Mindful, Neurotic, or Both: Efficacy of Online Single-Session Mindfulness

Mohd Zahid Juri[1]

School of Psychology, University of Queensland, Brisbane, Australia

[1]Corresponding e-mail:[m.juri@uq.net.au]

With the popularity of online websites and apps that use mindfulness audio recording to teach mindfulness practice, it piqued our interest to examine how online mindfulness resources like Headspace can be helpful to the non-clinical population. The current study aimed to investigate the efficacy of brief (15 min) single-session mindfulness on attention regulation (as measured by word-colour Stroop task). In response to the limitations outlined in previous studies, we also examine the moderation effect of two individual differences (i.e., neuroticism and dispositional mindfulness). This experimental design randomly assigned the participants into either the experimental (Headspace) or control group (audiobook recording). Their level of neuroticism and dispositional mindfulness were measured by using the IPIP-NEO-120 and MAAS scale respectively. Results indicate that, in the experiment group, participants' attention regulation on different levels of neuroticism varied across different level of dispositional mindfulness. However, the patterns of the results were not as expected. This study has shown that in general a single-session mindfulness might not be efficacious in enhancing attention regulation. However, there were specific groups of personality traits that benefitted from it.

Keywords: Single-session mindfulness, dispositional mindfulness, neuroticism, attention

Mindfulness was introduced as part of clinical intervention in the late 1970s (Kabat-Zinn, Lipworth, & Burney, 1985), and became part of various clinical interventions such as mindfulness-based cognitive therapy (MBCT; Segal, Williams, & Teasdale, 2002). Often, the intervention takes places over days or weeks (e.g., standard MBCT took 8 weeks; Segal et al., 2002). Bishop et al. (2004), proposed that mindfulness consists of two components:(1) Self-regulation of attention and (2) Orientation to experience.

Self-regulation is the process of sustaining the attention on the immediate experience (one's thoughts, feelings, and tactile sensations) and switching to their breathing to keep them rooted to their current experience. At the same time, the meditator is taught to adopt a particular orientation (i.e., curiosity, openness, and acceptance) towards their immediate experience to distinguish the different types of immediate experience and how they interact with one another (Bishop, et al., 2004). The therapeutic capability of mindfulness is believed to result from the combination of these two components (Klingbeil, et al., 2017).

Recent developments have attempted to apply mindfulness to non-clinical samples in recognition of the fact that negative affect (e.g., stress) is not unique to clinical populations and is a risk factor for mental and physical illness. To increase the accessibility of mindfulness practice, online resources (e.g., websites, videos, audio recordings) have been introduced. Several studies found that technology-assisted mindfulness and acceptance-based self-help can promote mindfulness and acceptance skills and significantly lower the level of anxiety and depressive symptoms (refer to the meta-analysis by Cavanagh, Strauss, Forder, & Jones, 2014).

However, even with the help of online resources, studies have found that a busy life schedule, lack of routine, strong negative emotions and negative perceptions of mindfulness were still common barriers to practicing mindfulness for non-clinical populations (Laurie & Blandford, 2016); even with readily accessible resources, the time-commitment is still a barrier. To investigate how this barrier might be overcome, the current study tries to determine the extent to which online single-session mindfulness is efficacious for a non-clinical sample.

Headspace

Headspace is an example of an online resource for the practice of mindfulness. It is used in this study because of its popularity among both the general public and researchers (e.g., Yang, Schamber, Meyer, & Gold, 2018). As of April 2019, the Headspace smartphone application (released on 6th January 2012), has been downloaded by over ten million people worldwide. It has both guided (365 in total), and unguided mindfulness meditation delivered using recorded audio or animated video. All guided meditations are pre-programmed and come in sets (e.g., day 1 – day 10).

Headspace mindfulness recordings (when used as a substitute for face-to-face intervention) have been found to be efficacious in improving mindfulness, wellness (Wen, Sweeney, Welton, Trockel, & Katznelson, 2017), decreasing perceived stress (Yang et al., 2018) increasing positive affect, reducing depressive symptoms (Howells, Ivtzan, & Eiroá-Orosa, 2014), increasing life satisfaction and decreasing burnout level (Wylde, Mahrer, Meyer, & Gold, 2017).

Stroop Task

As suggested by Bishop et al. (2004), we test the efficacy of single-session mindfulness by using a task that requires the inhibition of semantic process; specifically, the Stroop task (Stroop, 1935). The Stroop task is a well-established task used to suppress interference, to focus and to direct attention (Stroop, 1935), making it commonly used to assess the function of selective attention (MacLeod, 1991). It is suggested that mindfulness lowers the cognitive cost (Keng, Robins, Smoski, Dagenbach, & Leary, 2013) and increases the efficiency of cognitive resource allocation (Moore, Derose, Malinowski, & Gruber, 2012). By shifting attention from thought to breathing (or other sensations), mindfulness resolves the conflict among these immediate experiences making the meditator better at the Stroop task (Markowska, 2013). Hence, the Stroop task is arguably one of the best measures of attention regulation; and as an extension, the efficacy of single-session mindfulness.

