Cognition – Emotion Interface Dynamics in the Context of Mindfulness

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Abstract

Mindfulness is a state of being attentive to and being aware of what is taking place in the present (Brown & Ryan, 2003). In Buddhist tradition, the concept of mindfulness represents a quality of consciousness termed bare attention (Brown et al., 2007). Mindfulness strengthens executive functioning (Zylowska et al., 2008). Therefore, it is pertinent to see as to how different levels of mindfulness interact with emotional contexts during performance on working memory task.

The study aimed at investigating the specific role of mindfulness in handling the cognitive load contingencies during emotional context based working memory performance. The initial sample comprised of 200 boys in the age range of 15 to 19 yrs. (mean age = 17 yrs.) drawn from various Government Model Senior Secondary Schools of Chandigarh, in India. The methodology included a computation of repeated measures ANOVA and other descriptive statistics and t-values. Results highlighted interesting trends with overall high performance on working memory in the positive context and the least under negative emotional context with neutral context at power with the positive context more so for the moderate mindfulness group across different cognitive loads.

Keywords : *Mindfulness, working memory, executive functioning, attention, emotional context, cognitive load.*

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Introduction

Mindfulness is a mental mode characterized by full attention to the present-moment experience without judgment, elaboration, or emotional reactivity (Jha et al., 2010). Mindfulness begins by bringing awareness to current experience observing and attending to the changing ?eld of thoughts, feelings, and sensations from moment to moment by regulating the focus of attention.

There is an overlap between the quality of attention fundamental to mindfulness and executive functions (Zylowska et al., 2008), by decreasing the resource demands on working memory resulting in the improvement in attention-related behavioural responses under cognitive load, thus leading to better performance. The research shows that as the working memory demands of a task increase due to cognitive load, people's performance on the task decreases (e.g., Anderson et al., 1996).

Technically, executive attention is understood as a conscious control mechanism that facilitates the focus of attention on task- or goal-relevant information, while inhibiting the task-irrelevant information (Miller & Cohen, 2001) and is considered to be the result of the interplay between diverse frontal and subcortical neural systems. Attention involved in processing emotional information (Vuilleumier et al., 2001) and thus executive attention plays an important role in emotion regulation.

Emotions have been considered as an important component of the tapestry of consciousness and cognitive processes (Izard, 1991) as they may fuel or energize cognitive functioning.

Mindfulness assumes significance since the emotional content of stimuli is known to

affect the distribution of attention, e.g. emotional stimuli are likely to "grab" attention and thus gain prioritized processing. Multiple lines of evidence suggest that emotional stimuli can be processed relatively automatically (e.g., Ohman, 2002), namely independent of attention and awareness. Interestingly, evidence both for and against automacity has been presented. For e.g., emotional faces evoke responses in the amygdala even when attention is diverted to other stimuli (Anderson et al., 2003). Perhaps even more strikingly, amygdala responses are sometimes reported for emotional faces of which subjects are not conscious (Etkin et al., 2004). Therefore, these findings suggest that at least some types of emotional perception occur outside of cognitive processing and may rely on direct subcortical pathways conveying visual information to the amygdala (LeDoux, 1996).

Previously, it was widely held that the memory which was influenced by emotion was distorted or more easily forgotten (Brown & Kulik, 1977). For e.g., Ellis & Ashbrook (1987) found that emotions may increase the information processing load and drain attentional resources that otherwise might be devoted to task performance. But recent studies reported that the memories related to emotion were retained more vividly and in greater detail (e.g., Kensinger & Schacter, 2006).

Pessoa et al. (2002) in a spatial attention task, found no effects of simultaneously presented emotional stimuli on the task performance. That is only when sufficient attentional resources are available emotional stimuli are processed independently of the focus of attention (Pessoa, 2005). However, emotional words have been found to produce greater interference than neutral words in normal participants (McKenna & Sharma, 1995).

Positive emotions have been studied as facilitating factors in changing people's experience through their attitudes, motivation, creativity and problem-solving skills and also by facilitating working memory processes. Whereas on the other hand, negative information is found to draw attention more readily than positive or neutral information (Ohman et al., 2001) as negative stimuli have the power to disrupt people's ongoing activities.

