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# Concentrative Meditation Influences Creativity by Increasing Cognitive Flexibility

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Given the great importance of creativity in society, it is worth investigating how creative thinking can be enhanced. The link between meditation and enhanced creativity has been proposed by a number of authors; however, the reason why meditation leads to an increase in creativity is not clear. The current study aims to investigate the underlying mechanisms of different meditation styles on creative performance. A nonstudent sample was used and the experiment took place outside of the lab environment to maximize external validity. Two groups of experienced meditation practitioners performed a meditation session (either mindfulness or concentrative meditation). Participants' creativity and cognitive flexibility were assessed before and after the meditation session. The current findings demonstrate that meditation increases creative performance, irrespective of meditation style. Interestingly, only concentrative meditation led to an increase in cognitive flexibility. Possible explanations are discussed.

*Keywords:* creativity, cognitive flexibility, meditation, mindfulness, concentrative meditation

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Creativity is suggested to have many positive outcomes for health and wellbeing, such as increasing the rate of recovery from illness (for a review see Stuckey & Nobel, 2010). In addition, meditation has been of recent interest to behavioral and cognitive scientists because of its robust effects on cognitive processes (Hodgins & Adair, 2010; Moore & Malinowski, 2009; Ostafin & Kassman, 2012; Strick, van Noorden, Ritskes, de Ruiter, & Dijksterhuis, 2012). Similarly, several studies have investigated the link between meditation and creativity (e.g., Colzato, Ozturk, & Hommel, 2012; Cowger & Torrance, 1982; Horan, 2009; Orme-Johnson & Granieri, 1977), and have proposed that meditation could enhance creativity via its effects on cognitive processing. For instance, it has been shown that meditation influences the way we manage our attention (Davidson & Goleman, 1977; MacLean et al., 2010; Moore & Malinowski, 2009), is positively related to cognitive control (e.g., Moore & Malinowski, 2009), and that it can reduce habitual responses (Wenk-Sormaz, 2005). Therefore, it is worth investigating whether meditation can enhance creative thinking and possible mechanisms by which this occurs.

It is generally accepted that creativity involves the development of a novel product, an idea, or a problem solution that is of value to the individual and/or the social group (Amabile, 1983). In other words, creative work has to be novel and useful (Stein, 1953). One of the features of creativity that is often emphasized is cognitive flexibility—the mental ability to switch between different concepts, to overcome fixed association patterns, and to make new associations (Guilford, 1967). Researchers relate high cognitive flexibility to better creative achievement (Carson, Peterson, & Higgins, 2005), which is frequently and reliably measured using the Alternative Uses Task (AUT; Guilford, 1970). Researchers describe cognitive flexibility as the cognitive core of creativity and an important component of "real life" creativity (Beghetto & Kaufman, 2007; Hennessey & Amabile, 2010).

The most common distinction made between meditation styles involves mindfulness meditation (MM) and concentrative meditation (CM). MM practice aims to make individuals aware of the impermanence of everything that exists, and it is suggested that the MM technique involves an adoption of a particular attentional stance toward all objects (Davidson & Goleman, 1977). During MM, practitioners are asked to sit in a comfortable position, to relax, and to try to become aware of their own breathing, their physical sensations, and of their environment. When an individual notices that their mind wanders off or becomes focused on a particular object, emotion, or thought during meditation, their attention should be redirected to the body and environment. Thus, practitioners try to hold background awareness without attentional selection. In contrast, CM is a meditation technique—common to many traditions in the world, notably Buddhism—that requires focusing, pacifying, and calming; thereby enhancing the individual's atten-

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tional skills. During CM, practitioners are asked to sit in a comfortable posture and to focus their attention on one object or thought. In cases where individuals detect that they are distracted, they must first disengage their attention from the distraction and then redirect it to the object or thought they intend to focused on. Thus, practitioners try to be in a focused state of awareness and to actively guide their attention.

In practice, MM and CM meditation styles differ in the way the practitioner manages their attention during meditation. During MM, practitioners try to monitor possible thoughts and emotions without focusing on any one thought or emotion in particular; during CM, however, it is necessary to maintain attention on one particular object and to bring attention back to that object after observing distractions. Differences between the effects of MM and CM on the levels of brain activation have also been shown: MM, which permits mind wandering, involves more extensive activation of brain areas associated with episodic memories and emotional processing, when compared with that observed during CM (Xu et al., 2014). This difference could potentially affect the creative process.

Currently, MM is of great interest to researchers in various fields. MM has been proven effective in traditional anxiety and depression therapies and has a positive effect on personal development and interpersonal relationships (e.g., Ludwig & Kabat-Zinn, 2008). However, it is not clear which components of MM make it effective. With regard to creativity, MM may help to activate defocused attentional states, which have been linked to creativity (Kasof, 1997). Defocused attention leads to perceiving more characteristics of a stimulus, and thus results in a larger number of associations and greater potential to access and connect remote concepts. On the contrary, CM could have the potential to promote a controlled and focused attentional state (Lutz, Slagter, Dunne, & Davidson, 2008). There are theories emphasizing the importance of controlled, focused attentional effort in the creative process (Feist, 1999). The focused attentional state is especially important when we need to pursue a creative idea. It has been suggested that the creative process benefits from switching from defocused attention to more controlled and focused states (Gabora, 2002); for example, by first generating several creative ideas (i.e., starting broad), and then focusing on one of these ideas and developing it further. Theoretically, then, both meditation styles could enhance creativity; however, they may have different effects on creative output.

