Consciousness and Cognition 21 (2012) 1016–1022

Contents lists available at SciVerse ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Short Communication

Mindfulness meditation counteracts self-control depletion

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ARTICLE INFO

Article history:
Received 29 August 2011
Available online 5 February 2012

Keywords:
Self-control depletion
Mindfulness meditation
Emotion suppression
Attention control

ABSTRACT

Mindfulness meditation describes a set of different mental techniques to train attention and awareness. Trait mindfulness and extended mindfulness interventions can benefit self-control. The present study investigated the short-term consequences of mindfulness meditation under conditions of limited self-control resources. Specifically, we hypothesized that a brief period of mindfulness meditation would counteract the deleterious effect that the exertion of self-control has on subsequent self-control performance. Participants who had been depleted of self-control resources by an emotion suppression task showed decrements in self-control performance as compared to participants who had not suppressed emotions. However, participants who had meditated after emotion suppression performed equally well on the subsequent self-control task as participants who had not exerted self-control previously. This finding suggests that a brief period of mindfulness meditation may serve as a quick and efficient strategy to foster self-control under conditions of low resources.

1. Introduction

The literature on self-control depletion draws an unflattering picture of individuals low in self-control resources. They break their diets more readily (Vohs & Heatherton, 2000), give in to the allure of alcohol more easily (Muraven, Collins, & Nienhaus, 2002), cheat more often (Mead, Baumeister, Gino, Schweitzer, & Ariely, 2009), manage their emotions less efficiently (Muraven, Tice, & Baumeister, 1998), perform poorer on intellectual tasks (Schmeichel, Vohs, & Baumeister, 2003), and spend more money on impulse (Vohs & Faber, 2007) as compared to individuals with more resources.

The psychological literature suggests that self-control failures contribute to many individual and societal problems such as obesity, drug use, aggression, unwanted pregnancies, or crime, to name just a few (for overviews, see Baumeister, Heatherton, & Tice, 1994; Vohs & Baumeister, 2011). Given the far-reaching consequences of self-control failures, one important challenge is to identify means fostering self-control even under conditions of low resources. The aim of the present study is to test the idea that a brief period of mindfulness meditation counteracts the deleterious effects of self-control depletion.

The strength model of self-control by Baumeister and colleagues posits that self-control in different domains relies on a common, limited resource (Baumeister, Schmeichel, & Vohs, 2007a; Baumeister, Vohs, & Tice, 2007b). According to this model, exerting self-control in one domain depletes this resource to a certain extent and increases chances of self-control failure in any other task requiring self-control thereafter. A host of studies delivered evidence consistent with this model (see Hagger, Wood, Stiff, & Chatzisarantis, 2010, for a recent meta-analysis).

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doi:10.1016/j.concog.2012.01.008

In light of the considerable consequences of self-control failures, researchers have recently begun to investigate the psychological and physiological processes that allow for good self-control even under conditions of low resources. Gailliot and colleagues (2007) showed that a dose of glucose improves self-control. The administration of glucose may be a reasonable strategy to improve self-control if the glucose derives from healthy products. Typically, healthy products contain glucose from polysaccharides. The metabolism requires considerable time to actually make glucose available from polysaccharides, which prevents many healthy products from serving as a quick counterstrategy to self-control depletion. More fast-acting glucose (from monosaccharides or disaccharides) is contained in many unhealthy sweet snacks or drinks that are often consumed in addition to one's regular diet. Therefore, the consumption of high-energy sweet snacks may not be a wise strategy to counter self-control depletion in the long run. However, not only glucose consumption counteracts low resources, but also internal psychological processes. An abstract information-processing mode activates and leads to a focus on personal standards and values, which in turn fosters self-control (Agrawal & Wan, 2009; Baumeister, DeWall, Ciarocco, & Twenge, 2005). For example, participants who had thought and written about one of their core values after having been depleted of self-control resources persisted longer on a tedious task (a numeric puzzle) than participants who had thought and written about the values of a different person (Schmeichel & Vohs, 2009).