Negative as well as strong positive thoughts, may occupy working memory and are more likely to influence the operation of both the central executive and the episodic buffer sometimes leading to the disruption of the performance of cognitive tasks. Individuals with greater mindfulness have been found to have lower levels of emotional reactivity as compared to individuals with lower levels of mindfulness, in response to negative picture slides. As, it has been found that increased mindfulness strengthens one's ability to regulate emotional experience, as it helps people to better deal with the change in their emotions (Coffey & Hartman, 2008).

Being human is an emotional experience. As a teenager, one may be dealing with lots of emotional highs and lows. Negative emotions can come from a triggering event or an overwhelming workload. Negativity in cognitive style and resulting feelings of hopelessness (Jacobs et al., 2008) might make individuals believe that others will not respond well to their feelings or that supportive reactions from others may not make them feel any better. As a result, these individuals may become emotionally guarded and be more likely to suppress expression of emotions (Larsen et al., 2013).

Therefore, it is important to be aware of, to understand, and to relate to others, deal with

strong emotions and control one's impulses and also adapt to change and to solve problems of a personal or a social nature (Bar-On, 2000) when one is trying to perform well on a task.

Therefore, all the above raise the significant issue regarding the interplay of the executive control, emotional context and mindfulness from the cognitive output perspective. Thus, it was with this objective in view that the study in hand was started.

Research Questions

Does the nature of emotional context differentially interact with cognitive load during working memory performance?

Do individual differences on mindfulness influence the performance output under varying types of emotional contexts and cognitive load levels?

Methodology

Experimental Design

The 3x3x3 repeated measures design constituted of three levels of mindfulness, three conditions of emotional context and three levels of cognitive load conditions in the context of working memory performance with emotional context and cognitive load as repeated measures.

Procedure

The study was carried out in two phases. The phase wise description is as given below:-

Phase – 1

Sample

The initial sample comprised of 200 boys in the age range of 15 to 19 years, (mean age 17 years) from various Government Model Senior Secondary Schools of tricity of Chandigarh, Mohali and Panchkula .

APPARATUS AND EXPERIMENTAL MATERIAL

Mindfulness Attention Awareness Scale (MAAS) by Brown & Ryan (2003).

Phase-2

In Phase-2, 189 subjects classified under three levels of mindfulness viz. high (HM), moderate (MM) and low (LM) levels, on the basis of Phase-1, were administered three conditions of emotional context (viz. positive (b1), negative (b2) and neutral (b3)) respectively, for three levels of cognitive load conditions (i.e. no load (c1), moderate (c2) and high (c3)) based working memory task, individually.

The dependent variable was the performance and the number of correct responses were counted, for the purpose of scoring.

Care was taken that precise instructions are given to the subject, for each condition. To avoid the errors of habituation and anticipation, proper randomization in terms of cognitive load conditions and emotional context conditions were adhered to. A rest period of one minute was given after performance under each condition to avoid the effect of fatigue.

Analysis

Three-way repeated measures ANOVA, with repeated measures on the last two variables was carried out. t-values and any other descriptive statistics, were also utilized.

Results and Discussion

As per ANOVA, emotional context and cognitive load individually and conjointly seemed to exert significant influence (Mindfulness (F=0.98, df 2, 186), Emotional Context (F=48.59** df 2, 372), Cognitive Load (F=534.17** df 2, 372), Mindfulness X Emotional Context (F=0.17, df 4, 372), Mindfulness X Cognitive Load (F=2.03, df 4, 372), Emotional Context X Cognitive Load (F=5.69** df 4, 744), Mindfulness X Emotional Context X Cognitive Load (F=1.23, df 8, 744)) .

t- ratio based comparisons across variables indicated the trends shown in the table and the graphs. (See Table 1; Graphs 1, 2, and 3)