The current study investigates the effect of meditation on creativity and tests whether MM practice and CM practice have different effects on cognitive flexibility—an important aspect of creative thinking. To answer these questions, participants with experience in either MM or CM meditation styles were recruited and their creativity and cognitive flexibility levels were measured before and after a meditation session (MM or CM). Using a pre- and postmeasure design allowed a test of the effects of immediate meditation (an MM or CM session) on creativity. To enhance external validity, the study was administered outside of the laboratory and was conducted among a nonstudent sample.

## Method

### Participants

Thirty-nine participants (17 male, $M_{\text{age}} = 32.82$ years, $SD = 12.26$) with experience in meditation participated in the study. Several local meditation groups were contacted by e-mail to ask for their participation in the study. Two of these groups responded positively; one MM group and one CM group. Due to limited funding, only the CM group—for which the data were collected first—could be compensated for their participation. That is, 20 participants in the CM group were compensated for their time with 10 Euro, while the 19 participants in the MM group agreed to participate without compensation. Each participant experienced the experimental procedure only once. The mean age of the CM group was significantly higher than the mean age of the MM group.[1] However, there were no differences between the meditation groups in terms of their prior meditation experience and the amount of time they spent on meditation per week. For more details concerning participants' characteristics, see Table 1.

### Procedure and Design

Participants were assigned to the conditions, which they typically practice, thus they were either assigned to the CM condition ($N = 20$) or the MM condition ($N = 19$), meaning that assignment to condition was based on meditation group membership. In each condition, participants were divided into two (smaller) subgroups, as this allowed greater efficiency in administering the tasks of the experiment. As such, the experimental procedure was carried out twice for the CM condition and twice for the MM condition. All groups completed the pre- and postmeditation assessments of creativity, and all participants completed the experimental tasks in the same order. First, participants were invited individually to a separate room where they were instructed to complete the Stroop task to measure their cognitive control.[2] Subsequently, all participants received a booklet containing the instructions for the creativity tasks. Two different tasks were administered to measure creative performance, the Alternative Uses Task (AUT; Guilford, 1967) and a drawing task (Test for Creative Thinking-Drawing Production; TCT-DP; Urban & Jellen, 1996). The experimenter advised the participants when they could start (and stop) the provided tasks. The premeasure was immediately followed by the meditation session.

During MM, practitioners were asked to become aware of their own emotions and of the environment, and started with a brief focus on the breath. Participants had to concentrate on inhaling and exhaling for a few minutes to calm down and to prepare for mindful observation. Furthermore, participants were instructed to be open to any thoughts and sensations that came to their mind and body, to accept these thoughts and sensations, and to observe them for a while without judgment. Several times during the MM session, participants were reminded about the nonjudgmental observation of their thoughts and sensations.

During CM, the basic meditation of Buddhist tradition—Samatha—was used. During this style of meditation, the practitioner focuses their attention on the breath in order to reach a meditative state. Participants were instructed to concentrate on inhaling and exhaling, and to observe which part of the body their breath came

[1] Controlling for age in the main analysis revealed similar results.

[2] MM and CM groups did not differ on the Stroop difference scores (i.e., incompatible—compatible), and difference scores did not correlate with creativity scores (see Table 2). Thus, the results of the Stroop task were omitted, as there were no differences between the groups and the Stroop scores were not a variable of interest in the present study.

Table 1
*Group Descriptives: Age, Gender, Meditation Experience, and Weekly Practice*

| Measure | Concentrative ($n$ = 20) (8 males) | Mindfulness ($n$ = 19) (9 males) | $F$ | $p$ |
|---|---|---|---|---|
| Age | | | | |
| *M* | 36.85 | 28.58 | 4.88* | .03 |
| *SD* | 14.88 | 6.85 | | |
| Meditation experience (in months) | | | | |
| *M* | 64.45 | 31.42 | 1.96 | .17 |
| *SD* | 98.77 | 28.9 | | |
| Meditation practice (hours per week) | | | | |
| *M* | 3.275 | 3.50 | .04 | .84 |
| *SD* | 3.77 | 3.29 | | |

*Note.* $N$ = 39.
* $p < .05$.

from. Participants were instructed that if their attention begins to disengage from the breath, to let go of all of their distracting thoughts and to refocus on their breathing. This instruction was repeated several times during the CM session to remind the participants to focus on the process of breathing.

During both the CM and the MM sessions, participants sat in a circle together with the instructor, and sat on meditation pillows or benches. The MM and CM meditation sessions held during the study were led by each group's usual instructor (i.e., from their meditation center). Both instructors had substantial experience with the meditation style they were practicing during the study. In both conditions the meditation session lasted for 20 min and the experimenter was not present in the room during the meditation session.

After the meditation session, the creativity postmeasure was administered. Every participant received a booklet with the same tasks as in the premeasure; however, different versions of the tasks were used (i.e., with different target objects). Finally, questions regarding demographical information and meditation experience were completed.

