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The Relationship between Anxiety and Task Switching Ability

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The Relationship between Anxiety and Task Switching Ability

Amara Gul [α] & Glyn W. Humphreys [σ]

Abstract- This study examined task switching ability as a function of anxiety. Participants with mild anxiety switched between emotion and age classification among faces. There were few important results: (i) Individuals with anxiety categorized facial emotion faster than facial age (ii)There was a larger switch cost for age than the emotion categorization (iii) Anxiety was a significant predictor of task switch costs. We discussed why anxious individuals showed a deficit in cognitive control of facial attributes.

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I. Introduction

Anxiety is a physiological state causing adverse effects on the cognitive, somatic, behavioral and emotional functioning of an individual (Seligman, Walker, & Rosenhan, 2001). Previous research has suggested that anxiety is associated with cognitive and attentional bias, for example, difficulty in disengaging attention from emotional stimuli among anxious individuals has been observed both for words and pictures (Yiend & Mathews, 2001; see for review Bar-Haim et al., 2007; Fox et al., 2001, 2002; Sass et al., 2010) due to having an altered activity in amygdala-prefrontal circuits (Bishop, 2007). Studies using spatial cueing paradigm also report that anxiety impairs inhibition and attentional control as a result causes a decline in efficiency. For example, it is harder for anxious individuals to disengage attention from invalid cues (providing misleading information) than non-anxious individuals (Poy, Eixarch, & Avila, 2004), especially in case when threat-related stimuli serve as invalid cues (Fox et al., 2002). In an emotionl Stroop task, anxious individuals display interference on threat words (de-Ruiter & Brosschot, 1994) which can be attributed towards the activation of emotion nodes in semantic memory and facilitates the attention towards emotion congruent stimuli (Bower, 1981, 1987). Neural substrates of anxiety related processes across all emotional faces are the activations in amygdala and anterior cingulate cortex (Ball et al., 2012). The attentional deployment towards emotional stimuli is linked with deficit in performance on several cognitive tasks such as emotional Stroop (Simpson et al., 2000; Williams, Mathews, & MacLeod, 1996; Dresler et al., 2009) and flanker task (Fenske & Eastwood, 2003). Such allocation of attention is high when individuals perform cognitive tasks which are high in demand or negative emotional states such as anxiety exceeds an optimal level (Meinhardt & Pekron, 2003; Hanoch & Vitouch, 2004). As a result interference arises. The attention deficit has been observed when individuals perform dual task (Wood, Mathews, & Dalgleish, 2001) possibly because of depletion of attentional resources for the other task to be performed.

Individuals with high and low anxiety differ in their attentional allocation to emotion-related information. High anxious individuals showed a greater difficulty in disengaging attention from the spatial location of emotional cues than low anxious individuals (Mogg, Holmes, Garner, & Bradley, 2008; Fox, Russo, & Dutton, 2002). High anxious individuals show preferential attentional capture to emotional stimuli (Broadbent & Boradbent, 1988; Miskovic & Schmidt, 2012). It has also been stated that high anxiety is associated with low working memory capacity (Darke, 1988; Ashcraft & Kirk, 2001) and impairs the ability to inhibit goal-irrelevant information (Moriya & Sugiura, 2013). Bishop, Duncan, Brett, and Lawrence (2004) observed decreased activation of lateral prefrontal cortex (LPFC) and rostral anterior cingulate cortex (ACC-part of brain's limbic system) in high anxious individuals when presented with more threat related distracting stimuli than the control condition (i.e., fewer threat-related stimuli). The rostral ACC is involved in emotional processing and LPFC establishes cognitive control during attentionally demanding and higher cognitive tasks (for review Bush, Luu, & Posner, 2000; Drevets & Raichle, 1998).

A large body of literature suggested that anxiety impaired the volitional control of attention (which relies on the prefrontal neuronal circuits), for example, when anxious individuals were presented with facial expressions in peripheral field of vision and in response performed either pro or antisaccades, they exhibited more erratic prosaccades to facial expressions when antisaccade was required (Wieser, Paul, & Muhlberger, 2009). Similar results were found by Ansari, Derakshan, and Richards (2008) in a mixed antisaccade paradigm. Their participants performed a single task (i.e., separate blocks of anti and prosaccade trials) and mixed task (i.e., anti and prosaccade trials in random order within a

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blocks). Low anxious participants showed a switch benefit in antisaccade latencies within mixed task block when antisaccade trial was preceded by a switch trial compared to the condition where antisaccade trial was preceded by a repeat trial. However, high anxious individuals exhibited no improvement. The presence of anxiety can modulate the shifting ability (Jhonson, 2009). Goodwin and Sher (1992) reported worse shifting ability of high anxious than low anxious individuals (slower and more error-prone performance as measured by Wisconsin Card Sorting Task).

