Emotion And Cognition Integration – The Effect Of Anger On Working Memory

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Abstract

Emotions have always captured attention of philosophy, psychology and recently neuroscience. Through the history, emotions were considered as separate entity from thinking and cognition. It was mostly related with irrationality. Descartes claimed emotions were part of soul, based on his dualism theory. However, the period started with James-Lange changed this perspective. Together with cognitivist views, it has been understood that emotions have significant influence on cognitive functions. This focus towards relation between emotions and cognition led researchers to pay attention interaction concept. Neuroscience studies took this concept and strengthened with integration theory. It has been shown in many studies that emotions have significant effect on cognitive functions. In this study I have given studies to show how this integration with perception, decision making, memory, attention and working memory studies. Visual working memory and attention were mostly used to show this influence. However, findings of emotion influences on cognitive functions showed inconsistency. We wanted to see how one specific emotion, anger, affect visual working memory with regulated version of Recency-Probe Paradigm. We used memory sets with violent and neutral items and gave a recognition task to participants. Anger is relatively less studied emotion compared to others due to its difficult to measure and induce. We expected that anger-induced participants' reaction times and accuracy rates should differentiate with participants without induction. Even though there were slightly difference, we found no significant difference between reaction times of control and experimental group. In terms of accuracy also did not show significant difference. However, there was significant difference between reaction times to violent and neutral items inside the groups. We also found that results show inconsistency for emotion effect to cognitive functions.

Keywords: Anger; cognition; emotion; integration; working memory

INTRODUCTION

Emotions have considerable influence on our lives in daily activities. As William James expressed *"If we fancy some strong emotion, and then try to abstract from our consciousness of it all the feelings of its bodily symptoms, we find we have nothing left behind, no 'mind-stuff' out of which the emotion can be constituted, and that a cold and neutral state of intellectual perception is all that remains."* (Lynch, 1923). Yet, it has not been studied as other functions in psychology or cognitive sciences. Understanding the nature of emotions has always been controversial topic among philosophers. Classical philosophers considered emotions as primitives rather than involving constituents. Since ancient times it has been seen apart from mind and cognitive processes. Emotions were simply accepted as feeling apart from sensory information processing (Scarantino & Ronald, 2018). Plato had a famous idea of dualism and many of the perspectives were mostly based on his dualism approach. According to this theory, emotions are part of our souls and irrelevant to bodily changes. There are emotional reactions from animals as well, however, they are not aware of these states due to lack of soul. Aristotle was grounding on his ideas for emotions to more mind and sense combination. So, he was one of the leading names who considered the importance of mental processes on emotions (Shields & Zawadzki, 2012). The Stoics denied these assumptions and defend that emotions were forms of impulsive reactions which was sort of a threat to rational thinking (PETERS, 2000).

The 60s brought a new movement, cognitivism, which emphasizes the cognitive processing of mental representation as opposed to behaviorism dominance of observable response theories. According to Arnold (1960), emotions occur in different ways in different people even though the stimulus is the same. In fact, it may also change for the same person in time. This shows that the stimulus is not solitarily bringing out emotions, therefore the appraisal / representation matters. According to Arnold (1960) and (Lazarus, 1982) object-directedness and appraisal are the main factors of emotional processing. Emotions such as happiness, sadness or anger are related to something which is about intentionality of the object. Therefore, one needs cognitive processes for the appraisal of the belief that has been directed to object. There are alternative thoughts on intentionality of feelings. One of them is representationalism that considers related to intentional properties. One part of representationalism viewers consider emotional phenomenology as somatic bodily events. According to others, emotional phenomenology constituted by somatic, cognitive, conative, and affective components (PETERS, 2000). Sousa provides wider perspective for emotions via including perceptual and non-perceptual components. Again, (Gordon & de Sousa, 1991) has proposed that emotions can be explained

by ‘paradigm scenarios’ that are shaped during the childhood but within the exposure of education, art and culture, these scenarios can be able to change. Then we see life events through these paradigm scenarios functioning as schemes. Here again we see that reappraisal of emotions are possible in rational way even though previous representations evoked in childhood. These claims constituted a base for cognitive-emotional studies.

It is important to show how emotion and other cognitive functions influence each other. The period that cognitive psychology studies strengthened cognition-emotion integration has been widely supported with the cognitive neuroscience data. Neuroscience studies had boost effect on this field. Damasio’s neuroscientific studies led many researchers to discuss emotions based on the somatosensory system together with brain areas (Damasio, 1998). Examining the underlying neural connections of cognitive functions and emotion relations were a provided a basis for brain and mind connection with cognitive representation (Phelps, 2006).