## Creativity Measures

**Alternative uses task.** The Alternative Uses Task (AUT; Guilford, 1967) is often used in creativity research, and is considered a valid and reliable measure of divergent thinking (Akbari Chermahini & Hommel, 2012) and a reliable indicator of creativity (Runco & Acar, 2012). In this task, participants have to generate as many possible uses for a common, everyday object as they can within 2 min. In the current study, a brick and a shoe were selected as the common, everyday objects, and were presented in a counterbalanced order across the pre- and postmeditation measures (further referred to as stimulus presentation order). Thus, half of the participants in both meditation groups generated possible uses for a brick before the meditation session, and uses for a shoe after the meditation session; for the remaining half of the participants, the order for the two objects was reversed. The ideas generated during this task were scored on three criteria: *creativity, flexibility* and *fluency* (Guilford, 1967; Silvia et al., 2008).

*Creativity* scores were obtained in the following way: If 1% or fewer of the participants mentioned a particular idea, this idea scored 2 points. If 5% or fewer of the participants mentioned an idea, it scored 1 point. If an idea was mentioned by more than 5% of the participants it scored 0 points. Ideas deemed unclear or meaningless by the scorers also scored 0 points, regardless of how frequently they were mentioned by participants. A grand creativity score was obtained by summing the scores of all of the ideas generated by each participant. *Flexibility* represents the number of different semantic categories that the participants' ideas belong to. Each idea was assigned to one of the predefined categories, and the number of different categories was summed. A high score on flexibility indicates a better ability to switch between semantic categories (cf. a low score). First, a list of categories was made on the basis of the whole pool of ideas (see online supplementary Appendix B). Thereafter, each idea was assigned to one of these predefined categories. *Fluency* represents the number of appropriate ideas participants have produced within 2 min.

Two trained raters performed the scoring of the ideas, and Cronbach's alpha coefficients were calculated to establish the interrater reliabilities. The interrater reliabilities for creativity and flexibility scores were .96 and .93, respectively; as such, the average scores of the two raters were used in the analyses of creativity and flexibility. Fluency scores of the first rater were used in the analysis, as the number of ideas is an objective measure.

**TCT-DP.** The Test for Creative Thinking–Drawing Production (TCT-DP) is designed as an effective drawing-based instrument for measuring creative potential. Contextual and discriminant validity of this task was supported by the research (Dollinger, Urban, & James, 2004), and trained raters are able to produce a high reliability evaluation of this task (Kālis, Roçke, & Krūmiçna, 2014). In this task, participants were asked to finish a drawing that had been started by someone else. The unfinished drawing consisted of a square frame and six geometrical figure fragments. Participants were encouraged to be as creative as possible. Everyone had to finish the TCT-DP task in a maximum of 10 min.

The completed drawings made by participants were scored according to the 14 key criteria developed by the creators of the task, Urban and Jellen (1996). The detailed description of each criterion is presented in online supplementary Appendix A. The final score for the TCT-DP, which was used in the analysis, was calculated by adding up the scores of the 14 criteria.

Two trained raters performed the scoring, and the Cronbach's alpha coefficient was calculated to establish the interrater reliability. The two raters showed good interrater reliability of .84; therefore, an average score was used in the analysis.

## Results

Two participants did not submit the premeasures and thus were excluded from the analyses. Correlation coefficients were calculated for all tasks performed during the pre- and the postmeasures. The measures show (with some exceptions) moderate to high positive correlations (displayed in Table 2). As age and gender did not correlate with any of the measures, both variables were omitted from further analyses. The correlations are displayed in Table 2.

Each creativity measure (i.e., creativity, cognitive flexibility, fluency, TCT-DP) was analyzed separately using repeated-measures ANOVAs, with the time of measurement (pre- and postmeasure) as the within-subjects factor and meditation style (CM vs. MM) and stimulus presentation order as between-subjects factors. A significance level of $p < .05$ was adopted for all significance tests. Importantly, three-way interactions between stimulus presentation order, time of measure, and meditation type did not reach significance for any of the AUT scores (i.e., creativity and cognitive flexibility, both $F < 1$). Given that the presentation order of the stimuli had no effect on the relationship between time of measure and meditation type, order was omitted from the analyses. For the fluency scores, the three-way interaction was significant and thus all variables were retained in the main analyses.

To control for preexisting differences in creativity, cognitive flexibility, fluency, and TCT-DP between the groups, an ANOVA was performed on the scores obtained before the meditation session. There were small numerical differences for the premeasure scores; however, these did not reach statistical significance (see Table 3).

Table 3
*DV Scores at the Premeasure: Creativity, Flexibility, Fluency, TCT-DP, and Differences Between Groups*

| Measure | Concentrative ($n = 19$) | Mindfulness ($n = 18$) | $F$ | $p$ |
|---|---|---|---|---|
| Creativity premeasure | | | | |
| *M* | 8.36 | 9.69 | .48 | .50 |
| *SD* | 4.08 | 5.24 | | |
| Flexibility premeasure | | | | |
| *M* | 5.0 | 5.97 | 3.37 | .08 |
| *SD* | 1.43 | 1.78 | | |
| Fluency premeasure | | | | |
| *M* | 9.26 | 10.11 | .33 | .57 |
| *SD* | 3.78 | 5.23 | | |
| TCT-DP premeasure | | | | |
| *M* | 25.89 | 27.50 | .24 | .63 |
| *SD* | 10.60 | 8.00 | | |

*Note.* $N = 37$. TCT-DP = Test for Creative Thinking-Drawing Production.

