

Investigating the influence of meditation style and practitioner experience on change blindness using a flicker-paradigm.

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Research Article

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Abstract

Change blindness engenders an inability to detect changes made to a visual scene and has negative implications for areas such as road safety and eye-witness memory. Therefore, it's important to find ways of reducing change blindness to create a safer society. One way this might be achieved is through the practice of meditation. Regular practice of meditation may reduce the effects of change blindness by expanding a practitioner's consciousness and brain potential over time. This study compared the influence of practitioner experience and meditation style- Transcendental Meditation (TM) or Mindfulness-based Meditation (MBM), on change blindness susceptibility. Forty-six participants (30 female and 16 male) with a combined mean age of 42 years old, were assigned to two experimental groups depending on the pre-existing meditation style they practiced. Both groups completed an identical experimental task known as a flicker-paradigm where they had to identify changes made to various images. A two-way independent ANOVA revealed a significant effect of meditation style and experience on change-detection reaction times- ($F(1,42) = 7.22, p < 0.05, \eta^2 = .147$), with long-term transcendental meditation practitioners recording faster reaction times (mean = 5927.73, SD = 606.92) on average than long-term mindfulness-based practitioners (mean = 10949.92 SD = 984.72). These results support the contention that long-term practice of transcendental meditation is more effective at reducing change blindness than long-term practice of mindfulness-based meditation.

1. Introduction

Human perception has limitations and is prone to error. One such error is known as change blindness and refers to a lack of attention where changes made to a visual scene go undetected. These failures to detect change involve both visual memory and attention. It is important to understand why our perceptual systems may fail us and how this limitation may be ameliorated in order to create a safer and more harmonious society for all, particularly in areas such as road safety. Rensink et al. (1997) carried out one of the earliest investigations into change-blindness. Individuals were presented with two slightly dichotomous images, with a 0.25-second blank screen in between the images. This method was termed the "flicker-paradigm", as it created an illusion of flickering when performed. In the study, participants needed multiple attempts to notice a change between the images. Therefore, Rensink et al. (1997) demonstrated that a deficit of attentional resources underlies change blindness. When the limits of the attentional system were met by a high cognitive workload, change blindness was likely to occur (Rensink et al. 1997). Furthermore, Schankin et al. (2017) investigated the effect of varying stimuli on change blindness. In each trial, mudsplashes were used to divert attention away from the change that was made. They concluded that any object that distracts attention in a visual scene determines the speed of the change detection (Schankin et al. 2017). When the participants' attention was directed towards the distracting objects, they were less likely to notice alternations, and as a result, took longer to report that a change had taken place. Thus, change blindness suggests that our cognitive processes, namely perception and, attention, are vulnerable to cognitive overload and error. Therefore, it is salient to find a

way to reduce change-blindness. The following discussion will analyze the practice of mediation and its potential to decrease this perceptual error.

Meditation techniques have been practiced for thousands of years. Nowadays, there are numerous meditation styles available. Each technique explores consciousness from a different perspective and produces varying patterns of brain activation. Meditation expands a practitioner's conscious awareness and brain potential over time and may reduce the effects of change blindness (Travis, 2014). This research project focuses on two types: Transcendental Meditation (TM) and Mindfulness-Based Meditation (MBM). Firstly, a categorical distinction needs to be made between each technique. On the one hand, Mindfulness-based meditation is an open-monitoring meditation style, where the practitioner focuses their attention, in an unattached and non-judgmental way, to anything arising in the present moment, such as thoughts, sensations or emotions. In this way, practitioners act as witnesses to the ebb and flow of consciousness. On the other hand, the Transcendental meditation technique is an automatic-self transcendence meditation style where one is given a word with a unique sound known as a mantra. This word is specifically chosen to facilitate the process of settling the mind in a spontaneous and effortless way. During the practice, the practitioner uses his or her mantra to dive within and experience subtler levels of thought extending beyond the ordinary waking mind. Their mind becomes infused with pure-consciousness and they experience substantial improvements across a wide range of physiological and psychological variables. Thus, we may say that the overall goal of meditation is to expand consciousness and decrease both psychological and physiological stresses.