It is noted that some single-session mindfulness studies have inconsistent results. For example, whereas Mrazek, Smallwood, and Schooler, (2012) showed that single-session mindfulness improved attention, Johnson, Gur, David, and Currier (2015) showed that it does not. Watier and Dubois (2016) suggested that the varying result might be moderated by dispositional mindfulness. Dispositional mindfulness is a stable mental trait generally defined as the tendency of being mindful (Lutz, Jha, Dunne, & Saron, 2015). It is shown to vary naturally among the general public even in the absence of mindfulness training (Brown & Ryan, 2003). High dispositional mindfulness in individuals was associated with better performance in an attention task (Moore & Malinowski, 2009). In the study by Watier and Dubois (2016), the benefits of single-session mindfulness (i.e., better attentional regulation) only occurred for participants who had a low dispositional mindfulness.

Other than dispositional mindfulness, neuroticism was also proposed to moderate the relationship between mindfulness and attention regulation (Norris, Creem, Hendler, & Kober, 2018). This is due to its association with the decrease in attentional (visual field) control most likely due to the drop in attentional disengagement (Hahn, Buttaccio, Hahn, & Lee, 2015). Norris et al. (2018) showed that neuroticism moderated the relationship between single-session mindfulness and response inhibition whereby low neuroticism participants performed better than high neuroticism participants.

The limitation of both studies by Watier and Dubois (2016) and Norris et al. (2018) is that they conducted the study in the absence of baseline (pre-intervention) scores. This limits the extent to which they can infer that the difference in participants' performance was because of the mindfulness practice. Hence, to fill in the gap in these studies, the current study administers the Stroop task at both pre- and post-intervention. The current study also incorporates both individual differences to investigate the three-way interaction between these variables.

Hypotheses

Firstly, it is hypothesised that participants in the single-session mindfulness will have a significant improvement in the Stroop task compared to the control group. Secondly, in the control group there will be no changes in the Stroop task performance in low or high – neuroticism participants, regardless of the level of dispositional mindfulness. Thirdly, in the mindfulness group participants' Stroop interference differences for different levels of neuroticism will vary across the level of dispositional mindfulness where a) when the participants have high dispositional mindfulness, the Stroop interference difference will improve regardless of the level of neuroticism. b) However, when the participants have low dispositional mindfulness, the Stroop interference difference will improve only for participants with low neuroticism but not for high neuroticism.

Method

Participants

Eighty-one students (53 females) of the University of Queensland voluntarily took part in this study. Any first-year psychology students received two course credits for their participation. Participants' ages ranged from 17 to 49 years old (M = 21.58, SD = 6.35). Each participant was assigned a sequential number (1, 2, 3…) for confidentiality.

Design and Statistical Analysis

This experimental study was meant to investigate the efficacy of a single-session mindfulness by measuring participants' attention regulation (at pre- and post-intervention) using the Stroop task. The predictor was the group condition (mindfulness vs control); the outcome was Stroop interference difference (noted as $Stroop_{Int.Diff}$ and calculated using the equation 1 below); and the moderators were the level (low vs high) of dispositional mindfulness and neuroticism (measured using Mindfulness Attention Awareness Scale; MAAS and IPIP-NEO-120 respectively). Three separate analyses were conducted in SPSS to test each hypothesis. The first hypothesis was tested by using an independent group t-test, the second and third hypotheses were tested by using moderated multiple regression (MMR) while controlling for sex and age.

$$Stroop_{Int.Diff} = (Incongruent_{post} - Congruent_{post}) - (Incongruent_{Pre} - Congruent_{pre}) \quad (1)$$

Note. Post = Post-intervention, Pre = Pre-intervention

Materials and Measures

Headspace (Mindfulness condition). A 15-minutes guided mindfulness meditation (audio) was used. The audio is voiced by the co-founder of Headspace and a former monk, Andy Puddicombe. The participants visited the website version of Headspace and listened to the instructions given with headphones.

Audiobook (Control condition). A 15-minutes audiobook was used. The audiobook is a short story entitled ‘God Sees the Truth, But Waits’ by Leo Tolstoy, 1872. It is a story about a merchant who is wrongfully accused of a murder. This story was randomly picked from publicly accessible online audiobooks.