## AUT—Creativity Scores

An analysis of the creativity scores revealed a significant main effect for time of the measure (pre- and postmeasure), $F(1, 33) = 5.62$, $p = .02$, $\eta_p^2 = .15$ (see Figure 1). This suggests that participants generated significantly more creative ideas after the meditation session ($M = 11.09$, $SD = 5.83$) compared with before the meditation session ($M = 9.15$, $SD = 4.65$), with an average of approximately two more ideas generated following the meditation session ($t = 2.42$; $p = .02$; 95% CI [0.32, 3.57]). The main effect of meditation type as well as the interaction between the meditation type and the time of measurement was not statistically significant ($F < 1$). Estimates of the effects are presented in Table 4.

## AUT—Cognitive Flexibility Scores

The analysis of the cognitive flexibility scores revealed a significant interaction effect between measurement time (pre- and postmeasure) and meditation type, $F(1, 31) = 6.97$, $p = .01$, $\eta_p^2 = .17$. The average cognitive flexibility score of participants was different in the postmeasure compared to the premeasure and this difference changed across two manipulation types. A visual representation of this effect is presented in Figure 2. On average,

Table 2
*Correlation Coefficients Between Creativity, Fluency, Flexibility, and TCT-DP Pre- and Postmeasures, Stroop Task Scores (Incompatible—Compatible, ms), as Well as Age, Meditation Experience (in Months), and Meditation Practice (in Hours per Week)*

| Measures | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Creativity-Pre | — | | | | | | | | | | | |
| 2. Creativity-Post | .59** | — | | | | | | | | | | |
| 3. Flexibility-Pre | .71** | .24 | — | | | | | | | | | |
| 4. Flexibility-Post | .46** | .62** | .27 | — | | | | | | | | |
| 5. Fluency-Pre | .85** | .46** | .72** | .33 | — | | | | | | | |
| 6. Fluency-Post | .51** | .88** | .17 | .72** | .47** | — | | | | | | |
| 7. TCT-DP-Pre | .34 | .48** | .44* | .58** | .39* | .49** | — | | | | | |
| 8. TCT-DP-Post | .37* | .48** | .27 | .50** | .24 | .48** | .50** | — | | | | |
| 9. Stroop task | .08 | −.08 | −.03 | −.11 | .04 | −.11 | −.05 | −.19 | — | | | |
| 10. Age | .002 | −.07 | −.15 | −.06 | .007 | −.05 | −.08 | −.05 | .57** | — | | |
| 11. Experience | .03 | .10 | −.13 | .04 | .06 | .14 | −.06 | .09 | −.08 | .51** | — | |
| 12. Practice | .11 | −.18 | −.17 | −.16 | .005 | −.03 | −.21 | −.05 | −.11 | .14 | .346* | — |
| *M* | 9.15 | 11.09 | 5.47 | 5.77 | 9.68 | 9.89 | 26.60 | 27.19 | 15773.32 | 32.82 | 48.36 | 3.38 |
| *SD* | 4.65 | 5.83 | 1.66 | 1.69 | 4.5 | 4.16 | 9.44 | 10.33 | 14566.66 | 12.27 | 74.51 | 3.50 |

*Note.* $N = 37$. TCT-DP = Test for Creative Thinking-Drawing Production.
$^{*}p < .05$. $^{**}p < .001$.

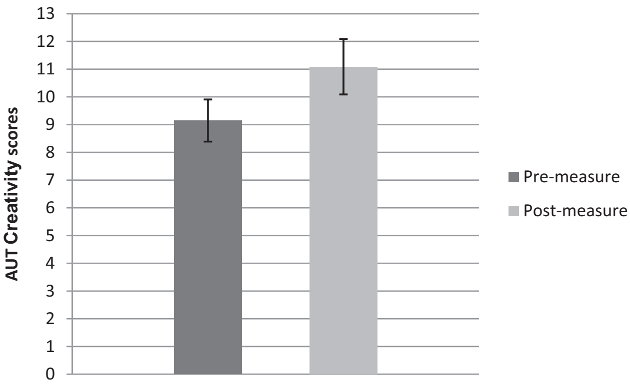


*Figure 1.* Mean scores on creativity before and after the meditation session. Note: error bars represent the standard errors of the mean.

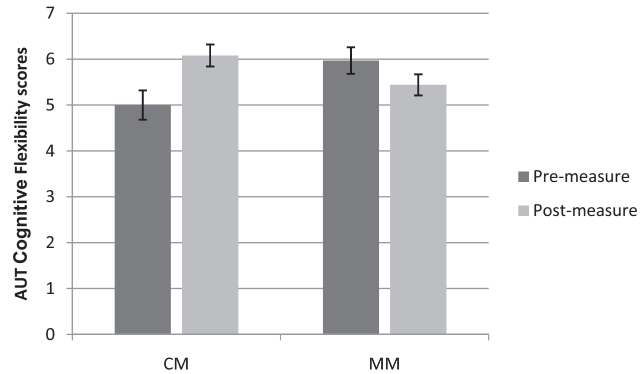


*Figure 2.* Mean scores on cognitive flexibility before and after manipulations. Note: error bars show standard deviations.

participants showed higher cognitive flexibility after CM ($M$ = 6.08; $SD$ = 1.43) than before CM ($M$ = 5.00; $SD$ = 1.93). A dependent sample $t$ test showed that there was a statistically significant increase in cognitive flexibility after the CM session (mean difference (post - pre) = 1.08; $t$ = 2.76; $p$ = .01; 95% CI [0.26, 1.90]). In the MM condition there was no significant difference between the cognitive flexibility scores pre- and post-meditation ($p > .05$). All other within- and between-subjects effects did not reach statistical significance (all $F < 1$). Estimates of all effects in this analysis are presented in Table 5.[3]