Attention can be explained as a function that decides which information will be chosen for perceptual processing (Phelps et al., 2006). Selecting the crucial stimuli in the environment with attention is highly influenced by emotions. Emotions have been working with the executive functions and enhance or impair relevant stimuli depending on the valence or arousal of the affective stimuli. There are considerable number of studies for the connection between emotion and visual attention. Some of these studies have shown that negative and high-arousal emotions enhanced the visual attention to threatening information, however, positive high-arousal emotions enhanced visual attention to rewarding information (Robinson, 2007). In another study, (Anderson, 2005) has focused how emotions were affecting attentional processes with attentional blink paradigm which illustrates that limited capacity for sources. However, results demonstrate that when the second target is affective, participants performed better in detection, which indicates how emotions influence attention. Equivalent results were shown in another study, effect of inattentional blindness have been decreased for emotional stimuli. However, the results were not same with the people who have amygdala lesions. These patients did not show improved performance for second targets (Anderson & Phelps, 2001). This shows that amygdala has a significant role for visual attention to decide which information will be perceived depending on the affective valence. One of the main roles of the amygdala is to provide modulation for sensory processing (Figure 2). Similar with previous findings, (Dolan, 2002) showed that whereas a lesion in right inferior parietal cortex triggering contralesionally deficiency, this affect has been decreased when people were shown affective stimuli. Especially, amygdala has parallel ways with visual cortex in terms of attention processes. It has

been well studied that emotional stimulus is highly related to amygdala together with increasing relation with attention (Pessoa, n.d.).

Working memory has a restricted capacity for using and directing the information for a brief time and for other executive functions (Baddeley & Hitch, 1947). Emotion and working memory relations who well-based evidence for emotion involvement in cognitive processes. Effect of emotions has been widely studied using stimuli with pictures, words, stories, etc. (Dolan, 2002). Having additional processing or emotional stimuli may facilitate or impair working memory performance (Kensinger & Corkin, 2003). Baddeley suggest that there is no single central executive concept; instead, there are many functions of central executive system which directs attention on relevant detail and inhibit irrelevant information. Hence, he claims that selective attention processes have a significant role for working memory operation by deciding which information to be used from long-term memory (Baddeley et al., n.d.). It is well known that affective stimuli can influence allocation of attentional sources and prioritize the relevant information (Kensinger & Corkin, 2003).

Working memory has a critical position for cognition and provide solid base for integration theory. Visual selective attention and visual working memory has a strong relation for encoding and maintenance functions. To hold an object in working memory influence attentional direction for that object, showing that working memory also affect attention will be allocated. Hence, there is also reciprocal connection between working memory and selective attention (Downing, 2014). Visual working memory uses the perceptual data that has been attended and decide which relevant information to be sustained (Chun, 2011). Working memory can prioritize the emotional information processing via attention biasing. Hence, working memory performance can be increased for the emotional content (Kensinger & Corkin, 2003).

Kensinger and Corkin (2003) found that effect of emotions on working memory tasks were not consistent in terms of accuracy; however, there were slower reaction time for negatively valanced stimuli. Another research by (Becerril & Barch, 2011) showed even though there were higher accuracy, still reactions were slower for negative stimuli. Perlstein et al. (2002) showed that affective stimuli can impede working memory performance.

(Eckhardt & Cohen, 1997) showed by using Emotional Stroop task anger-insulted participants performed worse for anger words. (Hansen & Hansen, 1988) showed that participants showed better performance for detecting angry faces in the happy faces crowd. Recent studies show that rage systems have strong interactions with memory systems (Jaak P,

2004). A study about how trait anger were influencing cognitive processing of emotional stimuli showed that trait anger enhances performance of emotional words, specifically words about anger (Parrott et al., n.d.).

