

# 1 The Relationship between Anxiety and Task Switching Ability

2 Amara Gul<sup>1</sup> and Glyn W. Humphreys<sup>2</sup>

3 <sup>1</sup> The University of Birmingham

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## 6 Abstract

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

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14 **Index terms**— task switching, emotion, face categorization, attention, cognition, anxiety.

## 15 1 Introduction

16 Anxiety is a physiological state causing adverse effects on the cognitive, somatic, behavioral and emotional  
17 functioning of an individual (Seligman, Walker, & Rosenhan, 2001). Previous research has suggested that anxiety  
18 is associated with cognitive and attentional bias, for example, difficulty in disengaging attention from emotional  
19 stimuli among anxious individuals has been observed both for words and pictures (Yiend & Mathews, 2001; see for  
20 review Bar-Haim et al., 2007; Fox et al., 2001; Fox et al., , 2002;;Sass et al., 2010) due to having an altered activity  
21 in amygdalaprefrontal circuits (Bishop, 2007). Studies using spatial cueing paradigm also report that anxiety  
22 impairs inhibition and attentional control as a result causes a decline in efficiency. For example, it is harder for  
23 anxious individuals to disengage attention from invalid cues (providing misleading information) than non-anxious  
24 individuals ??Poy, Eixarch, & Avila, 2004), especially in case when threat-related stimuli serve as invalid cues  
25 (Fox et al., 2002). In an emotionl Stroop task, anxious individuals display interference on threat words (de-Ruiter  
26 & Brosschot, 1994) which can be attributed towards the activation of emotion nodes in semantic memory and  
27 facilitates the attention towards emotion congruent stimuli (Bower, 1981(Bower, , 1987)). Neural substrates of  
28 anxiety related processes across all emotional faces are the activations in amygdala and anterior cingulate cortex  
29 (Ball et al., 2012). The attentional deployment towards emotional stimuli is linked with deficit in performance  
30 on several cognitive tasks such as emotional Stroop (Simpson et al., 2000;Williams, Mathews, & MacLeod,  
31 1996;Dresler et al., 2009) and flanker task (Fenske & Eastwood, 2003). Such allocation of attention is high when  
32 individuals perform cognitive tasks which are high in demand or negative emotional states such as anxiety exceeds  
33 an optimal level ??Meinhardt & Pekron, 2003;Hanoch & Vitouch, 2004). As a result interference arises. The  
34 attention deficit has been observed when individuals perform dual task ??Wood, Mathews, & Dalgleish, 2001)  
35 possibly because of depletion of attentional resources for the other task to be performed.

36 Individuals with high and low anxiety differ in their attentional allocation to emotion-related information. High  
37 anxious individuals showed a greater difficulty in disengaging attention from the spatial location of emotional  
38 cues than low anxious individuals (Mogg, Holmes, Garner, & Bradley, 2008; Fox, Russo, & Dutton, 2002).  
39 High anxious individuals show preferential attentional capture to emotional stimuli ??Broadbent & Boradbtent,  
40 1988;Miskovic & Schmidt, 2012). It has also been stated that high anxiety is associated with low working memory  
41 capacity (Darke, 1988;Ashcraft & Kirk, 2001) and impairs the ability to inhibit goal-irrelevant information  
42 (Moriya & Sugiura, 2013). Bishop, Duncan, Brett, and Lawrence (2004) observed decreased activation of lateral  
43 prefrontal cortex (LPFC) and rostral anterior cingulate cortex (ACCpart of brain's limbic system) in high anxious  
44 individuals when presented with more threat related distracting stimuli than the control condition (i.e., fewer  
45 threatrelated stimuli). The rostral ACC is involved in emotional processing and LPFC establishes cognitive

## 7 A) SWITCHING EXPERIMENT

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46 control during attentionally demanding and higher cognitive tasks (for review Bush, Luu, & Posner, 2000; Drevets  
47 & Raichle, 1998).

48 A large body of literature suggested that anxiety impaired the volitional control of attention (which relies on  
49 the prefrontal neuronal circuits), for example, when anxious individuals were presented with facial expressions  
50 in peripheral field of vision and in response performed either pro or antisaccades, they exhibited more erratic  
51 prosaccades to facial expressions when antisaccade was required (Wieser, Paul, & Muhlberger, 2009). Similar  
52 results were found by Ansari, Derakshan, and Richards (2008) in a mixed antisaccade paradigm. Their  
53 participants performed a single task (i.e., separate blocks of anti and prosaccade trials) and mixed task (i.e.,  
54 anti and prosaccade trials in random order within a blocks). Low anxious participants showed a switch benefit in  
55 antisaccade latencies within mixed task block when antisaccade trial was preceded by a switch trial compared to  
56 the condition where antisaccade trial was preceded by a repeat trial. However, high anxious individuals exhibited  
57 no improvement. The presence of anxiety can modulate the shifting ability (Jhonson, 2009). Goodwin and Sher  
58 (1992) reported worse shifting ability of high anxious than low anxious individuals (slower and more error-prone  
59 performance as measured by Wisconsin Card Sorting Task).