VARIABLE	GROUPS	HM		MM		LM	
		MEAN	t-ratios	MEAN	t-ratios	MEAN	t-ratios
b1	c1 vs c2	(3.24) vs (1.86)	8.27**	(3.32) vs (1.73)	9.86**	(3.19) vs (1.56)	10.39**
	c1 vs c3	(3.24) vs (1.16)	12.96**	(3.32) vs (1.10)	14.26**	(3.19) vs (1.03)	12.50**
	c2 vs c3	(1.86) vs (1.16)	4.90**	(1.73) vs (1.10)	4.08**	(1.56) vs (1.03)	3.46**
b2	c1 vs c2	(2.67) vs (1.57)	6.87**	(2.94) vs (1.49)	7.69**	(2.33) vs (1.54)	4.59**
	c1 vs c3	(2.67) vs (.75)	12.47**	(2.94) vs (.63)	13.17**	(2.33) vs (.76)	8.99**
	c2 vs c3	(1.57) vs (.75)	4.99**	(1.49) vs (.63)	5.42**	(1.54) vs (.76)	5.34**
b3	c1 vs c2	(3.21) vs (2.05)	6.96**	(3.40) vs (2.16)	7.47**	(2.94) vs (2.02)	5.52**
	c1 vs c3	(3.21) vs (1.16)	11.02**	(3.40) vs (.95)	14.87**	(2.94) vs (.95)	10.16**
	c2 vs c3	(2.05) vs (1.16)	5.39**	(2.16) vs (.95)	8.75**	(2.02 vs (.95)	7.09**

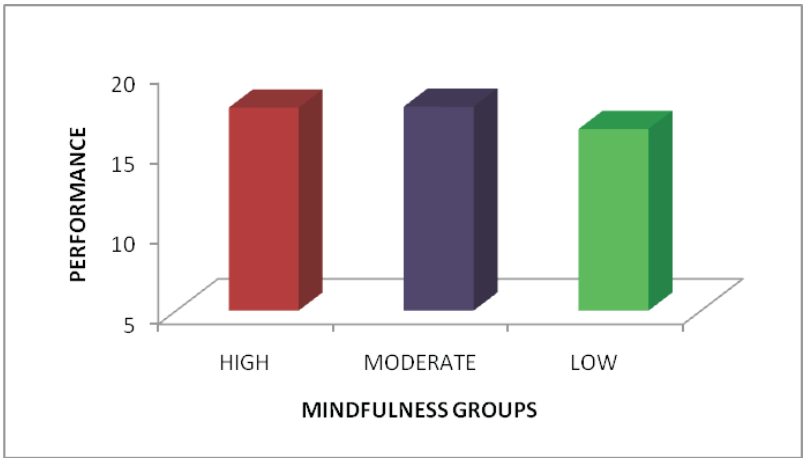
**= Significant at .01 level

Table 1. Showing significance of differences between means of performance on working memory task across various conditions.

HM- High Mindfulness	MM- Moderate Mindfulness	LM- Low Mindfulness
b1- Positive	b2- Negative	b3- Neutral
c1- No Load	c2- Moderate Load	c3- High Load

Index to table no.1

The results have indicated that the emotions have a powerful impact on memory as emotional state, or mood, influence the working memory performance (Vieillard & Bourgeant, 2005). Amygdala involvement, as found in the neurological studies, highlights the possibility that emotions may exert an important influence on working memory and executive control and a substantial switching cost has been found as associated with negative and positive emotional context as compared to neutral context (e.g. Gotoh, 2008). Osaka et al. (2013) found that negative and positive emotions modulate working memory system through distinctive neural circuits.