Demographics. Participants were asked to report their age, sex, nationality (Australian = 57%, Malaysian = 14%, Chinese = 9%), level of education (High school = 66%, vocational education training = 6%, university undergraduate = 18%, university post-graduate = 4%, and other = 6%). They were also asked to notify if they had practiced any form of meditation before (yes = 16%, no = 84%) and elaborate on the type of meditation and the frequency of practice if they answered ‘yes’ (daily = 5%, weekly & monthly = 1% each, rarely = 3% and other form of schedule = 6%). They also provided their current occupation (students = 100%), and whether English is their first language (yes = 63%, no = 37%). If ‘no’, they were asked to fill in their first language (Malay = 11%, Chinese = 9%, Japanese = 4%).

MAAS. Participants’ dispositional mindfulness was measured using the 15-item scale developed by Brown and Ryan (2003). Brown and Ryan (2003) showed that MAAS has good convergent validity, discriminant validity, and incremental validity when tested against multiple scales. When tested on the current sample, the scale was found to have a good internal reliability (α = .87). All the questions in this scale were the direct measure of participants’ dispositional mindfulness. The participants were asked to indicate how frequently they experience mindfulness in their daily life (e.g., “I snack without being aware that I'm eating”). These items used a 6-point Likert scale ranging from 1 = *almost always*, to 6 = *almost never*. The total scores were calculated, where a higher total score indicate a higher level of dispositional mindfulness.

IPIP-NEO-120 (Neuroticism only). Participants’ level of neuroticism was measured by using a 24-item scale taken from the original 120 personality questionnaire, IPIP-NEO-120, a short version of IPIP-NEO-300, by Johnson (2014). Johnson (2014) showed that IPIP-NEO-120 has a good convergent validity as it has medium correlation of .66 with NEO-PI-R (Costa & McCrea, 1992); another test that measures a very similar construct to IPIP-NEO-120. When tested on the current participants, the scale was found to have a good internal reliability (α = .88). 17 of the items were direct measures of neuroticism (e.g., “Worry about things”). The other seven items were reverse scored (e.g., “Am not easily annoyed”). The participants were asked to indicate how accurate these statements are to their personality. These items used a 5-point Likert scale ranging from 1 = *Very* *inaccurate*, to 5 = *very accurate*. The total scores were calculated, where a higher total score indicates a higher level of neuroticism.

Stroop task. Participants' attention regulation was measured by recording their average response time on five blocks of the word-colour Stroop task (at pre- and post-intervention). On average participants sat 70 cm away from the monitor and were provided with headphones. The colours used (as words and the font colour) in this Stroop task were 'red', 'green', 'blue', and 'yellow' (keyboard response, button C, V, B, and N respectively). The neutral words consisted of 'cup', 'fork', 'spoon', and 'saucer'.

There are three types of stimuli: congruent (words and the font colour are the same; e.g., the word 'Red' coloured red), incongruent (word and the font colour are not the same; e.g., the word 'Red' coloured yellow) or neutral (neutral words with a font colour; e.g., the word 'spoon' coloured blue). The Stroop task was programmed and run using Matlab version 2017b with a grey screen background. The first block was used as a practice block (24 trials) while the other four blocks were experimental blocks (36 trials each).

Participants received feedback at the end of each trial in the practice block only (correct or incorrect; and their response speed in millisecond). As for the other four blocks, participants only receive the average response speed (in milliseconds) and accuracy (in percentage; correct response/total response*100) at the end of each block.

Manipulation check. The participants were asked to notify "the extent to which you were truly meditating in between the computer tasks?", on the range from 1 = *Not at all*, to 10 = *very much*. Higher scores on this measure indicate that participants perceived that they were meditating to a larger degree compared to lower scores.

Procedure

The study was run in a standard computer lab. Only one participant was tested at a time. Researcher provided participants with an information sheet and informed participants that the participation was voluntary, anonymous, and they can withdraw anytime without penalty. The participants were instructed to fill in a battery of tests (on paper) consisting of the demographic questions (sex, age, nationality, level of education, mindfulness experience, occupation, and first language), MAAS and IPIP-NEO-120 (neuroticism) scale followed by the Stroop task (pre-intervention).

After participants completed all five blocks, they would move to another computer located at the corner of the room to give them more privacy. They either listened to Headspace or the audiobook for 15 minutes. The participants were randomised between groups by generating random numbers on https://www.random.org/ (where odd number = mindfulness group, even number = control). Finally, the participants repeat the five-blocks Stroop task (Post-intervention) and completed a manipulation check question. Participants were then debriefed by the researcher and were given the opportunity to ask questions.

Results

Preliminary Analysis

Normality check. The $\text{Stroop}_{\text{Int.Diff}}$ was not normally distributed with the skewness of 0.98 (*SE* = .27) and kurtosis of 2.25 (*SE* = .67, *M* = - 4.23, *SD* = 87.75). Hence, all data points in the $\text{Stroop}_{\text{Int.Diff}}$ were transformed using the square root operation. To deal with the negative scores, all data points were first added with the smallest number + 1 (146.73 + 1) to shift the score distribution to positive and to make sure that the smallest possible number was one. This transformation was normally distributed with the skewness of -0.30 (*SE* = .27), kurtosis of 0.49 (*SE* = .54, *M* = 11.32, *SD* = 3.93) and used for further analysis. Table 1 below summarises the correlation between the variables. The only significant correlation was between dispositional mindfulness (MAAS) and neuroticism (IPIP-NEO-120). However, since the correlation is less than .70, there is no issue of multicollinearity.