Both mediation practices have significant effects on physical and psychological health. Creswell (2017) reported significant reductions in stress-induced chronic illness, as well as improved immune system functioning in Mindfulness-based meditation practitioners. Previous research has also demonstrated the positive effects of the TM technique on physical health. For example, the practice of TM leads to health improvements among patients with high blood pressure (Bai et al. 2015), coronary heart disease (Paul-Labrador, 2006) and alcohol, tobacco, and drug addictions (Alexander et al. 1994). Moreover, both meditation techniques have been found to promote psychological well-being. Regular practice of both MBM and TM has been shown to positively influence mental health disorders, such as Major Depressive Disorder, Generalised Anxiety Disorder, and Post-Traumatic Stress Disorder. For instance, as Creswell (2017) highlights, Mindfulness-based Cognitive Therapy can effectively prevent relapses in depression and reduce the effect of anxiety disorders when compared to other "gold-standard" treatments such as Cognitive-Behavioural Therapy (CBT). In addition, TM has been found to alter baseline brain wave activity, and successfully reduce state anxiety (Tomljenović, 2015), reduce self-reported depression among university students (Burns et al. 2011), and improve primary measures of PTSD among war veterans (Rosenthal, 2011). Thus, these findings suggest that meditation techniques such as MBM and TM are very powerful tools to promote physiological and psychological wellbeing. However, as Rosenthal (2012) highlights, TM consistently outperforms MBM practice in the research literature and may be a more effective technique to promote health and wellbeing. Perhaps, this is due to the increased levels of activation in certain brain regions during TM practice, such as the Dorsolateral Prefrontal Cortex and the Anterior Cingulate Gyrus, as well as the distinct Alpha-1 brainwave patterns found only in TM

practitioners, as Travis (2014) contends. Finally, long term practice of the Transcendental Meditation technique has been associated with higher states of consciousness including finer levels of perception and cognition. Travis (2014) contends that this experience of higher states of consciousness during TM is “the engine that fosters higher human development”. Electroencephalography (EEG) studies have supported these claims. Long term meditation leads to more integrated brain functioning (Travis, 2014). When each brain region is operating coherently, a relaxed but wakeful state of functioning emerges. This means the brain can operate most optimally and efficiently. For instance, Travis (2014) shows that brain activity during TM practice is unique and engenders higher states of brain integration. Alpha-1 brainwaves produced during TM practice give rise to what is termed as a *restful alertness*. These brainwaves lead to finer states of perception, emotion and cognition outside of meditation with long-term practice. Moreover, TM has also been found to improve cognitive abilities, such as attention and executive functioning, in clinical populations. Grosswald et al. (2008) found TM to improve working memory, executive functioning and reduce ADHD symptoms in children by reducing levels of stress and anxiety. These two examples highlight the converging evidence of the effect of TM on cognitive processes. Thus, research probing meditation practices has proven its ability to improve brain-functioning and engender more efficient cognitive processing over time.

In addition to the style of meditation performed, meditation experience has a significant effect on cognitive processing. Nidich et al. (2005) conducted a study that investigated the cognitive abilities of elderly TM practitioners. They found that those practicing Transcendental Meditation demonstrated significantly higher levels of fluid reasoning ability, verbal intelligence, long-term memory, and speed of processing than non-meditation controls (Nidich et al. 2005). These results highlight the role of meditation experience in developing cognitive abilities and reducing the rate of age-related cognitive decline. Similarly, Hodgins et al. (2010) suggested that meditators demonstrate more flexible and efficient perceptual processing when compared to non-meditators. They used the “flicker-paradigm” to assess change blindness in a group of regular meditators outside the immediate practice of meditation. The results showed that the meditators needed less trials to notice changes and had faster reaction times than non-meditating controls. This suggests that perceptual processing is improved as a consequence of meditation. However, despite the positive findings of this study, the correlational nature of the results limits the scope of this research. The casual direction of the findings is not clear. As Hodgins et al. (2010) point out, it could also be that people with better perception choose to meditate, or another unknown variable might influence this process. Thus, interpretation of these research findings must be taken with caution. Moreover, this study only focuses on one meditation style, namely Mindfulness-based practice, which further limits the scope of the findings. Thus, there is a need to explore the effects of multiple meditation styles on change blindness susceptibility. By doing so, this will determine what meditative practice is the most effective at reducing the maladaptive effects of change blindness.