In the present study, we investigated the possibility that a brief period of mindfulness meditation may be another way to boost self-control after resource depletion. Mindfulness meditation has been incorporated into several psychological interventions in medical and mental health settings with good efficacy (e.g., Baer, 2003; Grossman, Niemann, Schmidt, & Walach, 2004; Hayes, 2004; Hoelzel et al., 2011; Kabat-Zinn, 1990) and in self-directed meditation trainings for laypersons in western cultures.

In mindfulness meditation, meditators strive to bring their complete attention to the present moment in a non-judgmental, accepting way (Kabat-Zinn, 1990). In a successful mindfulness meditation, meditators experience current feelings, thoughts, and bodily sensations with all senses very clearly and plainly, as something that passes by, without judging or evaluating it, and without having to act on these sensations. In a typical mindfulness exercise, meditators aim to focus their attention on a particular experience and become fully aware of this experience such as one's breath and the sensations it evokes in various parts of the body. Practiced regularly over a longer time span of months and even years, this state of mindfulness is considered to convert into a stable, dispositional tendency to be mindful (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Brown, Ryan, & Creswell, 2007).

The effects of mindfulness meditation have mostly been investigated in the context of clinical practice and research where it has been proven useful for a great number of psychological disorders and well-being in general (for an overview, see Brown et al., 2007). In recent years, growing evidence suggests that mindfulness meditation may also be beneficial for mechanisms involved in self-control. For example, it has been shown to improve emotion regulation (Baer, Smith, & Allen, 2004; Brown & Ryan, 2003) and aspects of attention regulation (Hodgins & Adair, 2010; Jha, Krompinger, & Baime, 2007), which is a crucial aspect of self-control processes (Baumeister et al., 1994; Metcalfe & Mischel, 1999). In addition, it is associated with improvements in executive functioning such as working memory and response inhibition (Chan & Woollacott, 2007; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010) that subsequently led to improved socioemotional functioning and emotion regulation (Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010; Sahdra et al., 2011). More generally, there is preliminary evidence that meditation training can result in increased control and more efficient use of limited brain resources (Slagter et al., 2007).

Most of the published work has investigated the effects of mindfulness as a trait (as assessed with established mindfulness inventories, e.g., Baer et al., 2006; Brown & Ryan, 2003), often comparing experienced meditators with non-meditators, or employed meditation interventions usually lasting over periods of several weeks or months that compared the effects of these interventions with control groups (e.g., waiting lists; Brown et al., 2007; Hölzel et al., 2011). Much less research has investigated the effect of brief mindfulness interventions (lasting only several minutes) on various indicators of emotional, cognitive, and behavioral functioning (Brown et al., 2007). Some of these studies support the idea that even briefly introduced states of mindfulness could foster self-control. For example, participants who had engaged in a brief mindfulness meditation exercise showed a reduced negativity to repetitive thoughts (Feldman, Greeson, & Senville, 2010), a reduced dysphoric mood compared to a rumination and a distraction control groups (Broderick, 2005), and better emotion regulation as indicated by lower self-reported negative affect in response to negative pictures and a greater willingness to expose oneself to negative pictures (Arch & Craske, 2006, see also Erisman & Roemer, 2010).

Most relevant for present purposes are two studies that can be interpreted as reporting preliminary evidence for an improved ability to control a dominant response tendency after a mindfulness induction. First, a 9-min focused breathing exercise led to less spider-avoiding behavior as compared to control conditions in spider fearful participants (Hooper, Davies, Davies, & McHugh, 2011). Second, participants who were made mindful by means of a raisin-eating task (Kabat-Zinn, 1990) displayed less aggressive behavior after a social-rejection feedback than participants in a control condition, withstanding a possible impulse to aggress against the person who delivered the negative feedback (Heppner et al., 2008).

In sum, growing evidence demonstrates relations of trait mindfulness and mindfulness training studies on outcomes associated with executive functioning and self-control. Additional preliminary evidence points to the possibility that even very brief mindfulness manipulations may temporarily foster self-control. The present study adds to this work by focusing on the immediate effects of mindfulness meditation on self-control. That is, we investigated effects of a single, brief period of mindfulness meditation on self-control performance. Importantly, while extant research has focused on the effects of mindfulness under 'normal' conditions, the present research adds a dynamic element by examining the potential benefits of

mindfulness on self-control performance specifically under conditions of low resources. Under such conditions, self-control success is at risk (Baumeister et al., 2007a, 2007b), and individuals are in particular need for an efficient stewardship of resources. Even though prior research in the context of the strength model of self-control suggests that it is often difficult for brief experimental manipulations to foster self-control for participants with full resources (e.g., Gailliot et al., 2007; Muraven & Slessareva, 2003; Schmeichel & Vohs, 2009; Tice, Baumeister, Shmueli, & Muraven, 2007), we assumed that a bolstering effect would be observable after self-control had been temporarily weakened.