Table 1

Correlation between age, sex, MAAS, IPIP-NEO-120, $\text{Stroop}_{\text{Int.Diff}}$ *(square root).*

	Age	Sex	Group	MAAS	IPIP-NEO-120	$\text{Stroop}_{\text{Int.Diff}}$ *(square root)*
Age	-					
Sex	-.05	-				
Group	.19	.03	-			
MAAS	.08	.01	-.22	-		
IPIP-NEO-120	-.05	-.03	.10	-.61**	-	
$\text{Stroop}_{\text{Int.Diff}}$ *(square root)*	-.06	.06	.09	.04	-.05	-

Note. Sex (1 = male, 2 = female) and group (0 = control group, 1 = mindfulness). ** $p < .001$.

Manipulation check. An independent group t-test indicated that the manipulation check scores were significantly higher for mindfulness (*M* = 7.05, *SD* = 2.40) than for the control group (*M* = 4.75, *SD* = 2.54), *t*(76) = -4.11, $p < .001$. Hence, the manipulation check was successful.

Main Analyses

Hypothesis 1. An independent group t-test indicated that $\text{Stroop}_{\text{Int.Diff}}$ (square root) scores between mindfulness and control group were not significantly different, *t*(77) = -0.82, *p* = .414.

Hypothesis 2. In the control condition, a moderated multiple regression (MMR) was used to test the relationship between the predictors (age, sex, MAAS, IPIP-NEO-120 and the interaction of MAAS x IPIP-NEO-120) and the outcome variable (square root $\text{Stroop}_{\text{Int.Diff}}$). Before the MMR was run, assumption checks were conducted. The normality check revealed that the transformed $\text{Stroop}_{\text{Int.Diff}}$ was normally distributed with the Shapiro-Wilk value of 0.98, *p* = .695. A curve estimation analysis revealed that MAAS had a quadratic relationship with the square root $\text{Stroop}_{\text{Int.Diff}}$. The quadratic model (*F*= 1.02, *p* = .371, R^2 = .05) had a better fit as compared to the linear model (*F* = 0.11, *p* = .746, R^2 =.00). Hence MAAS was squared for further analysis (β = -1.87, *p* = .188). The statistics and correlations are reported in table 2 below.

Table 2

Statistic and the correlation between age, sex, MAAS (squared), IPIP-NEO-120, $\text{Stroop}_{\text{Int.Diff}}$ *(square root) in the control group only.*

	M (*SD*)	Age	Sex	MAAS	IPIP-NEO-120	$\text{Stroop}_{\text{Int.Diff}}$ (square root)
Age	20.41 (4.06)	-				
Sex	-	-.35*	-			
MAAS (squared)	3585.49 (1378.11)	.25	-.08	-		
IPIP-NEO-120	64.83 (14.18)	-.11	-.07	-.62**	-	
$\text{Stroop}_{\text{Int.Diff}}$ (square root)	10.97 (4.41)	-.06	.12	.08	-.02	-

Note. Sex (1 = male, 2 = female). Since it was not meaningful, the descriptive data were removed. **p* < .05, ** *p* < .001.

The predictors of MAAS (squared) and IPIP-NEO-120 were mean-centred to minimize the multicollinearity between these predictors and the interaction term (MAAS squared x IPIP-NEO-120). In block 1, age (β = 0.11, *p* = .519) and sex (β = 0.16, *p* = .365) were entered to control for its effect on the whole model which accounted for a non-significant 3% variance in the $\text{Stroop}_{\text{Int.Diff}}$ (square root), $F_{ch.}(2, 38) = .482$, $p = .621$.

In block 2, the mean-centred MAAS (squared) and IPIP-NEO-120 were entered. They account for 2% of variance in the $\text{Stroop}_{\text{Int.Diff}}$ (square root) $F_{ch}(2, 36) = .28$, $p = .755$. In the control condition, MAAS (squared; β = .151, *p* = .487) and IPIP-NEO-120 (β = .14, *p* = .523) were not significant predictors of the $\text{Stroop}_{\text{Int.Diff}}$ (square root) with each accounting for 1% of the variance.

In block 3, the interaction explained less than 1% of the variance in the $\text{Stroop}_{\text{Int.Diff}}$ (square root), $F_{ch.}(1, 35) = 0.02$, $p = .901$. The interaction term was not significant, β = 0.03, *p* = .901. A total of 4% of the variance in the $\text{Stroop}_{\text{Int.Diff}}$ (square root) was explained by age, sex, MAAS, IPIP-NEO-120 and the interaction at block 3, $F(5, 35) = .29$, $p = .913$.