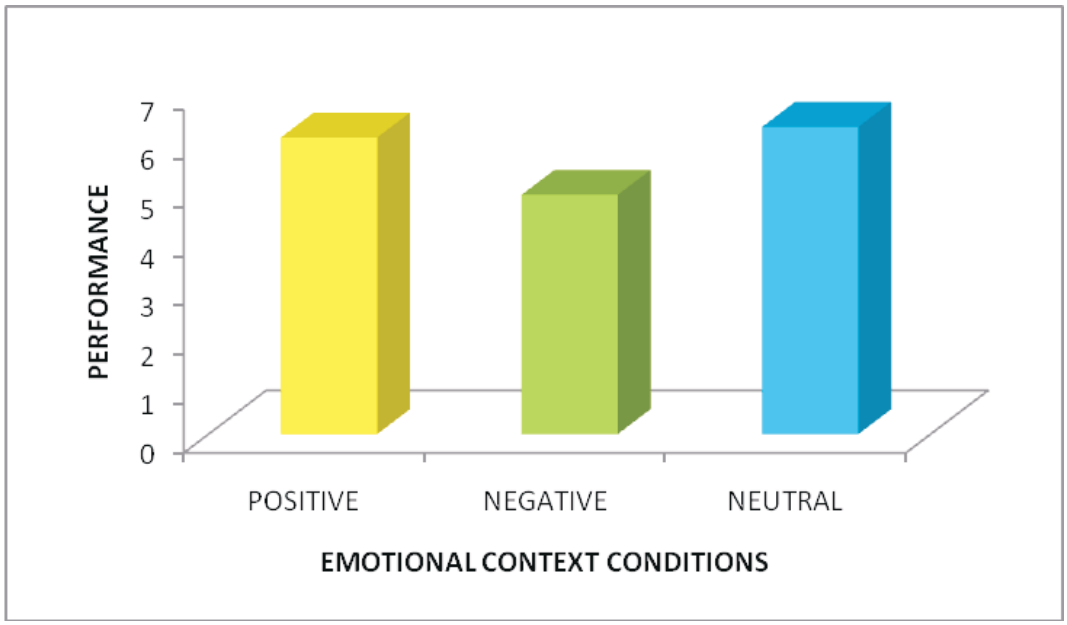
Graph 1: Trends of performance scores with respect to mindfulness groups (non-significant t-values).

Also, overloading of the working memory system induces a significant decline in subsequent working memory function. This may be due to a decrease in the brain activity in various regions including relatively large areas of the prefrontal cortex so much so that with increasing load on working memory, performance decreases (Yun et al., 2010).

The interaction effects of emotional context and cognitive load indicate that perhaps, emotions increase the load on information processing thus draining the attentional resources that otherwise might be devoted to task performance. Memory load might interact with the emotional content of the stimuli to effect both lower (e.g., attention and memory) and higher-order (e.g., logical reasoning and judgement) attentional processes (Ladouceur et al., 2005). Emotion might selectively affect spatial and verbal cognitive activities, perhaps this could be due to the attention resource competition underlying neutral mechanism of the selective interactive pattern between emotion and working memory (Li et al., 2013).

Though no significant differences could be seen in the performance of different mindfulness groups on the emotional context based working memory task, yet there is a trend for moderate mindfulness group showing highest possible performance on the neutral context based working memory task (See Graph No. 1). The moderately mindful subjects seem to be best able to balance out emotional and cognitive pressures. Perhaps, a non-judgmental awareness facilitates a healthy engagement with emotions allowing individuals to genuinely experience and express their emotions (Bridges et al., 2004), without adversely influencing the working memory performance.

Also, mindfulness can be framed in terms of its capacity to improve self-regulation (which is a limited resource) (Inzlicht & Kang, 2010), leading to more effective use of available working memory resources.



Graph 2: Trends of performance scores with respect to emotional context conditions (significant t-values).

Further, the t-ratio results show that neutral context facilitates working memory linked performance in the moderate mindful individuals by facilitating executive functioning (See Graph No. 2). It seems that the neutral context, under all the conditions of cognitive load, shows maximum availability of resources for the working memory performance followed by positive context linked functional resourceability and finally trailed by negative context linked functional resourceability.

It has earlier also been reported that performance is influenced by the intensity of stimulus i.e. positivity or negativity of the impinging stimulus (Kensinger, 2004). Men have been found to be better able to cognitively control the effect of emotions (Birditt & Fingerman, 2003), which further enhances their working memory performance.

In previous studies, positive emotions have been found to enhance abilities to process and retain new information and to create patterns of thought that are flexible and creative (Fredrickson, 1998). They have also been found to facilitate working memory processes (Erez & Isen, 2002). While positive affect might improve these processes partly through higher overall engagement and alertness (Rowe et al., 2007).

Yang et al. (2012) found that improved working memory under positive affect is not attributable to motivational differences, but results instead from improved controlled cognitive processing.