As pointed out by Schofield et al. (2015), despite the implications of change blindness for public safety, very little research has focused on what can be done to *reduce* the effects of change blindness. As previously stated, meditation may be one way to do this. In their study, Schofield et al. (2015) concluded that brief mindfulness training engenders greater conscious visual awareness of unexpected distractors

(Schofield et al. 2015). This suggests that even short-term practice of mindfulness-based practice, may positively influence visual attention ability, and reduce change blindness. However, participant's experience with meditation in this study was not sufficient to make accurate claims regarding the effects of meditation on cognitive processing. In addition, the fact that they performed the attentional task immediately after meditating may have had a negative impact on the results. Thus, in order to ascertain if meditation practice is associated with habitually better visual processing in real-life situations, it is important that participants are removed from the immediate practice of meditation and practice meditation for a longer term period.

Moreover, previous research has failed to explore the effects of Transcendental meditation on change blindness. Given that Transcendental meditation has been suggested to consistently outperform Mindfulness-based practice in the research literature and activate disparate brain regions, it is likely that TM practitioners will show superior perceptual development and reduced susceptibility to change blindness over mindfulness-based meditation. Despite the lack of research, TM has been shown to improve perception during problem-solving tasks. Dillbeck (1982) found that after two weeks of TM practice, participants displayed a reduction in top-down interference, such as beliefs and expectations, during problem-solving tasks. This led to better performance on letter and playing card detection tasks. Dillbeck (1982) suggests that regular practice of TM reduces interference of habitual cognitive schema gives rise to more flexible and efficient problem-solving ability. It is possible that the reduction of mental activity that aided problem-solving in Dillbeck (1982), might also assist in reducing the effects of change blindness. It is also likely that the reduction of anxiety associated with TM practice would boost attentional ability in a similar way, as Grosswald et al. (2008) found and reduce the effect of change blindness among the TM practitioners.

Therefore, the proposed study will explore whether TM practice leads to superior perceptual development compared to mindfulness-based practice, as well as the influence of varying levels of meditation experience on change blindness.

The hypotheses for this study are as follows:

1. Long term meditation practice will lead to faster reaction times on the flicker paradigm than short-term meditation practice.
2. Transcendental meditation practitioners will have faster reaction times on the flicker paradigm than Mindfulness-Based practitioners
3. Long-term Transcendental Meditation practitioners will have faster reaction times on the flicker paradigm than long term Mindfulness-Based practitioners and short-term Transcendental Meditation practitioners will have faster reaction times on the flicker paradigm than short term Mindfulness-Based practitioners.

2. Method

2.1. Design

This study compared the influence of a practitioner's experience and meditation style- Transcendental Meditation (TM) or Mindfulness-based Meditation (MBM), on their change blindness susceptibility. A between-participant, quasi-experimental design was used, which allowed for a direct comparison of *existing* groups of meditators. Participants practiced either Transcendental meditation or Mindfulness-based meditation and had short or long-term experience. There were two independent variables; meditation style and meditation experience. Meditation style had two levels; Transcendental meditation or Mindfulness-based meditation. Meditation experience also had two levels; short-term or long-term. Short-term experience was defined as meditation practice for less than one year but a minimum of two months, whereas long-term experience was defined as one year or more of meditation practice. The dependent variable was measured by averaging participant's change detection reaction times on the flicker-paradigm in milliseconds across the twelve trials. The experimental trials were also counterbalanced to minimize confounding variables. In order to account for trials where participants answered incorrectly, an error rate of 1.2% was established and added to participants overall mean score for the twelve rounds. This error rate was reported by Rensink et al. (1997) to account for large changes on the flicker-paradigm. As this study also made large changes to the images presented on the flicker paradigm, the use of this error rate was a suitable choice. Moreover, this study followed the British Psychological Association's ethical guidelines and was granted approval by the British Psychological Association and The Open University.

