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## Short Communication

How long is *now* for mindfulness meditators?Sebastian Sauer<sup>a,b,\*</sup>, Jana Lemke<sup>c,e</sup>, Marc Wittmann<sup>d</sup>, Niko Kohls<sup>a,b,e</sup>, Ursula Mochty<sup>f</sup>, Harald Walach<sup>c,e</sup><sup>a</sup> Human Science Center, Ludwig-Maximilians-Universität Munich, Germany<sup>b</sup> Peter Schilffarth Institute, Bad Toelz, Germany<sup>c</sup> Institute of Transcultural Health Studies, Viadrina University, Frankfurt (Oder), Germany<sup>d</sup> Institute for Frontier Areas in Psychology and Mental Health, Freiburg, Germany<sup>e</sup> Brain, Mind, and Healing Program, Samuelli Institute, Alexandria, USA<sup>f</sup> Institute of Medical Psychology and Behavioural Neurobiology, University of Tübingen, Germany

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## ABSTRACT

The experience of the present moment is characterized by an integrative mechanism that fuses successive events into a unitary phenomenological experience with a temporal limit of about 3 s. We hypothesized that proficiency of mindfulness expands the ability to stabilize an ambiguous percept in a bistable image paradigm using the Necker Cube, and that this effect is associated with individual differences in the level of mindfulness. Expanded duration of *nowness* as indicated by the ability to stabilize a bistable image stimulus for a longer period of time may improve cognitive resources and thus be of practical interest. In a sample of  $n = 38$  meditators and  $n = 38$  non-meditators, meditators showed longer duration of subjective *nowness*. This effect was associated with individual mindfulness levels. It is concluded that the subjective *now* can be longer for meditators than for non-meditators, and individual levels of mindfulness may convey this effect.

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## 1. Introduction

Subjective time has been a matter of empirical investigations in the Neurosciences and Psychology over the last 150 years (Pöppel, 1997; Varela, 1999). The experience of the present moment as a central category of temporality is a convincing intuition and it is complemented by findings pointing to the existence of discrete processing epochs that fuse successive events into a unitary experience (Pöppel, 1997; van Wassenhove, 2009; Wittmann, 2009, 2011). A striking example for the integrative mechanism of temporal perception is the perception of metronome beats: we do not hear a train of events, but automatically form temporal gestalts not longer than a few seconds as an accent is perceived on every other or every third beat. Another example of how temporal integration structures perception comes from multistable or ambiguous figures which alternate every few seconds, and where one perspective defines a *moment of nowness* of conscious experience (Metzinger, 2004; Pöppel, 1997; Varela, 1999). Many meditation techniques aim at altering conscious awareness by concentrating on the present moment. Expert meditators such as Buddhist monks experience prolonged stabilization in binocular rivalry up to some minutes (Carter et al., 2005).

Mindfulness as the ability to focus the attention on the present moment with a nonjudgmental attitude is associated with health and emotional regulation (Hollis-Walker & Colosimo, 2011; Sauer, Walach, & Kohls, 2011; Sauer et al., 2011). It can be developed through meditational practices (Falkenström, 2010). Evidence from fMRT studies shows that brain regions involved in attentional and emotion regulation processes, such as the dorsomedial prefrontal cortex and the amygdala, play a role in mindfulness (Frewen et al., 2010). A number of psychological studies corroborate that mindfulness impacts attentional subsystems as shown by the attentional blink paradigm (Slagter et al., 2007), the Attentional Network Test (Jha, Krompinger, & Baime, 2007), or the d2 attention test (Moore & Malinowski, 2009). Since cognitive resources that facilitate attention and working memory resources are pivotal for the processing of temporal perception including the subjective *now*, a neural basis for the influence of mindfulness on temporal processes seems plausible. From a psychological point of view, mindfulness training consists of deliberately staying in the experience of the present moment as long and as continuously as possible (Hollis-Walker & Colosimo, 2011). It may thus be speculated that regular training in mindfulness could in turn lead to a dilation of subjective *nowness*. Given that the temporal borders of subjective *nowness* can be considered to be the restraining borders of *zeitgestalt* perception, increased duration of subjective *nowness* would enable perception and constructions of subjectively novel *zeitgestalts*. Thus, if mindfulness is an avenue for stretching the temporal borders of subjective *nowness*, it could prove to be a tool

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of practical relevance. In summary, we hypothesized that meditation may expand the duration of nowness in Western meditators, and that duration of nowness is associated with individual mindfulness levels.