## AUT—Fluency Scores

An analysis of the fluency scores revealed a significant interaction between measurement time (pre- and postmeasure) and stimulus order, $F(1, 33) = 9.21$, $p < .005$, $\eta_p^2 = .22$. This interaction was qualified by a significant three-way interaction effect between order, measurement time (pre- and postmeasure), and meditation type, $F(1, 33) = 5.64$, $p < .03$, $\eta_p^2 = .15$. All other within- and between-subjects effects were found to be statistically nonsignificant (all $F < 1$). Post hoc analyses showed that for participants in the CM group, there was no effect of measurement time, stimulus presentation order, nor was there an interaction effect between these factors (both $p > .27$). In the MM group, the main effects were not significant (both $p > .58$), while a significant interaction effect between measurement time (pre- and postmeasure) and stimulus presentation order was found, $F(1, 16) = 8.93$, $p < .009$, $\eta_p^2 = .36$. A dependent sample $t$ test showed an increase in fluency when the AUT was first performed for the shoe and, thereafter, for the brick (mean difference (post - pre) = 3.78; $t$ = 2.13; $p$ = .07; 95% CI [−0.30, 7.86]). This pattern reversed (i.e., fluency decreased) when the AUT was first performed for the brick and, thereafter, for the shoe (mean difference (post - pre) = −3.11; $t$ = 2.11; $p$ = .07; 95% CI [−6.52, 0.29]). Estimates of the effects are presented in Table 6.

Table 4
*ANOVA Analysis of Creativity Scores*

| Factor | $df$ | Mean square | $F$ | Partial eta squared |
|---|---|---|---|---|
| Between subject effects | | | | |
| Order of stimuli presentation | 1 | .70 | .02 | .00 |
| Manipulation type | 1 | 11.89 | .26 | .01 |
| Order of stimuli presentation × Manipulation type | 1 | 21.37 | .49 | .01 |
| Within subject effects | | | | |
| Measure (pre-/post-) | 1 | 62.56 | 5.61* | .15 |
| Measure × Order of stimuli presentation | 1 | 53.53 | 4.80* | .13 |
| Measure × Manipulation type | 1 | 1.05 | .10 | .00 |
| Measure × Order of stimuli Presentation × Manipulation type | 1 | 7.05 | .63 | .02 |

*Note.* $N = 37$.
* $p < .05$.

## TCT-DP Scores

The main effects for meditation type, the time of measurement, and stimulus presentation order, as well as the interaction effects between these variables for the TCT-DP scores were statistically nonsignificant (all $F < 1$). Estimates of these effects are presented in Table 7.

# Discussion

The current field study investigated whether meditation can function as an effective tool to enhance creativity, and explored whether mindfulness meditation (MM) and concentrative meditation (CM) have differential effects on creativity. The current research found that, overall, participants were more creative after completing a meditation session (cf. prior to meditation), suggesting that meditation can function as a means to enhance creative thinking. These results are in line with previous research demonstrating the beneficial effects of meditation (Colzato et al., 2012; Cowger & Torrance, 1982; Horan, 2009; Orme-Johnson & Granieri, 1977). Interestingly, the effect of meditation on cognitive

[3] Given the high correlations between the AUT measures, we calculated difference scores for all three AUT creativity measures (subtracting the premeasure from the postmeasure) to control for multiple testing. The effect on cognitive flexibility stayed significant ($p$ = .020), with participants in the CM group scoring higher on cognitive flexibility than in the MM group.

Table 5
*ANOVA Analysis of Cognitive Flexibility Scores*

| Factor | *df* | Mean square | *F* | Partial eta squared |
|---|---|---|---|---|
| Between subject effects | | | | |
| Order of stimuli presentation | 1 | 1.82 | .50 | .02 |
| Manipulation type | 1 | .64 | .17 | .01 |
| Order of stimuli presentation × Manipulation type | 1 | 5.45 | 1.48 | .04 |
| Within subject effects | | | | |
| Measure (pre-/post-) | 1 | 1.13 | .72 | .02 |
| Measure × Order of stimuli presentation | 1 | 7.84 | 4.96* | .13 |
| Measure × Manipulation type | 1 | 11.01 | 6.97* | .17 |
| Measure × Order of stimuli presentation × Manipulation type | 1 | 1.84 | 1.16 | .03 |

*Note.* $N = 37$.
* $p < .05$.



flexibility was different for participants in the MM and CM groups: Only for participants in the CM session was an increase in cognitive flexibility observed. We suggest that CM enhances creativity by enhancing cognitive flexibility—an important cognitive mechanism underlying creative thinking. Considering that cognitive flexibility is the ability to change usual cognitive patterns, overcome cognitive fixedness, and thus to make novel (i.e., creative) associations between concepts (Guilford, 1967), increased cognitive flexibility might lead to an overall increase in participants' creativity. Importantly, recent research suggests that the measure of cognitive flexibility used in the current study might better reflect a measure of "semantic fluency" and could be seen as a fluency score for categories, and thus that creative people might have better access to associative memory (e.g., Benedek & Neubauer, 2013). Using this interpretation of the AUT measure of cognitive flexibility, our results could suggest that CM enhances access to associative memory. As CM practitioners try to reach a concentrative state of awareness and are better able to actively guide their attention, it might be that this ability helped participants in the current study to more easily switch between categories. Further research is needed to test this possibility.