The idea that meditation may be an appropriate means to counteract self-control depletion is also corroborated by work on Attention Restoration Theory (Kaplan, 1995). Based on research showing that meditation can change activity in brain areas implicated in self-control (e.g., Cahn & Polich, 2006; Tang et al., 2007), Kaplan (2001) proposed (but did not test) the hypothesis that a brief period of meditation would restore the ability for directed attention, a construct closely related to self-control resources (Kaplan & Berman, 2010).

In sum, we hypothesized that a brief period of mindfulness meditation would counteract the effects of self-control depletion. To this end, we approached participants of a 3-day introductory seminar on mindfulness meditation and asked them to take part in a short psychological study. We expected that participants who had exerted self-control (suppressing emotions) would perform worse on a subsequent self-control task as compared to participants in a control condition. We further assumed that participants who had meditated after emotion suppression would show less performance impairment than participants who had not meditated.

2. Method

2.1. Participants and design

Sixty-six participants (M_{age} = 43.27, SD_{age} = 11.91, 40 women) were assigned to one of three conditions: 'no emotion suppression', 'emotion suppression' and 'emotion suppression plus meditation'. They received a chocolate bar in return. There were no significant differences between conditions in terms of age ($F < 1$, $p > .55$) or gender ($\chi^2 = 1.78$, $p = .411$).

2.2. Procedure

Participants were approached at the end of the second day of a 3-day introductory meditation seminar in various German and Swiss cities. In these seminars, participants learned basic meditative skills such as relaxing, attending to and accepting ongoing thoughts, feelings, or sensations, visualizing, and using intuition (Bishop et al., 2004; Hölzel et al., 2011). The aim of the seminar was to teach participants skills to allow them to reach physical and mental relaxation and reduce stress with the means of various mental techniques. An experienced instructor guided participants through various meditation exercises before they had in turn the opportunity to practice each of these exercises independently. A particular focus lay on mindfulness meditation exercises in which participants learned to become aware of and direct their attention to sensations and experiences that they usually did not attend to. For example, they learned to attend to the sensations of their chest moving with the rhythm of breathing, focusing attention on this experience and redirecting attention to these sensations whenever it had turned to something different. Similar exercises dealt with sensations and observations of certain muscles (e.g., in the neck, the arms) in different bodily positions such as a comfortable sitting position or lying on a mattress on the floor. In addition, they were guided through a mental tour to become aware of things in their lives that they were particularly comfortable with at that point in time, or particularly uncomfortable, what was important in their lives and what was less important with the aim of finding acceptance and clarity for issues that felt previously unresolved. The seminars were independent from ideological, philosophical, or religious organizations.

On the second day, at the end of the official seminar agenda and with the consent of the course leader, the experimenter asked seminar attendants whether they would participate in a research study. Participants took part in groups of seven to seventeen. They were assigned to one of three experimental conditions. First, participants completed the resource manipulation task. Then, they engaged in an intermediate task for 5 min, which was either a line-drawing task (no emotion suppression and emotion suppression conditions) or meditation (emotion suppression plus meditation condition). Finally, all participants completed a version of the *d2 Test of Attention* (Brickenkamp, 1981) as the measure of self-control depletion, provided demographic information and were debriefed.

2.3. Materials

2.3.1. Manipulation of self-control resources

A sequence of five video spots (6.5 min in total) taken from www.youtube.com was shown to each group of participants via a silver screen. All spots were intended to elicit disgust emotions in participants by showing, for example, a doctor pulling a nymph out of a person's neck, or a close-up of someone squeezing a massive pimple on another person's back. Participants in the no suppression condition were asked to watch the video naturally and to allow all emotions that may arise in response to it. Participants in the suppression and the suppression plus meditation conditions were asked to suppress all emotions that may arise in response to the video so that it would be impossible to tell from their facial expression what they felt.

