AN INVESTIGATION ON BEHAVIOR COVERING THE CONNECTION BETWEEN THOUGHTFULNESS AND PERCEPTIVE RESILIENCY

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Abstract

The aim of the study is to explore the relationship between mindfulness and cognitive flexibility with an objective behavioural assessment. Mindfulness was assessed with breath counting (BC) accuracy recording on a computer program focusing on attentional self-awareness in the present. Ninety-four healthy volunteers from Thailand and the United Kingdom participated in a laboratory. Next, cognitive flexibility was measured by the Wisconsin Card Sorting Test (WCST) to assess shifting and inhibiting ability of executive functions. The WCST indicated perseverative behaviours and cognitive flexibility. The results showed BC accuracy negatively correlated with the score of failure to maintain set of the WCST, and uniquely predicted failure to maintain set score with hierarchical linear regressions. The findings suggest that the more individual pay attention to the self-awareness of the present, the greater their performance on inhibition tasks. Implications of the study contribute to the theoretical literature of mechanism of mindfulness on cognitive flexibility. Limitations of the study was discussed.

Keywords: Cognitive Flexibility, Behavior Covering, Thoughtfulness and Perceptive Resiliency

Introduction

Mindfulness in Buddhist Pali canyon is known as “Sa-ti”, traditionally meaning the awareness of the emerging experiences in ones’ own mind and body at the present state while maintaining equanimity [Phra Thepwehi (Prayut), 1993, p. 21]. In relation with cogntive psychology, mindfulness refers to being self-aware of the present experiences including feeling, thought, and sensation without elaborating on such experiences (Kabat-zinn, 1990). Mindfulness has gained widespread acceptance and attention both clinical and non-clinical sectors over the past two decades (Chiesa et al., 2017; Alsubaie et al., 2017). Mindfulness has therefore been studied in several areas, such as mental health (Chiesa et al., 2017). A key component of mindfulness includes the ability to utilise cognitive strategies to adapt to different circumstances, thus intricately linked to cognitive flexibility (Moore & Malinowsky, 2009). However, past studies have produced mixed findings between mindfulness and cognitive flexibility due to methodological heterogeneity among studies (Anicha, Ode, Moeller, & Robinson, 2011). Therefore, there does not appear to be a clear link between mindfulness and cognitive flexibility. A key limitation among studies is their use of subjective measures of mindfulness (Chiesa, 2013; Purser & Milillo, 2015). This study circumvents this by including an objective measure of mindfulness to reveal a more consistent relationship between cognitive flexibility and several aspects of mindfulness. Hence. the objective of the present study is as follow.

Research Objective

1.To investigate relationships between mindfulness and cognitive flexibility measured by the behavioral approach.

Literature Reviews

Measuring mindfulness: The function of mindfulness is to anchor, monitor, and maintain an individual’s awareness to the internal present moment, without the influence from excessive rumination. Consequently, mindfulness is a multi-dimensional process, encompassing concepts such as decentring (non-judgmental attitudes toward immediate experiences), curiosity (openness to inner present experience), etc. (Chiesa, 2013). Importantly however, methods of measuring mindfulness can differ. Subjective and objective measures of mindfulness have been developed. Several scales exist in the literature such as the the Five Facets of Mindfulness Questionnaire: FFMQ (Baer et al, 2006), however such methods may be contained bias. Not all participants may have the same understanding of mindfulness, and thus can have different interpretation of items on different scales (Chiesa, 2013; Gethin, 2011; Grossman & Van Dam, 2011; Purser & Milillo, 2015; Spinelli, Ibrahim, & Khoury, 2022). One common objective measure involves breath counting (BC), which focuses on breathing as an indicator of being in the present moment (Levinson et al., 2014). Herein, greater accuracy of breath counts by the individual indicates a greater degree of mindfulness. As a result, BC can be used as an objective measure of mindfulness (Spinelli, Ibrahim, & Khoury, 2022).