The analysis of fluency scores and TCT-DP scores did not yield any significant improvements following meditation. It is not surprising that fluency scores were unaffected by the meditation practice, as fluency (as defined by Guilford, 1967) is merely a representation of participants' verbal abilities. Moreover, fluency is highly dependent on the timeframe in which participants can generate ideas, which was rather short in the current study. The order effects found between the pre- and postmeasures of fluency in the MM group are surprising, as both versions of the task can be considered equally difficult. It might be that the order effects are coincidental, and given the small group size, the results should be interpreted with caution. In addition, there were no significant improvements on the TCT-DP task following mediation. This may partly be attributable to the fact that TCT-DP embraces a wide range of characteristics of the creative process: content, gestalt, composition, elaboration, risk taking, breaking of boundaries, unconventionality, affection, and humor. Perhaps meditation (as an attention modulating technique) did not target some of these factors, such as gestalt, composition, unconventionality, affection, and humor. Instead, other processes taking place during the manipulation may have influenced these factors. For example, the meditation session might have had a relaxing effect that minimized the expression of affectivity and humor in participants, which consequently led to the reduced TCT-PD score.

Interestingly, the absence of a significant effect of MM on cognitive flexibility partly contradicts previous research by Colzato, Ozturk, and Hommel (2012), which investigated the positive effects of open monitoring (which could be considered an equivalent to mindfulness meditation in our study) on cognitive flexibility. This inconsistency in findings may be explained by the nature of the mindfulness meditation technique practiced in the

Table 6
*ANOVA Analysis of Fluency Scores*

| Factor | *df* | Mean square | *F* | Partial eta squared |
|---|---|---|---|---|
| Between subject effects | | | | |
| Order of stimuli presentation | 1 | 6.62 | .22 | .01 |
| Manipulation type | 1 | 1.61 | .05 | .00 |
| Order of stimuli presentation × Manipulation type | 1 | 2.89 | .10 | .00 |
| Within subject effects | | | | |
| Measure (pre-/post-) | 1 | .52 | .07 | .00 |
| Measure × Order of stimuli presentation | 1 | 68.19 | 9.21* | .22 |
| Measure × Manipulation type | 1 | 4.59 | .62 | .02 |
| Measure × Order of stimuli presentation × Manipulation type | 1 | 41.74 | 5.64* | .15 |

*Note.* $N = 37$.
* $p < .05$.

Table 7
*ANOVA Analysis of TCT-DP Scores*

| Factor | *df* | Mean square | *F* | Partial eta squared |
|---|---|---|---|---|
| Between subject effects | | | | |
| Order of stimuli presentation | 1 | 2.90 | .02 | .00 |
| Manipulation type | 1 | 51.75 | .33 | .01 |
| Order of stimuli presentation × Manipulation type | 1 | 49.29 | .31 | .01 |
| Within subject effects | | | | |
| Measure (pre-/post-) | 1 | 5.47 | .10 | .00 |
| Measure × Order of stimuli presentation | 1 | 3.31 | .06 | .00 |
| Measure × Manipulation type | 1 | .09 | .02 | .00 |
| Measure × Order of stimuli presentation × Manipulation type | 1 | 26.36 | .49 | .02 |

*Note.* $N = 37$. TCT-DP = Test for Creative Thinking-Drawing Production.



current study. In the Buddhist tradition, long concentrative (Samatha) meditation training precedes the mindfulness meditation (Vipassana) practice (Bhikkhu, 1997). Therefore, the mindful meditative state might be difficult to achieve without sufficient experience, and our participants could have lacked sufficient practice of MM to reach this mindful meditative state.

Well known techniques to enhance creative thinking include, among others: brainstorming, metaphor generation, and practicing divergent thinking (for a review see Scott, Leritz, & Mumford, 2004). Furthermore, there is evidence showing that performance on creativity tasks can be enhanced by creativity training (Scott et al., 2004). Research has shown that creativity can also be increased by targeting more implicit processes, such as unconscious thought during distraction (Dijksterhuis & Meurs, 2006; Kühn et al., 2014), mind wandering (e.g., Baird et al., 2012), observation of schema violations (Ritter et al., 2014), and task reactivation during sleep (Ritter, Strick, Bos, van Baaren, & Dijksterhuis, 2012) to name a few examples. Thus, one might argue that training effects could partly explain the finding of increased creativity scores postmeditation. However, it does not seem likely that the 2-min task with brief instructions—which placed particular emphasis on the quantity of the answers provided—would elicit the training effects comparable, for example, to a training program of several lessons (Feldhusen, 1983). Furthermore, participants were unaware of the categories that were used in the current analysis, and thus did not know how to perform better on the second task. Further support for this idea is that the dependent variable that could have benefited from a training effect was fluency, as participants already knew during the postmeasure that they had to generate as many ideas possible. However, mean fluency scores remained unchanged following the manipulation.

## Limitations

Several limitations should be considered when interpreting the present results. First, it was not possible to control whether all of the participants followed the MM instructions equally well (i.e., some participants may have been more distracted than others). In addition, the CM instruction might have been easier to follow. As a manipulation check was not performed, there is no data available on how successful the meditation session was in this regard. Furthermore, a few participants noted that they sometimes practice other meditation styles when they are at home (cf. that performed during the experiment), which might have influenced the present findings.