On the other hand, negative context, seems to act as an opposing force to mindfulness and perhaps takes cognition resource away from optimum performance. In other words, it acts as an attention diverter and thus probably due to the resultant reduced mindfulness, errors increase. Negative emotions have been found to be inhibiting in the sense that they disturb one's ability to remain mindfully present, thus narrowing attentional focus and restricting thought-action repertoire (Fredrickson, 2003). In other words, negative context acts as a resource investment inhibitor.

As compared to negative affect positive affect leads to increased cognitive performance (Harrison et al., 2013). Perhaps, negative context is not being accepted as a generator of resource by the central executive towards performance. In numerous studies it has been found that negative stimuli act as an interference in a variety of effortful tasks as it makes it difficult to disengage attention from the stimulus (Gotoh, 2008).

It has also been found that fearful faces are likely to be encoded unconsciously, and these stimuli are heavily masked and plausibly processed subliminally (e.g., Kiss & Eimer, 2008). Subjects have shown impaired working memory performance when presented with highly arousing negative background pictures (Marx et al., 2011).

Anticevic et al. (2010) found that negative emotional distraction may lead to a below-baseline drop in prefrontal cortex activation which has not been found to be apparent during neutral distraction.

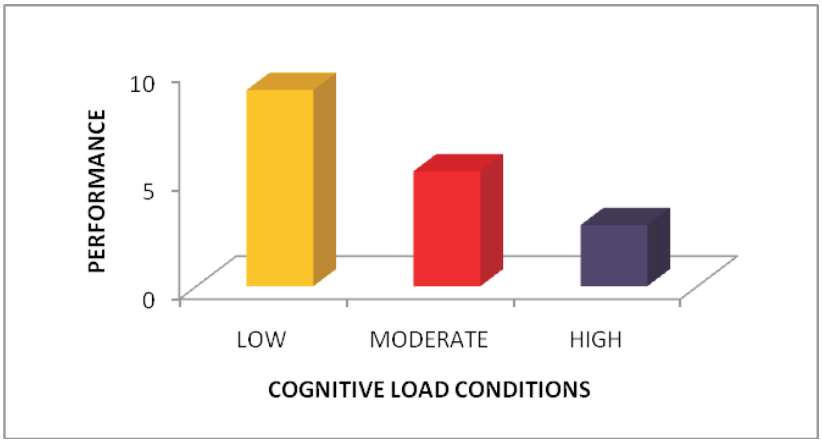
The results of the study in hand also imply that emotion perception requires the central attentional resources i.e., emotion perception is not fully automatic. People at times are slow to perceive emotions and slow to act appropriately on them when they are busy with another task

Graph 3: Trends of performance scores with respect to cognitive load conditions (significant t-values).

As the cognitive load increases, all the available resources seemed to be consumed by the working memory, hence lowering the performance (See Graph No. 3). Perhaps it could be because both cognitive tasks and emotional responses make use of the same limited mental resources (Baddeley, 2007). i.e. the resources that are used to perform a cognitive task are no longer available for emotional processes. Also the increasing demands on working memory seem to reduce the ability to ignore irrelevant stimuli, leading to lower performance (Pratt et al., 2011).

The divided attention is detrimental to working memory, especially under more difficult conditions (Kane & Engle, 2003). This is consistent with Gazzaley's (2011) recent review of the literature showing that as working memory load increases, attentional capacity decreases, and in turn, causes working memory performance to decline.

The implication of Baddeley & Hitch's theory (1974) also states that as the storage demands on the working memory system increase, the resources available for processing decrease.



The experimental stressors, such as time pressure, may increase the amount of cognitive load on a working memory task, leading to decrease in performance (Sliwinski et al., 2006).

Since adolescence is a time of increased emotional reactivity. In addition, given the increase in risky choices and behaviour during adolescence, it appears the value of positive and negative information may be exaggerated. Greater emotional reactivity and sensitivity during adolescence may play a role in the higher incidence of affective disorder onset and addiction during this developmental period. Therefore, it may be implied that being mindful, may help the adolescence of being capable of making rational decisions even in emotionally charged situations, that require decisions in the heat of the moment. Emotions need to be managed to get along with a civilized life. Indeed, successful emotion regulation is a prerequisite for adaptive functioning.

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