Emotion and attention studies mainly focused on negative and high-arousal emotion for threatening information (Ford et al., 2010). Emotions were examined in two dimensions, based on their valence, negative vs. positive, and engagement, low vs. high (Mogg & Bradley, 1998). For the valence dimension, high arousal bias visual selective attention for information processing for relatively valent emotions; for example, anxiety is negative but high arousal emotion, therefore it is expected to bias attention for threatening stimuli, whereas excitement is expected to bias attention for rewarding stimuli (Ford et al., 2010). Anger also has negative valence, so it is expected to bias attention for threats; however, it also shows active approach system and according to this, it is expected to bias attention for rewards (Carver & Harmon-Jones, 2009). Ford et al. (2010) showed that anger is directing attention to rewards, rather than threats and suggests that emotions can influence cognitive performance with motivation-based context. Therefore, it is also important to examine how anger affects our cognitive processes. (Cohen et al., 1998a) found that high-trait anger subjects tend to perform better anger-related tasks when they were induced with anger for. This demonstrates that anger-induced subjects automatically uses their attentional sources for violent cues (Cohen et al., 1998b).

Interest for specially anger stems from the experience when I was working as school psychological counselor. I have mostly faced with anger problems, and I realized that among emotions, anger was studied less than others. Besides, anger is a challenging issue to study experimentally. Influence of emotions differentiates depending on the emotions and examination of these influences. Based on previous research on integration of emotion and cognition, we wanted show how emotions affect cognitive functions via challenging visual working memory task. This way, wanted to give a supportive data for integration theory and see how this relation between emotions and cognitive functions integrate. Majority of the studies on this field were using Emotional-Stroop Task, face recognition or emotional story recall techniques for either emotion induction or emotional stimuli perception in experiments. We wanted participants to have emotional state of anger with awareness to form higher order representation of emotional consciousness. Among many emotion induction techniques, using visual methods, such as exposure to violent content, are effective for anger inducing (Lench et al., 2011). This is also supported with physiological data with cardiovascular measurements (Siedlecka & Denson, 2019).

For this reason, we decided to use violent content for anger inducing, and expect emotionally induced participants to show slower response times for violent items in the memory set. Secondly, we expect anger-induced participants to show higher-accuracy for violent items in the working memory task.

RESULTS

At first, accuracy means for all items have been analyzed and Independent-Sample T- Test has been applied. There was no significant difference ($p>0.05$) between the experimental group values ($M=0.66, SD=0.13$) and the control group values ($M=0.65, SD=0.14$).

Response accuracy for the violent items in the experiment has been measured. An Independent Sample t-test between groups has been applied. There was no significant difference ($p>0.05$) between the experimental group values ($M=0.52, SD=0.03$) and the control group values ($M=0.51, SD=0.02$).

Response accuracy for the neutral items in the experiment has been measured. A Paired Sample t-test between items has been applied. There was **significant** difference ($p<0.05$) between response accuracies for violent items ($M=0.52, SD=0.22$) and neutral items ($M=0.79, SD=0.15$); t (46) =-6.638, p=0.000.

Response accuracy for the neutral items in the experiment has been measured. A Paired Sample t-test between items has been applied. There was also a **significant** difference ($p<0.05$) between response accuracies for violent items ($M=.51, SD=0.2$) and neutral items ($M=.78, SD=0.17$); t (59) =--9.023, p=0.000.

Reaction times for the violent items in the experiment have been measured. An Independent Sample t-test between items has been applied. Results indicate that there was no significant difference between the experimental group ($M=942.708, S.D.= 174.8337$) and the control group ($M=975.550, S.D.=152.5777$).

Here the reaction times of the correct answers for the violent items in the experiment have been measured. An Independent Sample t-test between items has been applied. Results indicate that there was no significant difference between the experimental group ($M=926.405, S.D.=308.1098$), and the control group ($M=994.480, S.D.=172.3988$).

Reaction times for the neutral items in the experiment have been measured. Independent Samples t-test between groups has been applied. There was no significant difference between

the experimental group *(M*=904.524*, S.D.*= 253.4281*)* and the control group *(M*=905.852*, S.D.*= 238.1975).

Here the reaction times of the correct answers for the neutral items in the experiment have been measured Independent Samples t-test between groups has been applied. There was no significant difference between the experimental group *(M=916.579, S.D.=. 172.9881)* and the control group *(M=915.694, S.D.= 139.3953)*.

Reaction times for all the items in the experiment have been measured. Here we compared the reaction times to the violent items and neutral items in the experimental group. Paired Samples t-test between groups has been applied. There was no significant difference in the scores for the reaction times to violent items *(M=943.296, S.D.=173.0118)* and the reaction times to neutral items *(M= 914.192, S.D.=166.146)*; t (47) =1.501, p=0.140.

Reaction times for all the correct answers in the experiment have been measured. Independent Samples t-test has been applied. There was no significant difference in the scores for the reaction times to violent items *(M= 926.405, S.D.=308.1098)* and the reaction times to neutral items *(M= 916.579, S.D.=172.9881)*; t (46) =1.501, p=0.846.

