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Research report

Impact of short-term meditation and expectation on executive brain functions

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HIGHLIGHTS

- We examined expectations and framing processes in short-term meditation.
- A credible expectation control group was implemented.
- Suggestions modulated executive functioning: positive ones increased Stroop performance, negative did not.
- Suggestions modulated the small effect of meditation on verbal fluency.

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ABSTRACT

Meditation improves executive functions such as attention and working memory processes. However, it remains unclear to what extent contextual effects contribute to these improvements, since the role of meditation-associated expectations has not been investigated so far. In a randomized, single-blind, deceptive, between-subject design we compared the impact of short-term meditation (MG) on executive functioning with an expectation (ECG) and a passive control group (CG) as well as the effect of positive and negative outcome expectations. Fifty-nine healthy meditation-naïve volunteers participated on three consecutive days (20 min/session). Five groups were examined: 2 MGs, 2 ECGs and 1CG. While one MG and one ECG were given positive suggestions concerning the effect of meditation on attention, the other two groups were given negative suggestions. MGs practised a focused attention meditation technique; ECGs were told that they were practising meditation but were given instructions for a sham meditation. CG participants sat in silence with their eyes closed. Interference control (Stroop task), selective sustained attention (d2 task), figural and verbal fluency measures of executive functions were assessed. Results indicate that suggestions have a substantial impact on interference control and verbal fluency, with positive suggestions leading to an increase in performance, whereas negative suggestions impeded improvement. This proof of concept study demonstrates the importance of the implementation of a credible ECG to elucidate context effects in meditation processes. It also indicates that suggestions can modulate the small effect of meditation on verbal fluency.

1. Introduction

A growing body of evidence suggests that meditation practice can enhance self-regulation [18], boost various cognitive processes such as memory, attention and executive functions [11] and positively modify the underlying brain structure [16,28,49] and function [7,19,50,52]. It leads to facilitated attentional processing [23,44] and to improved filter mechanisms [22]. Moreover, meditators exhibited increased performance in all executive functions such as selective sustained attention [32,34,43], interference control [10,34,52], working memory [35,56], as well as in verbal fluency [56]. A meta-analysis [13] reported a medium effect size for the effect of meditation on attention.

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Most of the studies examined either intensive meditation training over several weeks or experienced meditators using cross-sectional designs [11]. The few studies that have investigated the influence of short-term meditation practice provide initial evidence of the beneficial effects on cognitive variables. For example, increased performance on the Stroop task was shown after three days [55] of 20-min meditation sessions, but not after two days of 15-min sessions [37]. Similarly, improvements in working-memory (n-Back task) and verbal fluency after four 20-min sessions [56] were reported. Finally, participants practising integrative body-mind training showed improved executive attention (attention network test, ANT) after five days of 20-min sessions [51].

While these convergent lines of evidence clearly demonstrate that the attention faculty is subject to neuroplastic changes and therefore trainable, it remains unclear if and as to what extent contextual effects, such as meditation-associated expectations, contribute to these improvements. An important methodological problem is the use of inactive control conditions such as passive wait-list control groups. Only a few studies implemented active control groups, such as relaxation training [43], stress reduction [21], music training [48], health enhancement program [30,41] or cognitive tasks [55]. However, to distinguish between the specific and non-specific effects of meditation, it is essential to control for the influence of expectations, which ideally should be equivalent between compared treatments. Meditation is currently omnipresent and it can be assumed that people have implicit or even specific expectations with regard to meditation and its potential benefits such as stress reduction, relaxation or enhanced concentration. So far, only one study has addressed this challenge and tested the influence of a breathing exercise deceptively labelled as meditation for a sham meditation group on mood and cardiovascular measures [57]. While meditation led to a stronger reduction in negative mood and heart rate, sham meditation only reduced tension and state anxiety, but to a lesser degree as the real meditation. Nevertheless, an analogue approach for the cognitive domain is missing. Bearing in mind that expectations have repeatedly been demonstrated to have measurable psychobiological effects [4,25,26], control conditions with equal expectations are needed to disentangle contextual from the specific treatment effects [6].