Hypothesis 3. In the mindfulness condition, an MMR was used to test the relationship between the predictors (age, sex, MAAS, IPIP-NEO-120 and the interaction of MAAS x IPIP-NEO-120) and the outcome variable (square root $\text{Stroop}_{\text{Int.Diff}}$). Before MMR was run, assumption checks were conducted. The normality check revealed that the $\text{Stroop}_{\text{Int.Diff}}$ (square root) was normally distributed with the Shapiro-Wilk value of 0.96, *p* = .202. Curve estimation analysis revealed that the MAAS had a quadratic relationship with the $\text{Stroop}_{\text{Int.Diff}}$ (square root). For MAAS, the quadratic model ($F = 5.25$, $p = .01$, $R^2 = 0.23$) had a better fit compared to the linear model ($F = .21$, $p = .648$, $R^2 = .01$). Hence, was squared for further analysis MAAS (β = 3.02, *p* = .003). The statistics and correlations are reported in table 3 below.

Table 3

Statistic and the correlation between age, sex, MAAS (squared), IPIP-NEO-120, $\text{Stroop}_{\text{Int.Diff}}$ *(square root) in the mindfulness group only*

	M (*SD*)	Age	Sex	MAAS (squared)	IPIP-NEO-120	$\text{Stroop}_{\text{Int.Diff}}$ (square root)
Age	22.84 (8.01)	-				
Sex	-	.11	-			
MAAS (squared)	3019.79 (1393.38)	.11	.15	-		
IPIP-NEO-120	67.63 (15.06)	-.05	.01	-.57**	-	
$\text{Stroop}_{\text{Int.Diff}}$ (square root)	11.70 (3.36)	-.19	.-.03	.00	-.17	-

Note. Sex (1 = male, 2 = female). Since it was not meaningful, the descriptive data were removed. *p < .05, ** p < .001.

The predictors of MAAS (squared) and IPIP-NEO-120 were mean-centred. In block 1, age (β = -0.19, p = .257) and sex (β = -0.00, p = .981) were entered. They accounted for a non-significant 4% variance in the $\text{Stroop}_{\text{Int.Diff}}$ (square root), $F_{ch.}(2, 35) = 0.68$, p = .516, $R^2 = 0.04$.

In block 2, the mean-centred MAAS (squared) and IPIP-NEO-120 were entered. They accounted for 4% of the variance in the $\text{Stroop}_{\text{Int.Diff}}$ (square root), $F_{ch.}(2, 33) = 0.75$, p = .480, $R^2 = 0.08$. In the mindfulness group, MAAS squared (β = -0.13, p = .551) and IPIP-NEO-120 (β = -0.25, p = .232) were not significant predictors of the $\text{Stroop}_{\text{Int.Diff}}$ (square root) with each accounting for 1% and 4% of variance respectively.

In block 3, the interaction uniquely explained 13% of the variance in the $\text{Stroop}_{\text{Int.Diff}}$ (square root), $F_{ch.}(1, 32) = 5.34$, p = .027, $R^2 = 0.21$. The interaction term (MAAS squared x IPIP-NEO-120) was significant, β = 0.38, p = .027. The result had a power of 0.49. A total of 21% of the variance in the $\text{Stroop}_{\text{Int.Diff}}$ (square root) scores were explained by age, sex, MAAS, IPIP-NEO-120 and the interaction at block 3, $F(5, 32) = 1.71$, p = .161. The interaction was the most important predictor in this model.

A simple slopes analysis was conducted to follow up the significant interaction (figure 1 below). In this analysis, the *original* MAAS, IPIP-NEO-120, and $\text{Stroop}_{\text{Int.Diff}}$ were used for ease of interpretation. Simple slopes of IPIP-NEO-120 at low and high level of MAAS was conducted at which the levels (low, high) were represented at one *SD* below and above the mean. At low levels of MAAS, high IPIP-NEO-120 showed pre-post improvement (had negative values) while low IPIP-NEO-120 were worse at post-intervention (had positive values); $\beta_s = -0.55$, p = .032, $sr^2 = 0.12$). At high level of MAAS, low IPP-NEO-120 showed pre-post improvement (had negative values) while high IPIP-NEO-120 were worse at post-intervention (had positive values; $\beta_s = 0.16$, p = .521, $sr^2 = 0.01$).