It is also important to note that participants were not assigned to the different meditation groups randomly. Although significant differences were not found between the groups in terms of their prior meditation experience and their premeasure creativity scores, there might be individual differences that have not been controlled for in the current study. For example, the age of the participants differed slightly between the groups, and our sample consisted of a greater number of female (cf. male) participants. Therefore, our results should be interpreted with caution, and future research should explore possible moderators for the differential effects of meditation styles on creativity. As our sample size was quite small, the generalizability of the present findings is limited.

## Conclusions and Future Directions

For future research, it might be useful to investigate whether the beneficial effects of meditation on creativity can be influenced by the style of meditation that is practiced on a daily basis (i.e., alone at home) and during weekly group sessions (i.e., in meditation meetings). Furthermore, it would be interesting to explore the effect of meditation on creativity using a longitudinal design to capture the development and fluctuations of regular practice. Importantly, the role of actively guiding attention in enhancing cognitive flexibility should be explored further.

To summarize, the findings of the current research extend the existing body of evidence for the link between meditation and creativity. The findings demonstrate that meditation may enhance creativity, and suggest that—in the case of CM—this effect may be due to enhanced cognitive flexibility. Overall, these findings suggest that meditation could be used as a means to improve creative performance.

## References

Akbari Chermahini, S., & Hommel, B. (2012). Creative mood swings: Divergent and convergent thinking affect mood in opposite ways. *Psychological Research, 76,* 634–640. http://dx.doi.org/10.1007/s00426-011-0358-z

Amabile, T. M. (1983). The social psychology of creativity: A componential conceptualization. *Journal of Personality and Social Psychology, 45,* 357–376. http://dx.doi.org/10.1037/0022-3514.45.2.357

Beghetto, R., & Kaufman, J. (2007). Toward a broader conception of creativity: A case for mini-c creativity. *Psychology of Aesthetics, Creativity, and the Arts, 1,* 73–79. http://dx.doi.org/10.1037/1931-3896.1.2.73

Baird, B., Smallwood, J., Mrazek, M. D., Kam, J. W., Franklin, M. S., & Schooler, J. W. (2012). Inspired by distraction: Mind wandering facilitates creative incubation. *Psychological Science, 23,* 1117–1122. http://dx.doi.org/10.1177/0956797612446024

Benedek, M., & Neubauer, A. C. (2013). Revisiting Mednick's model on creativity-related differences in associative hierarchies. Evidence for a common path to uncommon thought. *The Journal of Creative Behavior, 47,* 273–289. http://dx.doi.org/10.1002/jocb.35

Bhikkhu, B. (1997). *Mindfulness with breathing*. Boston, MA: Wisdom Publications.

Carson, S. H., Peterson, J. B., & Higgins, D. M. (2005). Reliability, validity, and factor structure of the creative achievement questionnaire. *Creativity Research Journal, 17,* 37–50. http://dx.doi.org/10.1207/s15326934crj1701_4

Colzato, L. S., Ozturk, A., & Hommel, B. (2012). Meditate to create: The impact of focused-attention and open-monitoring training on convergent and divergent thinking. *Frontiers in Psychology, 3,* 116. http://dx.doi.org/10.3389/fpsyg.2012.00116

Cowger, E. L., & Torrance, E. P. (1982). Further examination of the quality of changes in creative functioning resulting from meditation (zazen) training. *Creative Child and Adult Quarterly, 7,* 211–217.

Davidson, R. J., & Goleman, D. J. (1977). The role of attention in meditation and hypnosis: A psychobiological perspective on transformations of consciousness. *International Journal of Clinical and Experimental Hypnosis, 25,* 291–308. http://dx.doi.org/10.1080/00207147708415986

Dijksterhuis, A., & Meurs, T. (2006). Where creativity resides: The generative power of unconscious thought. *Consciousness and Cognition, 15,* 135–146. http://dx.doi.org/10.1016/j.concog.2005.04.007

Dollinger, S. J., Urban, K. K., & James, T. A. (2004). Creativity and openness: Further validation of two creative product measures. *Creativity Research Journal, 16,* 35–47. http://dx.doi.org/10.1207/s15326934crj1601_4

Feist, G. J. (1999). The influence of personality on artistic and scientific creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 273–296). New York, NY: Cambridge University Press.

Feldhusen, J. F. (1983). The Purdue creative thinking program. In I. S. Sato (Ed.), *Creativity research and educational planning* (pp. 41–46). Los Angeles, CA: Leadership Training Institute for the Gifted and Talented.

Gabora, L. (2002, October). Cognitive mechanisms underlying the creative process. In T. Hewett & T. Kavanagh (Eds.), *Proceedings of the Fourth International Conference on Creativity and Cognition* (pp. 126–133). Loughborough University, UK.

Guilford, J. P. (1967). Creativity: Yesterday, today and tomorrow. *The Journal of Creative Behavior, 1,* 3–14. http://dx.doi.org/10.1002/j.2162-6057.1967.tb00002.x

Guilford, J. P. (1970). Creativity: Retrospect and prospect. *The Journal of Creative Behavior, 4,* 149–168. http://dx.doi.org/10.1002/j.2162-6057.1970.tb00856.x

Hennessey, B. A., & Amabile, T. M. (2010). Creativity. In S. Fiske (Ed.), *Annual review of psychology* (pp. 569–598). Palo Alto, CA: Annual Reviews.