Cognitive flexibility and mindfulness: Cognitive flexibility is the process of adapting to changing circumstances using appropriate cognitive strategies (Cañas, Fajardo, & Salmerón, 2006). This involves several mechanisms such as inhibition, cognitive switching, and abstract reasoning (Lee & Orsillo, 2014; Moore & Milinowski, 2009). These are typical components of executive functions, involved in planning and goal directed behaviours. (Huang, et al., 2020; Murphy-Beiner & Soar, 2020). In relation to mindfulness, cognitive flexibility has been implicated in emotional regulation (Cañas, Fajardo, & Salmeron, 2003; Murphy-Beiner & Soar, 2020). Moreover, mindfulness involves the ability to shift attentional focus, inhibit negative rumination, and cognitively adapt to the changing environment (Wimmer, Bellingrath, Stockhausen, 2016; Fox, Kang, Lifshitz, & Christoff, 2015). As such, mindfulness and cognitive flexibility may bear a strong theoretical relationship.

Several studies have broadly supported the relationship between mindfulness and cognitive flexibility. For example, Moore & Malinowski (2009) reported a significant positive relationship between mindfulness assessed by the Kentucky Inventory of Mindfulness Scale (KIMS) and cognitive flexibility. However, different dimensions of mindfulness are known to exhibit independent relationships with performance on executive function tests. Anicha, Ode, Moeller, & Robinson (2011) revealed the different dimension of mindfulness (observing, acting with awareness, describing, nonjudgment, and nonreactivity) assessed with FFMQ was different related with cognitive flexibility. Individuals high in the nonreactivity (but not observing) facet of mindfulness exhibited greater cognitive control flexibility (Anicha, Ode, Moeller, & Robinson, 2011). Such studies indicate that the relationship between mindfulness and cognitive flexibility might be contingent on measurement methods. As such, we explore the relationship between an objective measure of mindfulness (BC), and the performance on a cognitive flexibility test.

Hypothesis

We hypothesis that BC would significantly correlate with performance on the WCST. We further hypothesise that BC as an indicator of mindfulness would significantly predict performance on the WCST.

Research Conceptual Framework

The research conceptual framework is based on theoretical concepts and previous findings that mindfulness has a significant relationship with cognitive flexibility (Figure 1).

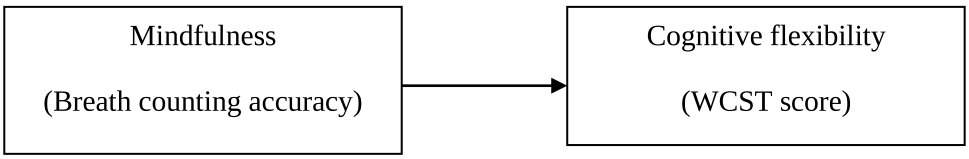

Figure 1: A conceptual framework of the study

Research Methodology

Participants

Ninety-four participants were included in the study. Participants were recruited from the United Kingdom and Thailand, each included 47 healthy participants. The age range was 18 to 62 (M = 20.32; SD = 0.53), with 80 females (85.1%).

Procedure

In the UK, participants were recruited via the Experimental Participation Requirements (EPR) system of university of Leicester. In Thailand, undergraduate and graduate students in university in Chiang Mai were recruited via social media advertisement in Facebook page of Chiang Mai university. The present study used an analogue laboratory to investigate the relationship between mindfulness and cognitive flexibility via a behavioural approach. Upon arrival at the laboratory, participants provided informed consent. The first session was the assessment of the cognitive flexibility via the Wisconsin Cards Sorting Test (Heaton et al., 1993). The final session evaluated the level of mindfulness by breath counting accuracy (Levinson et al., 2014), recording respiratory rate by a respiratory belt. The study lasted approximately 45 minutes.

Measure and Data scoring

Breath counting (BC) programme is a computerized programme to measure mindfulness through breath counting accuracy. The accuracy of breath counting was recorded via a computer program replicating the methodology outlined by Levinson et al. (2014). Participants counted their breath from 1 to 9 and was asked to respond with a downward arrow key after inhaling and exhaling between 1 to 8 breaths, followed by an upward-arrow key after the 9^{th} breath. The upward key was pressed if they miscounted their breath, restarting the cycle. BC accuracy was calculated as a percentage using the following formula: (Total incorrect ongoing 9-counts + the number of incorrect count probe responses + the number of self-caught miscounts) / (the number of ongoing 9-counts + the number of count probe responses + the number of self-caught miscounts). The Venier respiration monitor belt with Logger Pro 3 was used as an instrument to confirm the respiratory rate of the respondent. The BC program has exhibited sufficient validity (Levinson et al., 2014). Its accuracy of BC positively correlated with the trait mindfulness scale; the Mindful Attention Awareness Scale (Brown & Ryan, 2003) ($r = 0.20$, $p < 0.05$) and the Five Facets Mindfulness Questionnaire (Baer et al., 2006) ($r = 0.21$, $p < 0.05$) (Levinson et al., 2014).