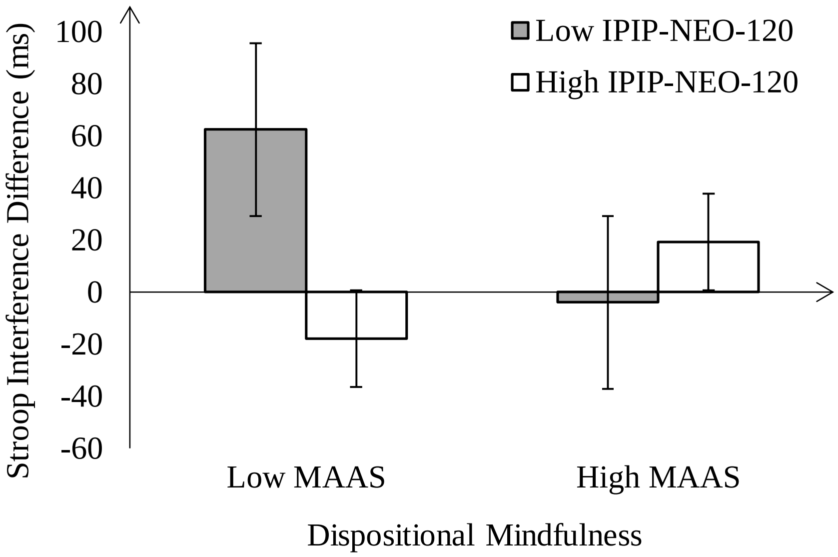

Figure 1. The effect of IPIP-NEO-120 on $\text{Stroop}_{\text{Int.Diff}}$ (pre – post) at different level of MAAS (low MAAS = -1 *SD*; high MAAS = +1 *SD*). Error bars represent standard error.

Discussion

Although, as a group, participants doing single-session mindfulness did not have improved attention regulation (pre-post) compared to the control group (hypothesis 1), we come to understand that this might have resulted from dispositional mindfulness and neuroticism moderating the effect of single-session mindfulness on attention regulation. As expected, among participants who listened to the audiobook, there was no improvement of attention regulation from pre- to post-intervention in low or high levels of neuroticism, regardless of the level of dispositional mindfulness (hypothesis 2). However, we found that participants who listened to Headspace had different attention regulation performance at different levels of neuroticism (across different level of dispositional mindfulness; hypothesis 3).

Interestingly, the pattern is not as expected. For hypothesis 3(a), contrary to expectations, when participants had a high level of dispositional mindfulness, the improvement of attention regulation at post-intervention only occurred in low levels of neuroticism but not at high levels of neuroticism. As for hypothesis 3(b), contrary to expectations, for participants who had low levels of dispositional mindfulness there was only an improvement of attention regulation at post-intervention for high levels of neuroticism and not for low levels of neuroticism.

High dispositional mindfulness

The surprising result of our third hypothesis was the highlight of this paper. For participants with high dispositional mindfulness, only participants who also had low levels of neuroticism performed better. This might indicate that the protective effect of mindfulness found in previous literature might not be extended to attention regulation as high neuroticism participants were found to perform worse at the task post-intervention.

The worsening attention regulation of high neuroticism participants might be explained by understanding the distinction between the tendency to be mindful (i.e., dispositional mindfulness) and the mindfulness skill cultivated via training and practice. Baer et al. (2008) suggested that non-meditator might be prone to maladaptive forms of attention regulation where they are unable to be flexible in attending and switching between their immediate experience (e.g., from observing their thought to breathing). This might be the case for our current participants as 84% of them had never performed any form of meditation.

It is possible that after performing the mindfulness practice, our participants who were naturally mindful and neurotic tended to their negative emotions, thoughts and feelings more but were not armed with the proper skills to deal with them. Thus, making the participants perform worse post-intervention. Hence, single-session mindfulness might not be helpful for someone who has naturally high dispositional mindfulness and high neuroticism if they do not have the skills to deal with their negative emotions.

Low Dispositional Mindfulness

The results showed that participants with low dispositional mindfulness performed better post-intervention when they had high levels of neuroticism and performed worse when they had low levels of neuroticism. This situation might be untangled by exploring the concept of mind-wondering which arguably has the opposite construct to mindfulness (Mrazek et al., 2012). Where mindfulness emphasises the importance of sustaining attention (e.g., Bishop's two-component model), mind-wandering disengages from a primary task in favour of processing internal unrelated information (Smallwood & Schooler, 2006). Hence, low dispositional mindfulness suggests that someone tends to mind-wander more. Since participants are not mindful, asking them to actively tend to their immediate experience might backfire and instead distract them from performing the second Stroop task well and jeopardising the response time. Participants with low neuroticism seem to be affected by this the most.

As for the high neuroticism individual, a study by Robison, Gath, and Unsworth (2017) shows that high neuroticism participants tend to mind-wander more. However, our results showed the opposite. This scenario might be further explained by the resource allocation argument with regards to neuroticism proposed by Smillie, Yeo, Furnham, Jackson, and Zedeck (2006).