2.2. Participants

Forty-six participants, 30 females and 16 males, with a combined mean age of 42 years old were assigned to experimental groups depending on their pre-existing meditation style. Mindfulness-based meditation participants were recruited from three yoga-studios across Dublin. Flyers containing information on the study and the researcher's contact details were distributed at these locations. Participants had to be over eighteen years old, practice MBM every day for at least 20 minutes and have healthy neurological functioning to participate in the study. It was very important that participants described their meditation practice to ensure it matched the study's definition of Mindfulness-based practice. For the purpose of this study, Mindfulness-based meditation was defined as an activity where the practitioner focuses their attention on the present moment in a non-judgemental and deliberate manner. It could be performed while sitting or moving, such as while walking or performing yoga- asanas.

Transcendental Meditation participants were recruited slightly differently. Firstly, permission was granted from the National Director of the TM movement in Ireland to study TM and recruit participants from the nationwide centres. Following the agreement, flyers containing information and contact details were distributed to three TM centres across the greater Dublin area and the study was explained in-person to potential participants at the monthly gatherings during February. The TM technique is a systematic technique and its definition has been clearly defined by Maharishi Mahesh Yogi and the Transcendental Meditation association. Thus, participants had to be registered at a TM centre, and taught by a certified

teacher in order to take part. In addition, participants in this group had to be over 18 years old, have healthy neurological functioning and practice the TM technique every day for at least twenty minutes in order to be eligible to participate.

Any interested individuals from both meditation styles made contact to arrange a time and place to meet and do the experiment. No reward was received by the participants for taking part.

2.3. Materials

A Lenovo 14" laptop running Open-Sesame 3.0.7 was used for the experiment. A template flicker-paradigm was provided by The Open University and adapted to suit the needs of the study. The flicker-paradigm offers a way of measuring change blindness by presenting a series of image pairs that contain minor alternations. The OpenSesame program automatically recorded reaction time in milliseconds and collected information on participant's meditation style, meditation experience, gender and age. Each participant was assigned a number (e.g.: 1,2,3) in order to assign them to IV groups.

2.4. Procedure

All participants were briefed about the specific focus and aims of the study and gave their informed consent before taking part. They were also given instructions for the flicker-task. The researcher's laptop running OpenSesame was used for the experimental task. Gender and age information was collected before the start of the experiment using a questionnaire and three practice trials preceded the experimental round. No data was collected during the practice stage, and participants had an opportunity to become familiar with the procedure and response key. Following this, twelve experimental trials began that contained images of various ordinary scenes. These images included office, bedroom, or living room environments. In each trial, two slightly dichotomous images were presented. In between each image, a blank screen appeared for 0.25 seconds and created the perceptual experience of flickering. A change was made to the first image shown in each pair, and the second image of each pair reflected this minor change. Participants viewed the images on the screen individually and tried to detect where the change was made. Twenty seconds were allocated to locate this change. If a change was detected within the time limit, participants were instructed to click the space bar key to acknowledge their perception of it. This recorded their reaction time in milliseconds. There were two blocks in the experiment that contained six image pairs respectively. Once the first block was completed, participants were instructed to press the space bar and continue to the second block. Moreover, the order of the experimental trials was randomized and all the participants in the study viewed and responded to the same images. This ensured accurate comparisons could be made between the groups. The total time for the experiment was around five minutes. Following the task, participants were instructed to read the debriefing form and thanked for their participation.

3. Results

A two-way repeated measure ANOVA was carried out to investigate the impact of meditation style and experience on change blindness susceptibility. Levene's test confirmed that the assumption of

homogeneity of variance was met, ($F(3,42) = 4.608, P > .05$). There was a significant effect of meditation style on change-detection times ($F(1,42) = 44.04, p < 0.05, \eta^2 = .512$), with TM practitioners (mean = 9550.14, SD = 4113.75) reporting faster reaction times than MBM practitioners (mean = 13125.23 SD = 2816.45). Meditation experience also had a significant effect on change-detection reaction times ($F(1,42) = 115.83, p < 0.05, \eta^2 = .734$) with long-term practitioners (mean = 8648.08 SD = 2683.36) recording faster reaction times than short-term practitioners (mean = 1443.0 SD = 2634.6). Moreover, there was a significant interaction-effect of meditation style and experience on change-detection reaction times ($F(1,42) = 7.22, p < 0.05, \eta^2 = .147$), with long-term Transcendental Meditation practitioners recording faster reaction times (mean = 5927.73, SD = 606.92) on average than long-term Mindfulness-Based practitioners (mean = 10949.92 SD = 984.72). These results support the main research hypothesis and suggest long-term practice of Transcendental Meditation is more effective at reducing change blindness than long-term practice of Mindfulness-Based Meditation.