Wisconsin Card Sorting Test: WCST (Heaton et al., 1993**)** is a neuropsychological measure designed to assess cognitive flexibility. WCST consists of various cards illustrated geometric figures with different colour, shape and number. Participants are to sort the cards according to a set of rules (i.e., by colour, shape, and number), and these rules change if participant sorts up to 10 cards correctly. Sorting feedback (correct or incorrect) is provided to participants each trial. WCST score includes: 1) the number of complete categories of correct card sort, 2) the number of perseverative errors (participants persist in incorrect strategy), 3) non-perseverative errors (random errors of card sorting), 4) set maintenance failure (incorrect sort strategy despite shown rule), and 5) total number of errors (sum of preservative and non-preservative errors). The split-half test-re-test reliability of WCST is sufficient (above 0.90) (Kopp, Lange & Steinke, 2021). The WCST is also relatively resistant to language and cultural influences (Tan, Burgess & Green, 2021; Tan & Burgess, 2022).

Data analysis

The Statistic Programme for Social Statistic: SPSS (IBM, Chicago, USA; IBM Corp. 2019) was conducted including descriptive statistic to analyze demographic data, Pearson's correlational analysis, and hierarchical multiple regress analysis to test hypothesis of the study. G*Power (Faul et al., 2007) which estimated that a sample size of 67 was required for correlations to detect a medium effect size (r = 0.5) with 80% power and a p value of 0.05).

Results

Correlations

According to Table 1, breath counting accuracy has a negative significant correlation with Failure to maintain set score [r (94) = -.35, p <.01)]. However, no significant correlation was identified between breath counting accuracy and total number of correct trials [r (94) = -.08, p = ns)], total number of errors [r (94) = -.07, p = ns)], perseverative response [r (94) = -.13, p = ns)], % of perseverative response [r (94) = -.12, p = ns)], perseverative errors [r (94) = -.08, p = ns)], % of perseverative errors [r (94) = -.03, p = ns)], non-perseverative errors [r (94) = -.10, p = ns)], % of non-perseverative errors [r (94) = -.05, p = ns)].

Table 1 Correlation between mindfulness measured via breath counting accuracy and cognitive flexibility measured via WCST

	M	*SD*	1	2	3	4	5	6	7	8	9	10
1. BC Accuracy	0.73	.16										
2. Total number of correct trials	80.62	17.71	-.08									
3. Total number of errors	26.09	39.23	-.07	.05								
4. Perseverative response	25.84	18.81	-.13	.57**	.22*							
5. % Perseverative response	23.56	14.47	-.12	.38**	.15	.90**						
6. Perseverative errors	13.56	9.64	-.08	.17	.35**	.82**	.73**					
7. % Perseverative errors	13.08	8.45	-.03	-.11	.24*	.53**	.73**	.74**				
8. Non-perseverative errors	8.86	8.00	-.10	-.05	.35**	.06	-.04	.21*	.07			
9. % Non-perseverative errors	8.69	7.23	-.05	-.24*	.24*	-.15	-.01	.03	.33**	.81**		
10. Failure to maintain set	0.76	1.09	-.35**	.35**	.01	.37**	.30**	.30**	.14	.03	-.07	

*p<.05. **p<.01

Note: M = Mean, SD = Standard deviation, 1. **=** Breath counting accuracy (BC Accuracy)

2 = Total number of correct trials of WCST, 3 = Total number of errors of WCST

4 = Perseverative response of WCST, 5 = % of Perseverative response of WCST

6 = Perseverative errors of WCST, 7 = % of Perseverative errors of WCST

8 = Non-perseverative errors of WCST, 9 = % of Non-perseverative errors

10 = Failure to maintain set of WCST

Hierarchical multiple regression analysis

Hierarchical multiple regression was performed to explore whether BC accuracy remained significantly associated with Failure to maintain set score of WCST after controlling gender (category was recoded to interval scale as dummy code; 0 = female, 1 = male), age, and country (category was recoded to interval scale as dummy code; 0 = UK, 1 = Thailand). The result shows in Table 2