Reaction times for all the items in the experiment have been measured. Here we compared the reaction times to the violent items and neutral items in the neutral group. Independent Samples t-test has been applied. There was a significant difference in the scores for the reaction times to violent items *(M= 975.628, S.D.=153.8862)* and the reaction times to neutral items *(M= 914.9645, S.D.=135.9313)*; t (58) =3.567, p=0.01.

Reaction times for all the correct answers in the experiment have been measured. Independent Samples t-test has been applied. There was a significant difference in the scores for the reaction times to violent items *(M=994.840, S.D.=172.3988)* and the reaction times to neutral items *(M= 915.694, S.D.=139.3953)*; t (59) =3.596, p=0.001.

DISCUSSION

At first, we aimed to be sure that there was no difference between the experimental and control group, and as expected we found no difference between groups. Whereas the experimental group have seen a violent video for anger-inducing, the control group have seen a neutral video. We compared the level of anger between groups and found that experimental group had significantly higher anger level. This way, we became sure that results were dependent on our manipulation check.

Our findings were consistent with the study of Storbeck & Maswood (2016) which showed that whereas happy mood increasing verbal and spatial working memory performance, sad mood had no effect on both working memory performances. However, results of again shows inconsistency for emotional affects, Zhang et al. (2017) showed that it results are changing depending on the working memory capacity of participants, while positive and negative emotions have improved the working memory performance in the high working memory capacity group, the results were right opposite for the low-capacity group.

Even in our daily lives, it is likely that we attend objects in our environment related to the mood or emotional state we have. Effect of emotions on working memory performance differentiates for reaction times and accuracies. It has been found in previous studies that whereas emotions enhance accuracy means, impair the reaction times performance (Kensinger & Corkin, 2003). We expected faster reaction times for the violent items in the experimental group due to biasing after emotional induction. It has been found that emotional states were efficient on our perceptual processes. We expected that anger can direct attentional sources for threatening stimuli in the experiment. At first, we checked the reaction times for the violent items between experimental and control group, and we found no significant difference between them. But data shows that the difference is closer to the significance (Table 13). This shows that anger-induced participants gave faster reaction to the violent items, even though the responses they gave were not correct indicating that participants tend to response faster to the violent items by directing attentional sources to the threatening stimuli.

The difference between the reaction time means of the experimental group for violent items and the reaction times for the correct answers is more than the same difference in the control group. We found that reaction times for the violent items in the experimental group is slower than neutral items without considering the correct answers. However, in the correct answers, we found that anger-induced participants gave slower reaction times for the violent items which means that emotional load and threatening stimuli impaired the working memory performance for reaction times. The same effect did not occur for the neutral items. Results show that reaction times for neutral items were similar with correct and general answers.

As we have emphasized in the limitations part, this study can be repeated with the experimental setup that leads less accuracy mistakes. Besides, in another study, working memory task can match with the anger scale results or participants with anger management problems can be used. Also, this study can be repeated with eye tracking methods to check how emotions affect our

perceptual process. For emotion inducing, shorter stimuli can be used. Another thing for the future studies to categorize participants according to their working memory capacity. Because, in several studies it has been shown that these effects can be modulated by the working memory capacity.

CONCLUSION

The relationship between emotions and cognition has a critical role for many aspects to understand the executive functions. So far, emotion studies have shown inconsistent results depending on methodology or emotions which are difficult to define and measure. We found that effect of emotions on cognitive functions shows differentiation depending on methodology and emotions. We found that working memory performance has changed for emotional stimuli; however, emotion induction did not affect the working memory performance in a way of enhancement. Examining the effect of emotion on cognitive functions should be more domain specific. Also, it was important to combine the emotional induction with working memory and emotional content working memory tasks. This combination of emotional loads is balancing the working memory performances, which is normally expected worse or better in case of just one load. However, as it has been shown in Kensinger and Corkin (2003), effect of emotions on working memory performances are not consistent whether in accuracy or reaction times. We showed that in order to explain how emotion and cognition integration is working, more distinguished and complex studies are necessary. This effect can be modulated depending on which emotion will be used, how this mood will be induced and measured, and if there will not be a mood induction, which sort of emotional stimuli will be used in the cognitive tasks. Even though we emphasized only to emotional state of anger, participant report for sadness scale showed significant difference as well. Therefore, these results can be examined under more properly under the negative emotions.

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