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

## 65 2 II.

## 66 3 The Present Study

67 Since the attentional bias in anxiety has widely been studied in distraction paradigms, but has not been  
68 assessed in task switching paradigm, it is unclear how anxiety modulates attention during switching between face  
69 categorization tasks. Task switching paradigm examines the central executive functions of inhibition, shifting and  
70 updating of the working memory representations. In task switching experiments, participants switch between  
71 two different tasks. Performance is faster on the trials when the task is repeated (repeat trials) than when it  
72 is changed (switch trials) producing switch cost (larger latencies and higher error rates for switch vs. repeat  
73 trials). Participant has to respond the alternate task-sets (Meiran, 2000; Rogers & Monsell, 1995), thus a cost  
74 on response times (i.e., reaction times) arises from the significant delay in adoption of the new task-set (Mayr  
75 & Keele, 2000) which involves simple activation of the task-set rule (Rubinstein, Evans, & Meyer, 2001) and  
76 inhibition of the task-rule relevant to the competing task-sets (Mayr & Keele, 2000). In the present study, we  
77 examined whether mild anxiety modulates task switching ability. Consistent with the argument that anxiety  
78 impairs central executive functions such as inhibition, shifting and attentional allocation ??

## 79 4 b)

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

## 88 5 c) Procedure

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

91 IV.

## 92 6 Results

## 93 7 a) Switching Experiment

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

98 The main effect of trial was significant  $F(1, 23) = 164.00, p < 0.001, \eta^2 = .87$ . RTs were slower on switch  
99 Volume XIV Issue VI Version I Emotion Task .01 (.00) .07 (.00) Age Task .09 (.00) .14 (.00)

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100 **8 b) Relationship between Anxiety Scores and Switch Costs**

101 V.

102 **9 Discussion**

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

106 Our results showed an asymmetry in switch costs with the effect on age decisions being larger than those  
107 on emotion decisions, although the emotion was an overall easier task. Interestingly, this effect emerged only  
108 among anxious individuals. This result supported the first hypothesis of the study. Switching between tasks of  
109 unequal difficulty is not symmetric often produces larger switch costs for the easier of the two tasks and has been  
110 attributed to the inhibition of the difficult task which is difficult to engage with while easier of the two tasks is  
111 more automatically performed (e.g., showed that emotion decisions were faster than the age decisions on repeat  
112 trials, we cannot attribute the asymmetry to the inhibition of the easier task because then the switch cost would  
113 have shown an opposite pattern (i.e., larger for the emotion than the age task). Rather the switch costs depict  
114 that the facial emotion is difficult to disengage from, thus switch costs are increased to the age task. As switching  
115 requires a successful manipulation of attentional control to allocate resources to the relevant task (Eysenck et  
116 al., 2007) and disengage the attention from the task which is irrelevant on the current trial, therefore in the  
117 current perspective, it seems that there is a diminished ability of disengaging attention from emotion attribute  
118 of the face, therefore performance on the non-emotion task has been suffered among anxious individuals. The  
119 preferential processing/ enhanced attentional allocation (i.e., enhanced P 100- ?? 1994). The results in the  
120 present study Regression analysis with anxiety scores as independent and switch costs (i.e., difference between  
121 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  
123 regression coefficients showed that anxiety scores,  $\beta = 0.76, t = 5.64, p < 0.001$  made positive contribution toward  
124 the explanation of switch costs. activity- Ball et al., 2012) to emotional faces has been observed in anxious  
125 individuals during their performance of Stroop task and face matching tasks.