4. Discussion

The current study found that Transcendental meditation practitioners had faster reaction times on the flicker paradigm when compared to Mindfulness-Based practitioners and demonstrated that long-term meditation practice leads to faster change detection than short-term practice. In addition, long-term Transcendental Meditation practitioners had significantly faster reaction times on the flicker-paradigm than long-term Mindfulness-Based practitioners. These results yield support to all three research hypotheses and suggest that Transcendental Meditation is more effective at reducing change blindness than short Mindfulness-based meditation.

These findings support previous research by Hodgins et al. (2010) who found that meditators needed fewer trials to notice changes and had faster change-detection reaction times than non-meditating controls. However, the current research adds a new dimension to Hodgins et al. (2010) by directly comparing two meditation styles and suggesting that some forms of meditation have a greater impact on change blindness than others. Moreover, the role of meditation experience in this study supports Nidich et al. (2005) who concluded that long-term TM practitioners have significantly faster cognitive processing than non-meditation controls. However, this study extends the scope of Nidich et al. (2005) by demonstrating the effects of meditation experience at a variety of ages across two meditation styles. By doing so, it suggests that this effect of experience is not strictly reserved for elderly individuals but is accessible for younger practitioners who devote themselves to a regular meditation practice for an extended period of time. The findings of this study also expand on Dillbeck et al. (1984), who concluded that regular practice of the TM technique leads to a reduction in top-down, conceptually driven mental activity during problem-solving tasks. This might explain the faster change-detection times of Transcendental Meditation practitioners in the current study. Habitual top-down cognitive interference may be reduced when attempting to detect change as a result of regular meditation and this may decrease an individual's susceptibility to change blindness. However, as Dillbeck et al. (1984) only recruited TM practitioners, future research should focus on comparing two or more meditation styles to

determine whether there is a reduction of conceptually driven mental activity across meditation styles during problem-solving and change blindness tasks.

Furthermore, the faster average reaction times among TM practitioners on the flicker paradigm may be explained with reference to Travis (2014). The unique state of Transcendental consciousness, regularly experienced by the TM participants while meditating, brings about significantly different physiological and neurological changes inside and outside of meditation compared to mindfulness-based practice (Travis, 2014). Thus, frequent exposure to Transcendental consciousness may explain TM practitioners' superior performance in the study. Future research could explore this idea further by asking participants to complete the flicker-paradigm during an fMRI investigation. This would establish whether participants from each group recruited different brain regions when attempting to detect change. Generally speaking, the results of this study convey the benefits of regular meditation practice for cognitive functioning and support the claim made by Rosenthal (2012) that Transcendental meditation consistency outperforms other practices in the research literature, including Mindfulness-based ones. Even though change blindness is a universal cognitive limitation as Rensink et al (1997) suggest, it can be reduced with regular practice of meditation. Therefore, this study supports this claim and suggests that Transcendental meditation is more effective than mindfulness-based practice at minimizing the effects of change blindness.

Moving on, it is worth considering the strengths and weaknesses of this research in order to gain a full appreciation of the findings. This study was the first of its kind to assess change blindness in Transcendental Meditation practitioners and directly compare TM and MBM practitioners on a change-blindness paradigm. This study suggests that the practice of TM leads to greater perceptual development over MBM. In addition, it highlights the need to understand the differences between the various meditation practices performed today and the fact that not all meditation styles offer equal benefits. Furthermore, as participants responded to the same images, clear comparisons could be made between the groups that enabled effective data analysis. However, the data collected may not represent real-world experience of perception. In such a controlled environment participants could focus their attention solely on the task. In a real-world context, such as driving on a busy dual carriage-way, there are many other distractions that must be navigated appropriately, for instance, other road users, traffic signs and road maintenance works. Therefore, this lack of real-world complexity in the experimental procedure limits the findings of this study. Future research may choose to add background distractions during the flicker-procedure, such as flashing lights or ambient noise. This may ameliorate the potential lack of real-world applicability. Secondly, the use of pre-existing groups was a limitation of the present study and this made it difficult to establish a base-line measurement of change blindness susceptibility. Pre-existing meditators were chosen due to the time and financial constraints of this study. Future research may wish to recruit participants with no background in meditation and test their change-blindness susceptibility before and after learning meditation. For instance, it could follow up with participants over a one, three and six-month period to explore the improvements, if any, in participants flicker-paradigm reaction times, resulting from their meditation practice. Finally, this study was limited by the lack of a non-meditating control group. When designing this study, it became increasingly clear that it would be very challenging