Regarding resource allocation, as high neuroticism participants were more susceptible to attentional dysregulation (Wallace & Newman, 1997; 1998), they are also likely to benefit more from a *factor* related to the better allocation of attentional resources (Smillie et al., 2006). For the current study, the *factor* that comes into play is the single-session mindfulness. The argument is that the participants with high neuroticism performed better than participants with low neuroticism because they gained more benefit from the single-session mindfulness; making them mind-wander less.

Implication and Future Research

The current study fills in the gap between the mindfulness (i.e., single-session mindfulness) literature and the individual differences (i.e., dispositional mindfulness-neuroticism relationship) literature as it incorporates the dispositional mindfulness-neuroticism relationship into our understanding of single-session mindfulness. The current study also extends previous work by compensating for the limitations in previous studies (by Watier & Dubois, 2016; Norris et al., 2018); where we provided a baseline (pre-intervention) score for our outcome measure (the Stroop task). Allowing us to determine (1) the baseline differences between the groups (in which we do not find any differences between mindfulness and control group) and (2) the treatment effect (pre – post-intervention).

The interaction between neuroticism and dispositional mindfulness found in this study might suggest that single-session mindfulness might be efficacious for people with a particular combination of traits (high neuroticism and low dispositional mindfulness) and worsen the performance of people with a different combination of traits (low neuroticism and low dispositional mindfulness). This study also highlights the importance of understanding the differences between dispositional mindfulness and cultivated mindfulness and how the pattern of the result might differ if we tested on meditators instead of non-meditators. Aside from that, although neuroticism is often associated with negative outcomes, our results suggest that high neuroticism might foster the effect of single-session mindfulness on attention regulation; given that the person also has low dispositional mindfulness.

The limitation of the study, however, is we did not assess participants' negative affect (i.e., mood, stress, anxiety etc.) and did not control for the effect of the negative affect in the MMR models. We also did not formally ask participants their motivation for participating in this experiment which might contribute to a sample biased towards a particular group (e.g., students who want to practice mindfulness). Plus, most of the participants are female students, which limits the generalisability of this study.

Future research should assess participants' negative affect and motivation to (1) control their effect in the MMR model and (2) assess any changes from pre- to post-intervention. Lastly, future studies could also test the effect of single-session mindfulness on meditators versus non-meditators to verify that these two groups perform the cognitive task differently.

References

Baer, R., Smith, G., Lykins, E., Button, D., Krietemeyer, J., Sauer, S., . . . Williams, J. (2008). Construct validity of the five facet mindfulness questionnaire in meditating and nonmeditating samples. *Assessment, 15(3)*, 329-342. doi:10.1177/1073191107313003.

Bishop, S., Lau, M., Shapiro, S., Carlson, L., Anderson, N., Carmody, J., . . . Devins, G. (2004). Mindfulness: A proposed operational definition. *Clinical Psychology: Science and Practice*, 230-241. doi: 10.1093/clipsy.bph077.

Brown, K., & Ryan, R. (2003). The benefits of being present: Mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology, 84*, 822–848. doi: 10.1037/0022-3514.84.4.822.

Cavanagh, K., Strauss, C., Forder, L., & Jones, F. (2014). Can mindfulness and acceptance be learnt by self-help?: A systematic review and meta-analysis of mindfulness and acceptance-based self-help interventions. *Clinical Psychology Review, 34(2)*, 118-129. doi: 10.1016/j.cpr.2014.01.001.

Costa, P., & McCrea, R. (1992). Revised NEO personality inventory (NEO-PI-R) and NEO five factor inventory (NEO-FFI): Professional manual. *Odessa, FL: Psychological Assessment Resources*.

Hahn, S., Buttaccio, D., Hahn, J., & Lee, T. (2015). Rapid communication: Personality and attention: Level of neuroticism and extraversion can predict attentional performance during a change detection task. *Quarterly Journal of Experimental Psychology, 68(6)*, 1041-1048. doi: 10.1080/17470218.2015.1032986.

Howells, A., Ivtzan, I., & Eiroá-Orosa, F. (2014). Putting the 'app' in the Hapiness: A randomized controlled trial of a smartphone-based mindfulness intervention to enhance wellbeing. *Journal of Happiness Studies, 17(1)*, 163-185. doi: 10.1007/s10902-014-9589-1.

Johnson, J. A. (2014). Measuring thirty facets of the Five Factor Model with a 120-item public domain inventory: Development of the IPIP-NEO-120. *Journal of Research in Personality, 51*, 78-89. doi: 10.1016/j.jrp.2014.05.003.

Johnson, S., Gur, R., David, M., & Currier, Z. (2015). One-session mindfulness meditation: A randomized controlled study of effects on cognition and Mood. *Mindfulness, 6(1)*, 88-98. doi: 10.1007/s12671-013-0234-6.

Kabat-Zinn, J., Lipworth, L., & Burney, R. (1985). The clinical use of mindfulness meditation for the self-regulation of chronic pain. *Journal of Behavioral Medicine, 8, 163e190*.

