavior. Let us consider how control states may be systematically modulated by FAM and OMM, respectively. As elaborated elsewhere (Hommel, 2012), biologically plausible models of decision-making (for a review, see Bogacz, 2007) share two basic ingredients: mutual inhibition between representations of alternatives, such as A and B in the Fig. 1, and top-down support for goal-compatible alternatives (e.g., Duncan et al., 1997; see A in our example). Following the reasoning of Colzato, Ozturk, and Hommel (2012; Colzato et al., 2015), control policies can be expected to modulate the strength of the top-down bias (control route 1) and/or local competition (control route 2; see Hommel, 2012). If so, the strong emphasis on focusing and the exclusion of irrelevant thoughts in FAM would be expected to induce an increase of top-down bias and/or local competition, while the emphasis on openness and lack of exclusion in OMM would be expected to induce a decrease of bias and competition. In other words, FAM should establish a rather "serial", "exclusive" control mode that would lead individuals to select one target at the time, while OMM should establish a rather "parallel",

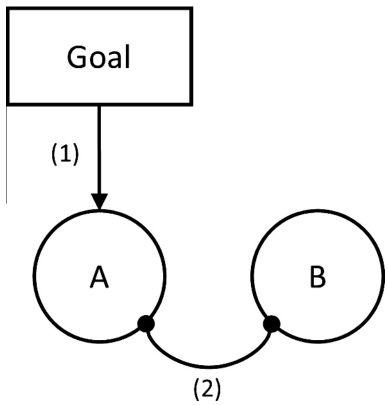

Fig. 1. Possible mechanisms involved in decision making. The goal-relevant alternative A is supported by the goal representation (1) but competes with choice alternative B through mutual inhibition (2). Thus, in addition to the competition, bias is provided by the goal. In the case of the AB, OMM might induce weak top-down control and/or reduced local competition and establish a rather "parallel" control mode that supports the selection of multiple targets, which should lead to a smaller AB; FAM would have the opposite effect.