Emotion suppression has repeatedly been used to deplete self-control resources (Hagger et al., 2010). All instructions were given in writing, not verbally. Despite the assessment in groups, participants were unaware of the other experimental conditions.

2.3.2. Intermediate tasks

Participants in the no suppression and suppression conditions completed up to six connect-the-dots figures in which the connected dots formed mundane objects (e.g., elephant, airplane). The task was chosen to be neither boring nor resource demanding. Participants in the suppression plus meditation condition were asked to meditate following the procedures they had learnt in the seminar. Both intermediate tasks lasted 5 min.

2.3.3. d2 Test of attention

The d2 is a widely established and well-validated standardized test of attention and concentration (Brickenkamp, 1981). The test consists of *d*s and *p*s, which are shown in 14 rows with 47 characters each. Each character is marked with one to four apostrophes on the top and/or at the bottom (e.g., two on the top and two at the bottom in the case of four dashes). Participants are instructed to cross out as many d characters with two apostrophes as possible without committing errors of commission or errors of omission. The d2 test is structurally similar to the "crossing-out-letters task" that is often used in research on the strength model of self-control (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Hagger et al., 2010). It requires the control of attention as the test-takers need to quickly and reliably discriminate between adjacent and similarly looking, but slightly different letters. In addition, the d2 requires inhibitory control as the participants have to inhibit the impulse to cross out very similarly looking *d*s with more or less than two apostrophes and similarly looking *p*s with one to four apostrophes while at the same time they are instructed to go fast and to commit no errors. Thus, with attention and inhibitory control the d2 test draws on two hallmarks of self-control more generally (Baumeister et al., 2007a, 2007b). The d2 has been successfully used previously as a measure of self-control strength (Hui et al., 2009) and performance on the d2 is positively related with long-term meditation experience (Moore & Malinowski, 2009).

Participants started to work on the d2 simultaneously. Every 20 s the experimenter gave a sign and participants started with a new row. Participants were instructed to work as fast as possible without committing errors. We employed the most widely used indicator for overall performance on this test as our dependent variable (i.e., the total number of items processed minus errors, TN-E; Brickenkamp, 1981). However, almost identical results emerged for other indicators of performance such as the total number of items processed (TN) and the concentration performance (CP: TN-errors of commission).

3. Results

3.1. Pretest

An independent pretest with 24 participants showed that it was more exhausting to suppress emotions during the disgust-eliciting films than to let flow emotions (mean of two manipulation check questions: 'How exhausting was it for you to follow the instructions during the film clip?' and 'How much did you have to concentrate to follow the instructions during the film clip?', Cronbach's $\alpha = .85$, 7-point scale ranging from 0 to 6; $M_{\text{no suppress}} = 1.21$, $SD_{\text{no suppress}} = 1.16$; $M_{\text{suppress}} = 3.25$, $SD_{\text{suppress}} = 1.45$; $t(22) = 3.81$, $p = .001$, $d = 1.62$). The same pretest showed that suppressing emotions during the films impaired subsequent performance on the d2-test ($M_{\text{no suppress}} = 561.33$, $SD_{\text{no suppress}} = 53.20$; $M_{\text{suppress}} = 488.92$, $SD_{\text{suppress}} = 95.91$; $t(22) = 2.29$, $p = .032$, $d = 0.98$), indicating that successful performance on the d2 test requires self-control resources.

3.2. Main study

In the main study, d2 performance was analyzed with a one-way between-subjects ANOVA with three conditions (no suppression, suppression, suppression plus meditation). This analysis revealed a significant main effect ($M_{\text{no suppress}} = 462.44$, $SD_{\text{no suppress}} = 72.77$; $M_{\text{suppress}} = 415.92$, $SD_{\text{suppress}} = 65.81$; $M_{\text{sup+med}} = 455.42$, $SD_{\text{sup+med}} = 55.54$; $F(2,63) = 3.50$, $p = .036$, $\eta_p^2 = .100$; see Fig. 1). A priori defined contrast analyses showed that, as expected, emotion suppression led to poorer d2 performance as compared to the no suppression condition ($t(63) = 2.35$, $p = .022$, $d = 0.59$). Corroborating hypotheses further, performance in the suppression plus meditation condition was significantly better than in the suppression condition ($t(63) = 2.16$, $p = .035$, $d = 0.54$) while the no suppression and suppression plus meditation conditions did not differ ($t < 1$, $p = .723$, $d = 0.09$; all analyses two-tailed). Thus, participants who had meditated after emotion suppression showed a similar d2-performance as participants who had not exerted self-control in the first task.