## 2. Methods

### 2.1. Measures and stimuli

We employed the Necker Cube as a paradigm to investigate temporal dynamics of consciousness such as the subjective nowness (Atmanspacher & Filk, 2010; Kornmeier, Ehm, Bigalke, & Bach, 2007; Meng & Tong, 2004). The Necker Cube is a bistable image that can be perceived in one of two perspectives, either the lower-left face as being in front or the upper-right face as being in front (Fig. 1). Mindfulness was measured using one of the most widely used psychometric scales, the Mindfulness Attention and Awareness Scale (MAAS; Baer, 2011; Brown & Ryan, 2003). The MAAS captures how frequently respondents have the experience of mindlessness described in each of 15 statements using a 6-point Likert scale from 1 (*almost always*) to 6 (*almost never*), where high scores reflect more mindfulness. All items are coded negatively (i.e., opposite of mindfulness). Sample items include “I drive places on ‘automatic pilot’ and then wonder why I went there” and “I rush through activities without being really attentive to them”.

### 2.2. Sample

The sample included  $n = 38$  mindfulness meditation experts (21 female, 17 male) and an age-matched group of  $n = 38$  non-practitioners (28 female, 10 male), recruited in the UK, Germany, and Switzerland. Meditators were trained in either Tibetan, Zen or Diamond Way Buddhism techniques. Mean age was 51 years in both groups. Inclusion criteria were at least 5 years of daily meditation practice for the meditation group, and no meditation experience for the control group.

### 2.3. Procedure and design

The experiment was run computerized either in a laboratory of the University of Northampton or in meditation retreat centres. The procedure consisted of the following steps: Instructions, Practice, Necker Cube block 1 and 2, measurement of self-reported mindfulness (paper–pencil). Duration of each block was 3 min. Participants were first instructed to simply indicate the change of the Necker Cube perspectives during a preset time of 3 min (block 1) by pressing a button in a computerized setting and then were

additionally instructed to hold the perspective as long as possible (block 2). It was expected that meditators show longer reversal times (RevT), i.e., longer duration of perceiving one of the two perspectives. Thus, the design was cross-sectional and quasi-experimental. The study protocol was approved by the ethical committee of one of our institutions.

### 2.4. Analysis

Alpha level was set to 0.05 (two-tailed). RevT that were below 0.1 s (s) or two standard deviations above the mean were excluded to limit the influence of outliers (Whelan, 2010); 12% of trials were excluded on this base (meditators: 3%; non-meditators: 18%). SPSS V19 was used for statistical calculations.

## 3. Results

Mean RevT of each participant is depicted in Fig. 2, for block 1 (panel A: without instruction to hold the perspective), and for block 2, respectively (panel B: with instructions to hold the perspective). Visual inspection suggests that in block 1, RevT between meditators and non-meditators did not differ substantially (meditators:  $M = 4.72$  s,  $SD = 2.17$  s; non-meditators:  $M = 4.49$  s,  $SD = 2.02$  s). By contrast, in block 2, RevT differed substantially between meditators and non-meditators (meditators:  $M = 7.98$  s,  $SD = 3.47$  s; non-meditators:  $M = 6.23$  s,  $SD = 2.54$  s).