to establish what was contributing to participants' performance. For example, if one-quarter of participants did mindfulness, one-quarter were Christians, one-quarter regularly drank and used recreational drugs, and one-quarter was Asian, it would be very hard to control such a wide variety of people. Therefore, the choice was made to directly compare two meditation styles for the sake of simplicity and in accordance with the budget of this project. Future studies may decide to extend the scope of this study to encompass other backgrounds, lifestyles, and spiritual practices.

Overall, this study has laid the groundwork for future research into perception and meditation. As already mentioned, this is a very important area to focus on due to its real-world applicability. Meditation can offer a systematic technique to develop human attention and perception by cultivating human consciousness and expanding brain potential. Moreover, this research study highlights the role of meditation style and experience as meditating factors of change blindness susceptibility. Thus, meditation techniques, like the ones explored in this study, convey our latent ability to unlock the full potential of our cognitive capacity and thereby appreciate finer levels of reality. Ultimately this will enhance the positive impact of our actions and create a more prosperous society. Therefore, meditation practice, particularly the practice of Transcendental Meditation, should not just be viewed as spiritual-based pursuits but instead capture the attention of scientists and policymakers, as powerful tools to engender a safe and harmonious society.

5. Conclusion

Meditation style and practitioner experience are worthy considerations when seeking to reduce change blindness and improve cognitive processing. However, it's important to keep in mind that the various styles of meditation on offer today fail to offer equal benefits to the practitioner. In this study, Transcendental Meditation practitioners were less prone to change blindness than Mindfulness-based meditation practitioners. Longer-term meditators in both styles were also less prone to change blindness. Despite the limitations of this study, these results are promising, and it is hoped that they will act as a springboard for further research into meditation and change blindness

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Declarations

Competing interests: The author declares no competing interests.

Figures

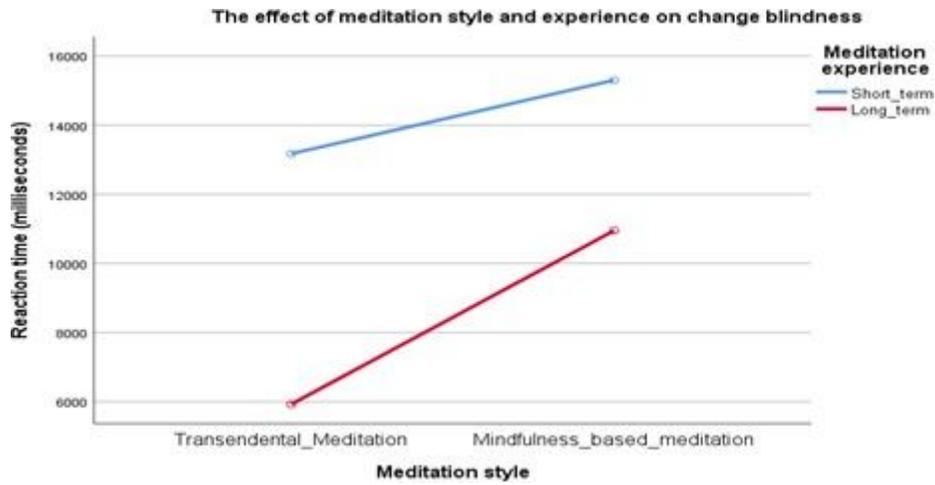


Figure 1

Profile Plot: Mediation experience/style & reaction time on flicker-paradigm