4. Discussion

A brief period of mindfulness meditation counteracted the effects of self-control depletion and led to similar levels of performance on a task requiring self-control as compared to a control condition that did not exert self-control previously. By

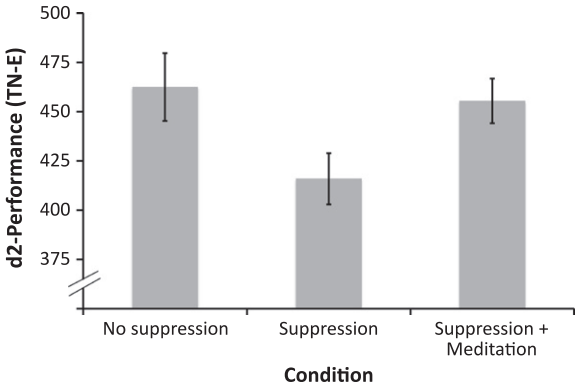

Fig. 1. d2 Performance as a function of condition (no emotion suppression vs. emotion suppression vs. emotion suppression plus meditation). After emotion suppression, participants showed impaired d2 performance as compared to the no emotion suppression condition, but this effect was absent in the emotion suppression plus meditation condition. Error bars indicate standard errors of the mean. TN-E: Total number of items processed minus errors.

contrast, another group that was depleted of self-control resources and subsequently engaged in a number-drawing task instead of mindfulness meditation showed the expected impairment in self-control performance.

This study complements recent research on the effects of mindfulness meditation on attention processes (Hodgins & Adair, 2010; Jha et al., 2007) as it shows beneficial effects of meditation in a task requiring attention control and inhibition. It extends these studies in at least two important ways. First, we investigated an immediate, short-term effect of a brief period of mindfulness meditation as compared to effects after several days, weeks, or months of meditation training, or differences between regular meditators or non-meditators that were not under investigation here. Second, and more centrally, we focused on a context in which individuals are in particular need for an efficient handling of mental resources, that is, after self-control depletion.

These results set the stage for further investigations that will address several critical questions on the relationship between mindfulness meditation and self-control after resource depletion. One critical issue refers to the mediating processes behind the observed effect. While the positive effects of mindfulness in general have been intensively researched in the last two decades, the underlying psychological processes that would allow for a deeper understanding why mindfulness is so broadly beneficial are not yet well understood (e.g., Baer, 2007; Brown et al., 2007; Hoelzel et al., 2011). This is true for the present findings as well. In the following, we speculate about two possible mechanisms that may have contributed to the observed effect. First, a central aspect of mindfulness meditation is to increase awareness of acute inner experiences (e.g., Bishop et al., 2004; Brown et al., 2007). Increased self-awareness in turn has been shown to reduce the deleterious effects of self-control depletion (Alberts, Martijn, & de Vries, 2011), leading to the hypothesis that self-awareness may have been one mechanism that can account for the present findings. Second, mindfulness meditation may have led to a feeling of deep relaxation (Baer, 2003), which could have helped to boost self-control performance thereafter (Tyler & Burns, 2008). Even though both of these potential mechanisms may turn out to have some explanatory value, it is conceivable that it may not be a single mechanism that is responsible for the positive effects of mindfulness in the present study, but that there may be different processes contributing jointly, just as a number of different mechanisms have been discussed with respect to the beneficial effects of mindfulness more generally (Brown et al., 2007; Hölzel et al., 2011). When investigating these issues it will be important for future research to also employ different initial self-control tasks and different dependent variables in order to find out how generalizable the counteracting effect of mindfulness on self-control depletion is. Although various self-control tasks share a common ground (i.e., that they require self-control), self-control is a multi-faceted construct with different domains (e.g., emotion control, attention control, inhibitory control), in which each task has further specific qualities and requirements (Duckworth & Kern, 2011).