An ANOVA with repeated measures showed a significant and substantial main effect of block (within factor;  $F(1,72) = 73.59$ ,  $p < 0.001$ ;  $\eta_{\text{partial}} = 0.51$ ), whereas the main effect of group proved only to be marginally significant (between factor;  $F(1,72) = 3.38$ ,  $p = 0.07$ ;  $\eta_{\text{partial}} = 0.04$ ). In addition, there was a significant interaction effect of block and group of medium size ( $F(1,72) = 6.52$ ,  $p = 0.01$ ;  $\eta_{\text{partial}} = 0.08$ ). Thus, meditators seemed to be able to hold one perspective significantly longer compared to non-meditators when instructed to do so. Correspondingly, two independently computed  $t$ -tests for unpaired samples analyzing intersample group differences for both blocks confirmed that RevT differed significantly in block 2 (Fig. 3;  $t(73) = -2.50$ ;  $p = 0.02$ ;  $d = 0.58$ ) but not in block 1 (Fig. 3;  $t(72) = -0.47$ ;  $p = 0.64$ ;  $d = 0.11$ ).

To assess the influence of self-reported mindfulness on RevT, we performed a correlation analysis. Self-reported mindfulness correlated with longer RevT both in block 1 ( $r = 0.23$ ;  $p = 0.049$ ) and in block 2 ( $r = 0.29$ ;  $p = 0.01$ ), suggesting that individual mindfulness levels, and not only maintenance of mindfulness practice, are related to RevT. The effect of mindfulness is validated by the fact that the mean mindfulness level in the meditation group ( $M = 4.60$ ;  $SE = 0.41$ ) was substantially higher compared to the

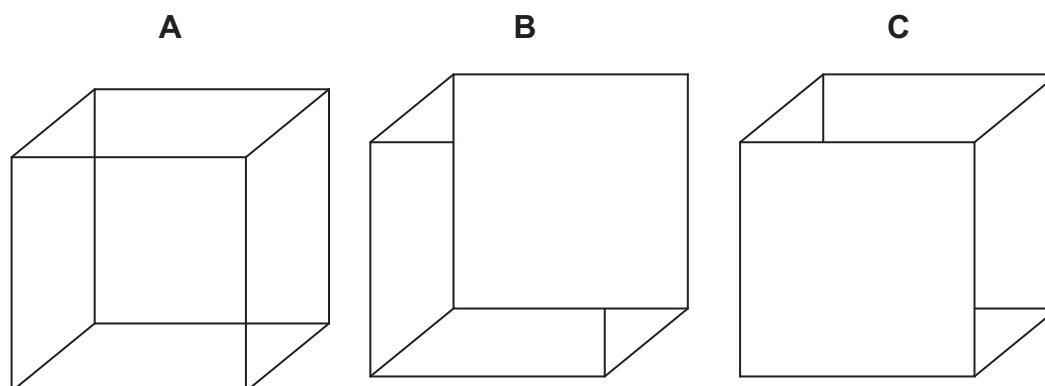
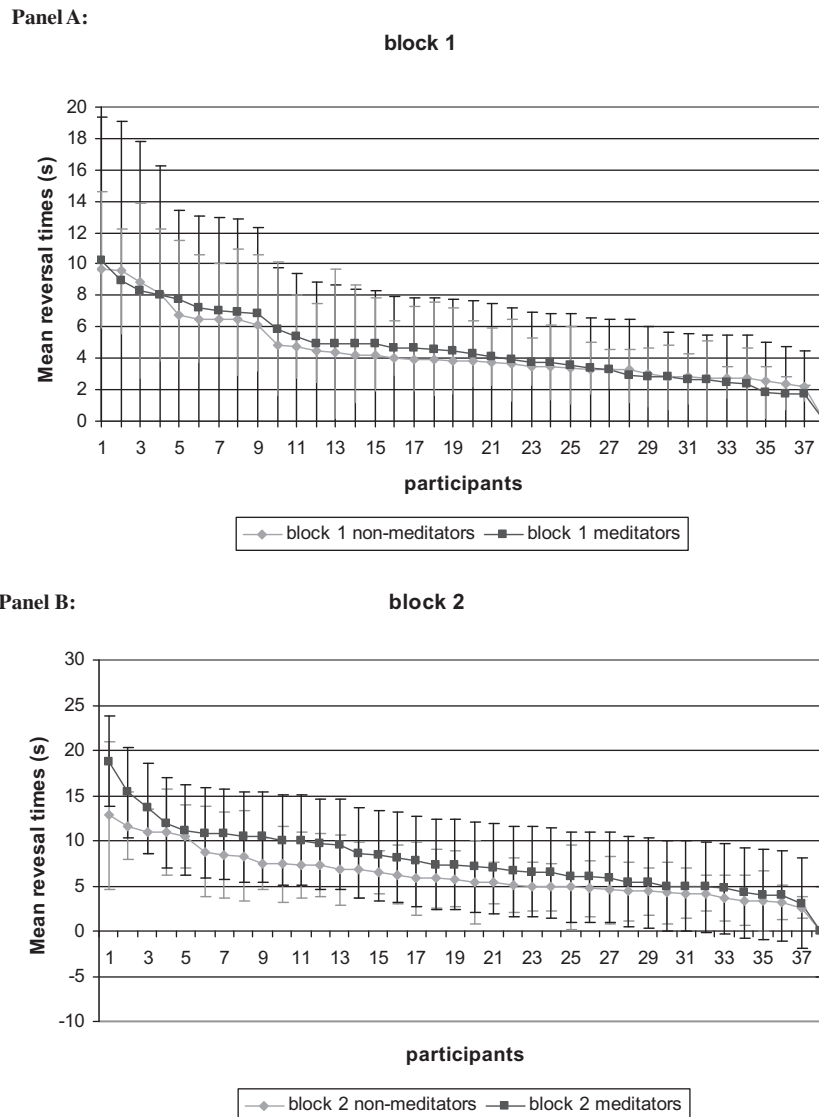