126 In addition, switch cost for the age was increased with the level of anxiety. The results indicate the difficulty  
127 in switching attention from facial emotion to compute age, slowing the age decisions on switch trials in anxious  
128 individuals. This tendency is increased with high anxiety scores. Consistent with these findings, it is convincing  
129 to say that individuals with anxiety are unable to manipulate their attentional resources in order to exert an  
130 efficient cognitive control. This conclusion is also supported by the previous research (e.g., which suggests that  
131 anxiety reduces top-down control over emotional distractors evident in the reduced recruitment of the neural  
132 network involving the cortical areas-ACC (anterior cingulate cortex) and LPFC (lateral prefrontal cortex) which  
133 are engaged in cognitive control and reduces performance on tasks which involve shifting (e.g., Goodwin &  
134 Sher, 1992) Our results are consistent with the previous research suggesting the deficit of attentional deployment  
135 away from the emotional stimuli in anxious individuals, but at the same time it is important to note that the  
136 previous studies have employed differential paradigms, for example the picture version of dot-probe paradigm  
137 (MacLeod, Mathews, & Tata, 1986) where individuals are presented with two pictures (emotional/non emotional)  
138 simultaneously followed by a simple probe to which a response has to be made. The efficiency of response to  
139 the probe following the emotional picture compared with non-emotional picture determines the attentional bias  
140 to the emotional picture. The similar results have been found in studies using spatial cuing task (e.g., Fox,  
141 Russo, Bowles, & Dutton, 2001; Fox, Russo, & Dutton, 2002; Mogg, Holmes, Garner, & Bradley, 2008) where  
142 a single emotional face is presented as a cue for a simple probe which can either appear on the same or on a  
143 different location of the emotional face. The high anxious individuals take longer to disengage attention from  
144 the emotional face. Here we used task switching paradigm where the participant has to make decisions of the  
145 emotion/age of a single emotional face which alternates every trial. As the participants are engaged in a different  
146 task every second trial while the face is alternated every trial-it provides a measure of cognitive control and  
147 reflects the allocation of attentional resources.

148 The neurocognitive mechanisms of anxiety support a common amygdala-prefrontal circuitry during cognitive-  
149 affective processing. The anxiety is characterized by the hyper-activation of the amygdala toward emotional  
150 stimuli and a prefrontal underrecruitment to modulate the activation of amygdala at neural level. As a result  
151 the cognitive system is biased due to the activation of emotion-related representations and a failure to implement  
152 cognitive control to inhibit the emotion-related representation in order to activate the non-emotion representations  
153 (Bishop, 2007). Anxiety is associated with deficits in working memory and inhibitory control (Eysenck & Calvo,  
154 1992; Fox, 1994).

155 The results of the present study showed that attentional bias toward emotion interfered to compute age among  
156 faces; as a result the switching ability suffered.

157 **10 VI. Limitations and Future Directions**

158 The present study employed a small number of non-clinical sample. Thus, future research must include  
159 comparatively larger sample and clinically significant level of anxiety. Results of the present study have

## 10 VI. LIMITATIONS AND FUTURE DIRECTIONS

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160 implications to understand affective disorders and to design therapeutic interventions for anxiety disorders. As a  
161 conclusion, anxiety impairs cognitive control of emotional stimuli (i.e., greater engagement with emotion). As a  
162 result, the non-emotion task endures greater switching cost than the emotion task. Mild anxiety predicts switch  
costs.

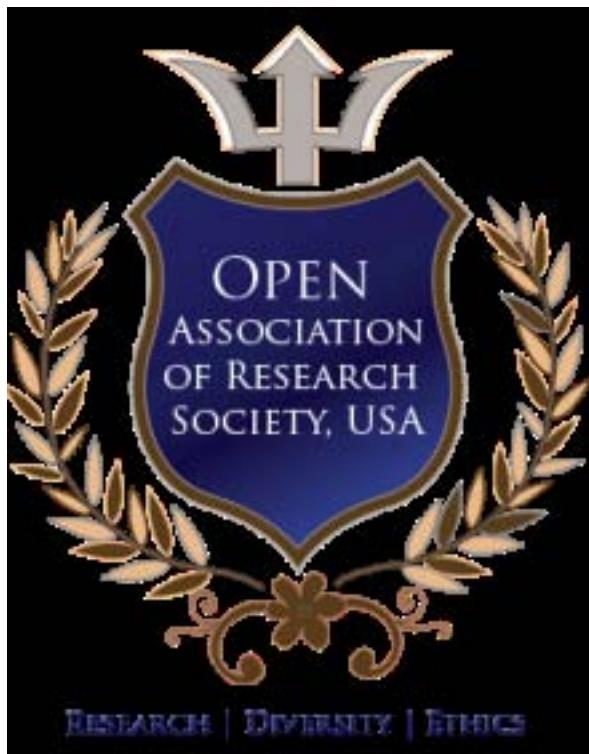


Figure 1:

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Figure 2:



Figure 3: Figure 1 :

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reaction times (ms)	600 700 800 900 1000	Emotion
Mean	400 500	
	300	
	200	
Switch		Repeat

[Note: Age ( $M=953.38ms$ ) than repeat ( $M=623.00ms$ ) trials. Errors ( $M$ ) and Standard Errors ( $SE$ ) in Task switching Experiment Allport et al.]

Figure 4: Table 1 :

Figure 5:



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