The above mentioned findings can be seen in the context of the attentional control theory (Eysenck, Derakshan, Santos, & Calvo, 2007) derived from the processing efficiency theory (Eysenck & Calvo, 1992). Anxiety impairs the central executive functions such as inhibition and shifting. It has an adverse effect on the goal-directed and stimulus-driven attentional system. The cognitive performance is decreased due to an increased attention to emotion-related stimuli and a reduced attentional control.

II. The Present Study

Since the attentional bias in anxiety has widely been studied in distraction paradigms, but has not been assessed in task switching paradigm, it is unclear how anxiety modulates attention during switching between face categorization tasks. Task switching paradigm examines the central executive functions of inhibition, shifting and updating of the working memory representations. In task switching experiments, participants switch between two different tasks. Performance is faster on the trials when the task is repeated (repeat trials) than when it is changed (switch trials) producing switch cost (larger latencies and higher error rates for switch vs. repeat trials). Participant has to respond the alternate task-sets (Meiran, 2000; Rogers & Monsell, 1995), thus a cost on response times (i.e., reaction times) arises from the significant delay in adoption of the new task-set (Mayr & Keele, 2000) which involves simple activation of the task-set rule (Rubinstein, Evans, & Meyer, 2001) and inhibition of the task-rule relevant to the competing task-sets (Mayr & Keele, 2000). In the present study, we examined whether mild anxiety modulates task switching ability. Consistent with the argument that anxiety impairs central executive functions such as inhibition, shifting and attentional allocation (for review, see Eysenck, Derakshan, Santos, & Calvo, 2007; Bar-Haim et al., 2007; Derakshan & Eysenck, 2009; Ansari & Derakshan, 2010) we hypothesized that mild anxious individuals would show a greater attentional allocation to facial emotion compared with age, as a result larger switch cost for the age task would arise. Second, mild anxiety scores would correlate with task switch costs.

III. Method

a) Participants

24 postgraduate students (ages 22-25 years, mean 23.50 years) with mild anxiety as an inclusion criteria for the sample participated in the study. Half of them were female. They were screened with a subscale of anxietyin the Depression Anxiety Stress Scale (Lovibond & Lovibond, 1995) which has good internal consistency (Cronbach's alpha=.89; Brown et al., 1997) and test-retest reliability for the current sample (r=.98,p<0.001). The Anxiety scale is a screening instrument to assess autonomic arousal, skeletal muscle effects, situational anxiety, and subjective experience of anxious affect among normal adolescents and adults. Subjects responded using 4-point severity/frequency scales to rate the extent to which they have experienced each state *over the past week*. The questionnaires were marked according to the score range 0-7 = normal, 8-9= mild anxiety, 10-14 = moderate, 15-19=severe anxiety, 20 and above = extremely severe.

b) Switching Experiment

The switching experiment was designed with 32 facial photographs which portrayed happy and angry expressions. The experiment was designed with Rogers and Monsell's (1995) alternating-run task switching paradigm where the task changed every second trial. The order of the tasks was counterbalanced across participants. For half of the participants the order of the tasks started from emotion while for other half of the participants the order of the tasks started with the age task first. The experiment was designed in E-prime software (Schneider, Eschman, & Zuccolotto, 2002, version1.2) and was presented on computer screen. Background colors of the screen served as cue to the tasks. Participants made manual responses to the tasks using the key board. Total trials of the experiment were 241.

c) Procedure

Participants were given description of the experiment, following they performed the experiment in a silent room. They were said thanks for their participation and debriefed at end of the session.

IV. Results

a) Switching Experiment

Response times (RTs) were excluded above 2.5 standard deviations from each participants' mean. RTs for the first trial were discarded because no task switch took place. The switch costs (mean RTs switch minus repeat trials) were calculated subsequently, mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with trial (*switch* vs. *repeat*), and task (*emotion* vs. *age*) as within subject factors.