Fig. 1. The Necker Cube. Panel A shows the standard, ambiguous form of the Necker Cube that was presented to the participants. Panels B and C show modified versions that try to capture the two perspectives.



**Fig. 2.** Mean reversal time (RevT) and standard deviation for each non-meditator and meditators in block 1 (panel A; without instruction to hold the perspective while looking at the Necker Cube) and in block 2 (panel B; with instructions to hold the perspective while looking at the Necker Cube). RevT of participants is depicted in descending order, i.e., participants with high RevT are depicted on the left part of the x-axis. Visual inspection suggests that no practically relevant differences between the two groups prevailed in block 1 (panel A). In block 2 (panel B), however, visual inspection suggests that meditators showed substantially longer RevT compared to non-meditators (i.e. several seconds).

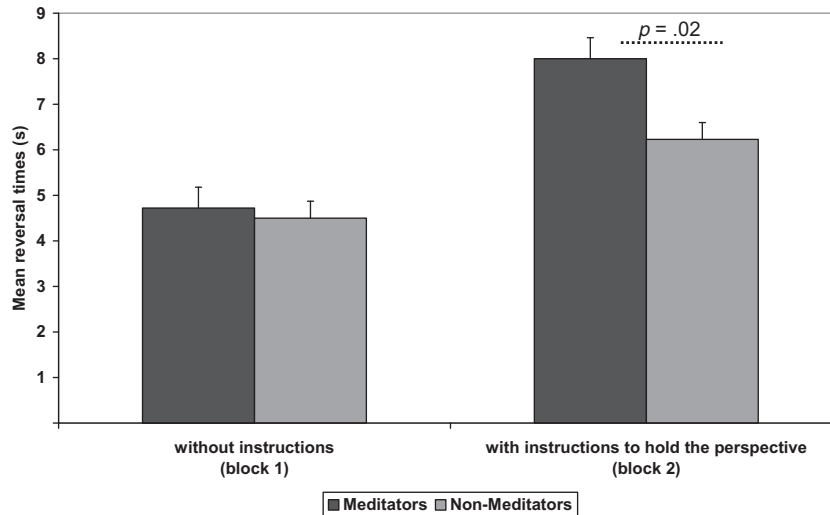
non-meditation group ( $M = 3.96$ ;  $SE = 0.55$ ;  $t(73) = -5.80$ ;  $p < 0.001$ ;  $d = 1.33$ ). In a more in-depth analysis, we statistically controlled the effect of possible confounders (caffeine [intake vs. no intake], age, and sex) on RevT in block 2 using analysis of covariance. Only the effect of group (meditators vs. non-meditators), but not caffeine, age or sex, exhibited a significant effect on RevT, thus corroborating the results of the  $t$ -tests (group:  $F(5.77,1) = 0.02$ ; age:  $F(1.38,1) = 0.24$ ; sex:  $F(0.001,1) = 0.98$ ; caffeine:  $F(0.1,1) = 0.91$ ). For control purposes, we compared mean group differences between meditators and non-meditators using a non-parametric Mann–Whitney– $U$ -test. Results were similar to the  $t$ -tests (block 1:  $p = 0.53$ ; block 2:  $p = 0.02$ ). Comparing median values yielded similar results as comparing mean values.