Keng, S., Robins, C., Smoski, M., Dagenbach, J., & Leary, M. (2013). Reappraisal and mindfulness: A comparison of subjective effects and cognitive costs. *Behaviour Research and Therapy, 51(12)*, 899-904. doi: 10.1016/j.brat.2013.10.006.

Klingbeil, D., Renshaw, T., Willenbrink, J., Copek, R., Chan, K., Haddock, A., . . . Clifton, J. (2017). Mindfulness-based intervention in youth: A comprehensive meta-analysis of group-design studies. *Journal of School Psychology, 63*, 77-103. doi: 10.1016/j.jsp.2017.03.006.

Laurie, J., & Blandford, A. (2016). Making time for mindfulness. *International Journal of Medical Informatics, 96*, 38-50. doi: 10.1016/j.ijmedinf.2016.02.010.

Lutz, A., Jha, A., Dunne, J., & Saron, C. (2015). Investigating the Phenomenological matrix of mindfulness-related practices from a neurocognitive perspective. *American Psychologist, 70(7)*, 632-658. doi: 10.1037/a0039585.

MacLeod, C. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin, 109*, 163-203.

Markowska, A. (2013). Attention processes in mindfulness: The influence of mindfulness intervention on performing Stroop based tasks. *Acta Neuropsychologica, 11(4)*, 333-344, doi: 10.5604/17307503.1090458.

Moore, A., & Malinowski, P. (2009). Meditation, mindfulness and cognitive flexibility. *Consciousness and Cognition, 18(1)*, 176-186. doi: 10.1016/j.concog.2008.12.008.

Moore, A., Derose, J., Malinowski, P., & Gruber, T. (2012). Regular, brief mindfulness meditation practice improves electrophysiological markers of attentional control. *Frontiers in Human Neuroscience, 6(2012)*, 18. doi: 10.3389/fnhum.2012.00018.

Mrazek, M., Smallwood, J., & Schooler, J. (2012). Mindfulness and mind-wandering: finding convergence through opposing constructs. *Emotions*, Advance online publication. doi: 10.1037/a0026678.

Norris, C., Creem, D., Hendler, R., & Kober, H. (2018). Brief mindfulness meditation improves attention in novices: Evidence from ERPs and moderation by neuroticism. *Frontiers in human neuroscience, 12,* 315. doi:10.3389/fnhum.2018.00315.

Robison, M., Gath, K., & Unsworth, N. (2017). The neurotic wandering mind: An individual differences investigation of neuroticism, mind-wandering, and executive control. *The Quarterly Journal of Experimental Psychology, 70(4)*, 649-663, doi: 10.1080/17470218.2016.1145706.

Segal, Z., Williams, J., & Teasdale, J. (2002). *Mindfulness based cognitve therapy for depression.* New York: Gulford.

Smallwood, J., & Schooler, J. (2006). The restless mind. *Psychological Bulletin. 132(6),* 946-958. doi: 10.1037/0033-2909.132.6.946.

Smillie, L., Yeo, G., Furnham, A., Jackson, C., & Zedeck, S. (2006). Benefits of all work and no play: The relationship between neuroticism and performance as a function of resource allocation. *Journal of Applied Psychology, 91(1),* 139-155. doi: 10.1037/0021-9010.91.1.139.

Stroop, J. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology, 18,* 643-661.

Wallace, J., & Newman, J. (1997). Neuroticism and the attentional mediation of dysregulatory psychopathology. *Cognitive Therapy and Research, 21(2),* 135-156. doi: 10.1023/A:1021828628571.

Wallace, J., & Newman, J. (1998). Neuroticism and the facilitation of the automatic orienting of attention. *Personality and Individual Differences, 24(2),* 253-266. doi: 10.1016/S0191-8869(97)00153-0.

Watier, N., & Dubois, M. (2016). The effect of a brief mindfulness exercise on executive attention and recogntion memory. *Mindfulness, 7(3),* 745-753. doi: 10.1007/s12671-016-0514-z.

Wen, L., Sweeney, T., Welton, E., Trockel, L., & Katznelson, M. (2017). Encouraging mindfulness in medical house staff via smartphone app: a pilot study. *Academic Psychiatry, 41(5),* 646-650. doi: 101007/s40596-017-0768-3.

Wylde, C., Mahrer, N., Meyer, R., & Gold, J. (2017). Mindfulness in novice pediatric nurses: Smartphone application versus traditional intervention. *Journal of Pediatric Nursing, 36,* 205-212. doi: 10.1016/j.pedn.2017.06.008.

Yang, E., Schamber, E., Meyer, R., & Gold, J. (2018). Happier healer: Randomized controlled trial of mobile mindfulness for stress management. *The Journal of Alternative and Complementary Medicine, 24(5),* 55-513. doi: 10.1089/acm.2015.0301.