The main effect of trial was significant F (1, 23) =164.00, p<0.001, $\eta p2$=.87. RTs were slower on switch

(M=953.38ms) than repeat (M=623.00ms) trials. There was a reliable main effect of task F (1, 23) =41.07, p<0.001, ηp2=.64. The RTs were faster on the emotion than the age task (emotion M=743.50 vs. age M= 832.86ms).The interaction between trial x task was significant F (1, 23) =41.02, p<0.001, ηp2=.64, Switch (emotion M= 880 ms, age M= 1025 ms) Repeat (emotion M= 606ms, age M= 639ms), Fig.1. The switch cost was larger for emotion than the age task t (23) = 6.40, p<0.001, emotion (M= 274.55 ms), age (M= 386.26 ms).

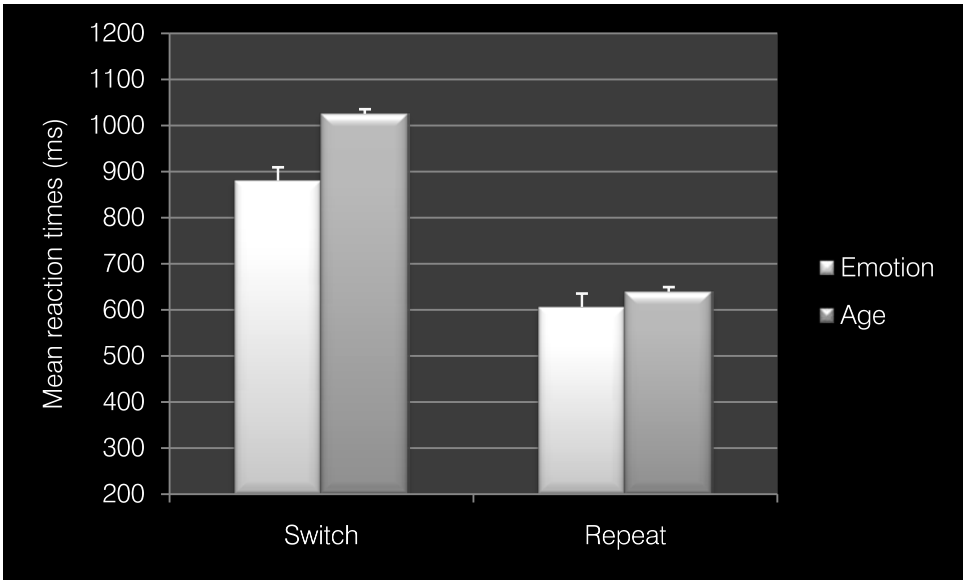

Figure 1 : Mean reaction times (ms) in task switching experiment. Error bars represent standard errors.

Table 1 : Mean Errors (M) and Standard Errors (SE) in Task switching Experiment

	Switch M (SE)	Repeat M (SE)
Emotion Task	.01 (.00)	.07 (.00)
Age Task	.09 (.00)	.14 (.00)

b) Relationship between Anxiety Scores and Switch Costs

Regression analysis with anxiety scores as independent and switch costs (i.e., difference between RTs on switch and repeat trials) as dependent variable showed a significant result F (1, 23) =31.83, p<0.001, R^2 = 0.59. Hence, the independent variable explained almost 59% of the variance of the switch costs. Standard regression coefficients showed that anxiety scores, **β**=0.76, t=5.64, p<0.001 made positive contribution toward the explanation of switch costs.

V. Discussion

There were two main aspects of the study. The first was the relative ease of switching between emotion and a non-emotion attribute of a face among mild anxious individuals. The second objective was to examine the relationship between anxiety and task switching abilities specifically when tasks of social significance are involved.