While the above mentioned sham meditation could be a potential remedy, it has the disadvantage of involving a central active element. Alternatively, studies could control for expectations by changing the labels of the meditation methods, for example into “Benson Technique” [43] and “guided attention practice” [37]. However, generalizability is still limited because the usual meditation-associated expectations are missing. To specify their contribution to the overall effects of meditation, one has to introduce an additional group with the common label. [14] showed that the labelling of hypnosis induction, either as relaxation or as hypnosis had more influence on suggestibility than the induction itself. This method could be transferred to meditation research. One could either use groups that practise the same meditation method but are labelled differently, or manipulate the expectations by delivering different suggestions about the effect of meditation.

We therefore set out to compare the effects of short-term focused attention meditation with an expectation and an additional passive control group on executive functioning (Stroop task, d2, verbal and figural fluency) in healthy meditation-naïve participants. Furthermore, we investigated the effect of positive versus negative outcome expectations. We hypothesized that (1) executive functioning, in particular Stroop interference control, is improved by short-term meditation and that (2a) expectation manipulation via positive suggestion boosts, while (2b) negative suggestions worsen these effects.

2. Material and methods

2.1. Recruitment and participants

Sixty healthy volunteers (47 female, 13 male) aged between 18 and 78 (mean = 28.6 SD = 11.4) with broad professional and educational backgrounds were included in the study.

The participants were recruited by flyers distributed throughout the city of Basel (e.g., in cafes/bars, museums, the university etc.) and by advertising in Internet forums. The advertisement described the experiment as a study examining the influence of meditation on cognitive processes in healthy volunteers with no experience of meditation. Exclusion criteria were as follows: prior meditation experience, color blindness, motor impairment of writing hand, impaired visual acuity, attention deficit hyperactivity disorder, psychological/psychiatric treatment, drug consumption, or current use of central nervous system medication. Participants obtained no remuneration for their attendance. The study was conducted in accordance with the Declaration of Helsinki and approved by the Local Ethics Committee of Canton Basel, Switzerland.

2.2. Interventions

2.2.1. Meditation

For the study we used mindfulness of breathing, which can be very beneficial for the development of attentional balance [54]. It is recommended for the first four stages of shamatha training and is also found in Zen, Vipassana, Tibetan Buddhism [54] and in a variety of modern mindfulness-based interventions [33]. The participants were told to focus their attention on breathing sensations, while ignoring distractions (e.g., thoughts). At the beginning they were invited to close their eyes, to feel the temperature of their body, their feet and the pressure caused by the sitting position. Subsequently, they were instructed to feel their breathing sensations (between the upper lip and the entrance to the nostrils) and whenever their mind wandered, to come back to an awareness of the breathing sensations. The beginning and the end of the session in all groups were marked by the sound of cymbals. At the end of the session, participants were again invited to feel the temperature of their body, their feet and the pressure caused by the sitting position. Introduction, training and the supervision of this technique were provided by an experienced teacher with more than 25 years of meditation experience.

2.2.2. Expectation control

Participants in the expectation control groups were told to practise a simple and basic meditation technique, with the goal of simply being present in the here and now and setting all other activity aside. It was stressed that nothing had to be carried out or achieved. The instructions matched those of the meditation groups, except that participants in the real meditation groups were instructed to direct their attention back to their breathing sensations, while volunteers in the expectation control groups were simply asked to come back to the here and now. Thus, while the expectation control groups were only informed about the goal of the meditation but not provided with any method, the meditation groups were given a method to achieve it. The introduction and instructions were provided by the same teacher who led the meditation groups.

2.2.3. Control

The participants of the control group just sat in silence on a chair with their eyes closed. They were aware that they were not practising meditation. The use of the word ‘control group’ was avoided, to prevent a negative motivational impact. The following description was delivered in order to highlight the importance of this group: “A