Hodgins, H. S., & Adair, K. C. (2010). Attentional processes and meditation. *Consciousness and Cognition, 19,* 872–878. http://dx.doi.org/10.1016/j.concog.2010.04.002

Horan, R. (2009). The neuropsychological connection between creativity and meditation. *Creativity Research Journal, 21,* 199–222. http://dx.doi.org/10.1080/10400410902858691

Kālis, E., Roçke, L., & Krūmiçna, I. (2014). Investigation of psychometric properties of the test for creative thinking—Drawing production: Evidence from study in Latvia. *The Journal of Creative Behavior, 50,* 47–63.

Kasof, J. (1997). Creativity and breadth of attention. *Creativity Research Journal, 4,* 303–315. http://dx.doi.org/10.1207/s15326934crj1004_2

Kühn, S., Ritter, S. M., Müller, B. C. N., van Baaren, R. B., Brass, M., & Dijksterhuis, A. (2014). The importance of the default mode network in creativity—A structural MRI study. *The Journal of Creative Behavior, 48,* 152–163. http://dx.doi.org/10.1002/jocb.45

Ludwig, D. S., & Kabat-Zinn, J. (2008). Mindfulness in medicine. *Journal of the American Medical Association, 300,* 1350–1352. http://dx.doi.org/10.1001/jama.300.11.1350

Lutz, A., Slagter, H. A., Dunne, J. D., & Davidson, R. J. (2008). Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences, 12,* 163–169. http://dx.doi.org/10.1016/j.tics.2008.01.005

MacLean, K. A., Ferrer, E., Aichele, S. R., Bridwell, D. A., Zanesco, A. P., Jacobs, T. L., . . . Saron, C. D. (2010). Intensive meditation training improves perceptual discrimination and sustained attention. *Psychological Science, 21,* 829–839. http://dx.doi.org/10.1177/0956797610371339

Moore, A., & Malinowski, P. (2009). Meditation, mindfulness and cognitive flexibility. *Consciousness and Cognition, 18,* 176–186. http://dx.doi.org/10.1016/j.concog.2008.12.008

Orme-Johnson, D. W., & Granieri, B. (1977). The effects of the age of enlightenment governor training courses on field independence, creativity, intelligence, and behavioral flexibility. In D. W. Orme-Johnson & J. T. Farrow (Eds.), *Scientific research on the transcendental meditation program: Collected papers* (Vol. 1, pp. 713–718). Rheinweiler, Germany: MERU Press.

Ostafin, B. D., & Kassman, K. T. (2012). Stepping out of history: Mindfulness improves insight problem solving. *Consciousness and Cognition, 21,* 1031–1036. http://dx.doi.org/10.1016/j.concog.2012.02.014

Ritter, S. M., Kühn, S., Müller, B. C. N., van Baaren, R. B., Brass, M., & Dijksterhuis, A. (2014). The creative brain: Corepresenting schema violations enhances TPJ activity and boosts cognitive flexibility. *Creativity Research Journal, 26,* 144–150. http://dx.doi.org/10.1080/10400419.2014.901061

Ritter, S. M., Strick, M., Bos, M. W., van Baaren, R. B., & Dijksterhuis, A. (2012). Good morning creativity: Task reactivation during sleep enhances beneficial effect of sleep on creative performance. *Journal of Sleep Research, 21,* 643–647. http://dx.doi.org/10.1111/j.1365-2869.2012.01006.x

Runco, M. A., & Acar, S. (2012). Divergent thinking as an indicator of creative potential. *Creativity Research Journal, 24,* 66–75. http://dx.doi.org/10.1080/10400419.2012.652929

Scott, G., Leritz, L. E., & Mumford, M. D. (2004). The effectiveness of creativity training: A quantitative review. *Creativity Research Journal, 16,* 361–388.

Silvia, P. J., Winterstein, B. P., Willse, J. T., Barona, C. M., Cram, J. T., Hess, K. I., . . . Richard, C. A. (2008). Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity, and the Arts, 2,* 68–85. http://dx.doi.org/10.1037/1931-3896.2.2.68

Stein, M. I. (1953). Creativity and culture. *The Journal of Psychology, 36,* 311–322. http://dx.doi.org/10.1080/00223980.1953.9712897

Strick, M., van Noorden, T. H., Ritskes, R. R., de Ruiter, J. R., & Dijksterhuis, A. (2012). Zen meditation and access to information in the unconscious. *Consciousness and Cognition, 21,* 1476–1481. http://dx.doi.org/10.1016/j.concog.2012.02.010

Stuckey, H. L., & Nobel, J. (2010). The connection between art, healing, and public health: A review of current literature. *American Journal of Public Health, 100,* 254–263. http://dx.doi.org/10.2105/AJPH.2008.156497

Urban, K. K., & Jellen, H. G. (1996). *Test for creative thinking-drawing production (TCT-DP*). San Diego, CA: Swets Test Services.

Wenk-Sormaz, H. (2005). Meditation can reduce habitual responding. *Advances in Mind-Body Medicine, 21,* 33–49.

Xu, J., Vik, A., Groote, I. R., Lagopoulos, J., Holen, A., Ellingsen, O., . . . Davanger, S. (2014). Nondirective meditation activates default mode network and areas associated with memory retrieval and emotional processing. *Frontiers in Human Neuroscience, 8,* 86. http://dx.doi.org/10.3389/fnhum.2014.00086

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