#### 4. Discussion

In this study, we hypothesized that the present *now* can be expanded for individuals who meditate as compared with people who do not meditate and that this effect is conveyed by individual

mindfulness levels. Results provide initial support for this hypothesis. Interestingly, differences in the duration of the present moment (as measured by RevT) were only found in block 2, when participants were instructed to hold the perspective as long as possible; by contrast, in block 1, RevT did not differ significantly between the two groups. An explanation for this fact may be that mindfulness is transiently activated in situations of demand such as in block 2. Furthermore, participants were not instructed to be mindful so that the manifest mindfulness during the experiment may have been relatively weak. Additionally, the effects reported in other studies rely on much more experienced meditators such as monks or people having completed intense and long-term meditation retreats (Carter et al., 2005; Slagter et al., 2007). As our participants were not experts in the above sense – though having maintained mindfulness training regularly for several years – it seems encouraging that effects were still found.

However, some limitations of the present study need to be considered. First, the design clearly precludes strong causal interpretations. Comparing group means is a straight-forward and valuable approach for providing initial support to causal hypotheses, but



**Fig. 3.** Differences in mean reversal times in the Necker Cube test are significantly larger for meditators compared to non-meditators in block 2 (when instructed to hold the perception as long as possible) but not in block 1 (without further instructions). Error bars indicate two standard errors.

bears the restriction that other differences between the groups, such as life style, may be the real cause between the differences in the variable under investigation. For that reason, we also measured mindfulness to test whether mindfulness predicts the differences under investigation, i.e., RevT. Nevertheless, even positive results do not suffice for strong causal conclusions; longitudinal and experimental designs are needed. Secondly, as most of the testing of the meditators took place in meditation centers, we could not rely on a more sophisticated apparatus such as eye movement tracking. This lack of experimental control is undesirable, but it is likely that only an unsystematic bias was introduced thus reducing the effect sizes but not favoring the meditation group. Furthermore, the validity of mindfulness scales has been subject of criticism (Grossman, 2008). However, in a recent review, Baer (2011) concludes that despite shortcomings existing measurement approaches are “useful and informative” (p. 241). Thus, we think that the validity of the results is not strongly compromised. Thirdly, the relative high number of excluded short RevT in the non-meditators group warrants consideration in future studies. Interestingly, the excluded trials primarily consisted of implausibly short RevT in the non-meditators group. A possible explanation is that non-meditators have less awareness about consciousness fluctuations such as changes in the Necker Cube perception. More stringent research is clearly needed to replicate the results and to understand the role of mindfulness in temporal perception.

It is noteworthy that, in block 1, RevT in were within time periods of nowness typically reported (Kagerer, Wittmann, Szegel, & von Steinbüchel, 2002; Pöppel, 1997). However, in block 2, RevT of participants, especially for meditators, were longer than typical time periods of nowness, although some evidence of such longer periods has been reported previously (Schleidt & Kien, 1997). This surplus in RevT may be explained by the fact that the perception of bistable images can be modulated by attention (Ooi & He, 1999). Since it has been shown that mindfulness is a way to improve attentional resources, it can be theorized that mindfulness accounted for the increased RevT by means of increased attentional resources (Lutz, Slagter, Dunne, & Davidson, 2008; Slagter et al., 2007).

Given particularly the potential relevance of mindfulness as a way to expand the borders of working memory and perception, this study is a first step in understanding and eventually using the benefits of mindfulness as a training of being present. For

now, we conclude that the present *now* can be longer for meditators than for non-meditators, and that mindfulness may convey this effect.

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