Table 2 Hierarchical Multiple Regression between Mindlessness (Breath counting accuracy) and cognitive flexibility (Failure to maintain set of WCST)

	B	**SE B**	**β**	**t**	**p**
Step 1					
1. Gender	.20	.31	.07	.65	.52
2. Age	-.01	.02	-.05	-.51	.61
3. Country	-.73	.22	-.34	-3.28	.001
Step 2					

1. Gender	.16	.30	.05	.52	.60
2. Age	-.001	.02	-.003	-.032	.97
3. Country	-.64	.21	-.30	-3.03	.003
4. BC Accuracy	-2.02	.65	-.30	-3.13	.002

Notes: R^2 = .21 (p <.01)

According to Table 2, in step 1, gender, age, and country significantly predicted the score of failure to maintain set [F (3, 89) = 4.14, R = .35, R^2 = .12, ΔR^2 = .12, p < .01]. In stage 2, BC accuracy found a significant ΔR^2 in predicting the score of failure to maintain set [F (4, 88) = 5.86, R = .46, R^2 = .21, ΔR^2 = .09, p < .001]. As well, country of the residents significantly predicted the score of failure to maintain set (β= -.30, p = 0.003).

Discussions

Our first hypothesis was partially supported, where BC accuracy is negatively with cognitive flexibility. However, this was restricted to failure to maintain set, with no significant relationship with other components on the WCST. Our second hypothesis was also supported, where BC significantly predicted failure to maintain set on the WCST, after adjusting for a number of covariates. The present finding is accordance with previous studies e.g., Fox, Kang, Lifshitz, & Christoff, 2015; Lukseng, Siripornpanich, & Chutabhakdikul 2020).

The possible explanation of relationship between BC accuracy and set maintenance failure could be attributed to similar cognitive constructs. BC accuracy reflects self-awareness with attention on the present breathing (Levinson et al., 2014). Higher BC accuracy could indicate better ability to maintain attention, whereas those to fail to maintain sets are likely to change their sorting strategy where appropriate (Figueroa & Youmans, 2013). These individuals may not be aware of the present moment, with internal and external distractions, consequently failing to maintain a cognitive process. Mindful individuals tend to pay and maintain their attention and aware of the present personal experiences. With this, they can inhibit themselves to pay attention to unrelated stimuli and respond, which is a main strategy of cognitive flexibility (Lee & Orsillo, 2014; Moore & Milinowski, 2009; Russell & Arcuri, 2015). Therefore, the more mindful individuals are, the more they can exhibit a greater degree of cognitive flexibility. However, BC accuracy failed to show the significant association with the other dimensions of WCST. It is possible that other cognitive process of WCST involves a shifting strategy of cognitive flexibility, whereas BC is more likely to be related to the inhibition aspects of executive functions.

Our results have implications toward understanding mechanisms of mindfulness on cognitive flexibility. This demonstrates that mindfulness is more likely to be salient in aspects of cognition that requires inhibition, control, and self-monitoring, as opposed to those that include shifting strategies. However, our study is not without limitations. The first limitation is that the study may not be generalizable to all populations, especially to clinical settings. As such, our contribution is pointed toward theoretical works of mindfulness. Future studies may expand our work to include clinical populations, or a larger array of socio-cultural background. Moreover, this study only has explored one aspect of mindfulness (present self-awareness with attention) exclude non-elaborating so future studies should explore all aspects of mindfulness for a more comprehensive understanding of the relationship between mindfulness and cognitive flexibility.

Conclusions

Overall, these studies illustrate how mindfulness (attentional self-awareness of the present experiences) related negatively with cognitive flexibility measured by score of failure to maintain set of WCST. The more mindful individuals are, the better they are at cognitive inhibition. The implication of the study expands theoretical understanding mindfulness on cognitive functions. Still, the limitation of study including the lack of heterogeneity of sample should be noted, and studies in the future should investigate among samples with diverse background to increase generalization of these findings. In addition, the facet of non-elaboration should be explored to expand understanding of this topic.

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