A second important question is how long the beneficial effect of brief meditation periods after self-control depletion will hold up. This is not only relevant from a basic research point of view, but to the same degree for applied contexts in which self-control demands may stretch over considerable time spans. Future research may test this by implementing an unexpected third self-control task, for example, as part of an ostensibly unrelated study. Finally, an interesting possibility is that enduring meditation practice may in the long run help to establish a particularly resource-conserving information-processing mode that may effectively work like a buffer against self-control depletion, because resources are not as easily used up to considerable degrees as in individuals who are not trained in a similar manner. Preliminary supportive evidence for the assumption of resource-efficient information-processing in meditators comes from the previously mentioned neuroscientific work (Slagter et al., 2007), and from behavioral studies showing a reduced tendency to engage in rumination (e.g., Borders, Earleywine, & Jajodia, 2010; Jain et al., 2007), which has been shown to reduce self-control resources (Denson, Pedersen, Friese, Hahm, & Roberts, 2011).

One limitation of the current study is that it did not realize a fully crossed design of self-control depletion and mindfulness meditation. This was due to the field character of the study and the corresponding difficulties of recruiting a sufficient number of participants for four experimental conditions. However, we would like to stress that the realized three experimental

conditions suffice to adequately address the study's research question, namely, the suitability of a brief period of meditation to counteract the effects of self-control depletion. For this endeavor, the missing cell (no depletion/meditation) is the least crucial. Research in the realm of the strength model of self-control suggests that it is difficult for experimental manipulations to raise self-control performance above baseline levels for non-depleted participants (e.g., Gailliot et al., 2007; Muraven & Slessareva, 2003; Schmeichel & Vohs, 2009; Tice et al., 2007). That is not to say that brief manipulations will have no effects on self-control under conditions of high resources. However, it may turn out that self-control performance will profit more readily from brief (mindfulness) manipulations under conditions of low (as compared to high) resources, after a provocation (cf. Heppner et al., 2008), or any other factor that fosters impulsive responding. Future research using a fully crossed design and different intensities of brief mindfulness manipulations will test this speculation.

A second potential limitation of the present study is that participants were attendees of an introductory meditation seminar who had undergone two days of training in the seminar at the time of the data collection and who can be argued to believe in the beneficial effects of meditation. For several reasons we do not think that the characteristics of our sample can account for the findings. First, participants in all experimental conditions were attendees of the seminar. Because we used a between-participants design they were neither aware of the existence nor nature of the respective other experimental conditions. Consequently, the data collection in the context of the seminar suggested to all participants, not just those meditating during the study, that we were interested in effects of meditation. Thus, all participants should have been equally motivated to show the benefits of meditation. Second, in previous research, participants in waiting list control conditions did not show similar effects as meditation groups did (e.g., Grossman et al., 2004; Moyer et al., 2011; Powers, Vording, & Emmelkamp, 2009). This situation structurally resembles the situation of the present study: All participants were generally interested in meditation, but only some actually meditated during the study. Third, there was no indication of less motivation in the non-meditating experimental groups as compared to the meditation group. In addition, the d2 test of attention is difficult to fake (Brickenkamp, 1981) and the results were similar across various indicators of d2-performance. Fourth, previous research on brief mindfulness interventions employing undergraduate samples naïve with respect to meditation found theoretically predicted results (e.g., Arch & Craske, 2006; Heppner et al., 2008). Taken together, the literature suggests that engaging in mindfulness meditation has unique effects that cannot be fully accounted for by previous experience with meditation or beliefs in its positive effects. The findings obtained in the present study are thus unlikely to be due to the specific characteristics of the sample employed.

5. Conclusion

In sum, this study showed the deleterious effect of emotion suppression for performance in a task requiring attention control and inhibition. A brief period of mindfulness meditation counteracted this effect and led to similar performance as in the control condition with full resources. Mindfulness meditation may be an efficient, quick, and healthy way to counteract the short-term effects of self-control depletion.

Acknowledgment

Preparation of this manuscript was supported by a grant from the Fund for the Promotion of Young Academics of the University of Basel to the first author.

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