Our results showed an asymmetry in switch costs with the effect on age decisions being larger than those on emotion decisions, although the emotion was an overall easier task. Interestingly, this effect emerged only among anxious individuals. This result supported the first hypothesis of the study. Switching between tasks of unequal difficulty is not symmetric often produces larger switch costs for the easier of the two tasks and has been attributed to the inhibition of the difficult task which is difficult to engage with while easier of the two tasks is more automatically performed (e.g., Allport et al., 1994). The results in the present study showed that emotion decisions were faster than the age decisions on repeat trials, we cannot attribute the asymmetry to the inhibition of the easier task because then the switch cost would have shown an opposite pattern (i.e., larger for the emotion than the age task). Rather the switch costs depict that the facial emotion is difficult to disengage from, thus switch costs are increased to the age task. As switching requires a successful manipulation of attentional control to allocate resources to the relevant task (Eysenck et al., 2007) and disengage the attention from the task which is irrelevant on the current trial, therefore in the current perspective, it seems that there is a diminished ability of disengaging attention from emotion attribute of the face, therefore performance on the non-emotion task has been suffered among anxious individuals. The preferential processing/ enhanced attentional allocation (i.e., enhanced P 100- Sass et al., 2012), attentional bias (i.e., greater interference-de Ruiter & Brosschot, 1994) to emotional words and selective attention (i.e., greater amygdala

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activity-Ball et al., 2012) to emotional faces has been observed in anxious individuals during their performance of Stroop task and face matching tasks.

In addition, switch cost for the age was increased with the level of anxiety. The results indicate the difficulty in switching attention from facial emotion to compute age, slowing the age decisions on switch trials in anxious individuals. This tendency is increased with high anxiety scores. Consistent with these findings, it is convincing to say that individuals with anxiety are unable to manipulate their attentional resources in order to exert an efficient cognitive control. This conclusion is also supported by the previous research (e.g., Bishop et al., 2004) which suggests that anxiety reduces top-down control over emotional distractors evident in the reduced recruitment of the neural network involving the cortical areas-ACC (anterior cingulate cortex) and LPFC (lateral prefrontal cortex) which are engaged in cognitive control and reduces performance on tasks which involve shifting (e.g., Goodwin & Sher, 1992), inhibition (e.g., Bar-Haim et al., 2007; Derakshan & Eysenck, 2009) and cognitive control (Mathews & MacLeod, 1985; Dresler, Mériau, Heekeren, & van der Meer, 2009; Johnson, 2009). In present case, emotion is interfering to compute age among faces as a result switch cost for the age is suffered.

Our results are consistent with the previous research suggesting the deficit of attentional deployment away from the emotional stimuli in anxious individuals, but at the same time it is important to note that the previous studies have employed differential paradigms, for example the picture version of dot-probe paradigm (MacLeod, Mathews, & Tata, 1986) where individuals are presented with two pictures (emotional-non emotional) simultaneously followed by a simple probe to which a response has to be made. The efficiency of response to the probe following the emotional picture compared with non-emotional picture determines the attentioanl bias to the emotional picture. The similar results have been found in studies using spatial cuing task (e.g., Fox, Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002; Mogg, Holmes, Garner, & Bradley, 2008) where a single emotional face is presented as a cue for a simple probe which can either appear on the same or on a different location of the emotional face. The high anxious individuals take longer to disengage attention from the emotional face. Here we used task switching paradigm where the participant has to make decisions of the emotion/age of a single emotional face which alternates every trial. As the participants are engaged in a different task every second trial while the face is alternated every trial-it provides a measure of cognitive control and reflects the allocation of attentional resources.

The neurocognitive mechanisms of anxiety support a common amygdala-prefrontal circuitry during cognitive-affective processing. The anxiety is characterized by the hyper-activation of the amygdala toward emotional stimuli and a prefrontal under-recruitment to modulate the activation of amygdala at neural level. As a result the cognitive system is biased due to the activation of emotion-related representations and a failure to implement cognitive control to inhibit the emotion-related representation in order to activate the non-emotion representations (Bishop, 2007). Anxiety is associated with deficits in working memory and inhibitory control (Eysenck & Calvo, 1992; Fox, 1994). The results of the present study showed that attentional bias toward emotion interfered to compute age among faces; as a result the switching ability suffered.

VI. Limitations and Future Directions

The present study employed a small number of non-clinical sample. Thus, future research must include comparatively larger sample and clinically significant level of anxiety. Results of the present study have implications to understand affective disorders and to design therapeutic interventions for anxiety disorders. As a conclusion, anxiety impairs cognitive control of emotional stimuli (i.e., greater engagement with emotion). As a result, the non-emotion task endures greater switching cost than the emotion task. Mild anxiety predicts switch costs.

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