# PRACTICE, STIMULUS-SPECIFIC EFFECTS AND INDIVIDUAL DIFFERENCES IN TASK SWITCHING

**by**

**AMARA GUL**

**A thesis submitted to the University of Birmingham for the degree of**

**DOCTOR OF PHILOSOPHY**

**School of Psychology**

**University of Birmingham**

**June 2012**

# ABSTRACT

This thesis points to the important roles of learning, individual differences in emotional intelligence (EI) and general intelligence (IQ), and culture (British vs. South Asian), on task switching. Participants switched between word identities and colour and between different face dimensions (emotion, gender and occupation). In general switch costs were reduced as participants practiced. Most interestingly, Stroop interference across blocks of trials was stronger for stimuli that form integrated representations, providing evidence that learned bindings between word forms and colours influence Stroop effects. In a separate study, people with high IQ were generally better able to task-switch while EI had a selective effect depending on the task. Individuals with high EI had low switch costs when emotion classification was involved, but not when switches were made between gender and occupation decisions. In a third set of studies, culture was found to affect the speed of face categorization, which may reflect cultural biases to emotion (in the White British population) and unfamiliarity in using facial cues to gender in South Asian participants. Finally, there was also evidence of implicit coding of facial emotion and gender - but not occupation. The implications for understanding task switching were reviewed in a final chapter.

# DEDICATION

Dedicated to

*My beloved mother*

who always prays for my success, happiness, and prosperity

*My gracious father*

who has always been a source of strength, inspiration, and proud for me

# ACKNOWLEDGEMENTS

I would like to express my sincerest, deep, reverential meritorious and devoted thanks to my learned, worthy, honourable, and graceful supervisor Prof. Glyn W. Humphreys for his scholarly guidance, professional advice, illustrious encouragement, very sympathetic attitude and ever remembering supervision to make me to complete this task. He has always been a source of inspiration and dignity for me throughout my study and stay.

I am also extremely thankful to Prof. M. Jane Riddoch for her kind co-operation. I have no phrase for her friendly behavior and support.

I offer my sincere thanks to the Islamia University of Bahawalpur for award of scholarship and study leave.

Last but not least, I am thankful to my family whose hearty prayers brought every success in my life.

## TABLE OF CONTENTS


| Content | Page No. |
|---|---|
| Chapter 1: Introduction | 1 |
| 1.1. Practice effects in task switching | 3 |
| 1.2. Asymmetric switch cost between different tasks | 4 |
| 1.3. Asymmetric switch cost between attributes of face | 6 |
| 1.4. Individual differences in task switching | 10 |
| | 12 |
| Chapter 2: Practice, Switching and Colour-word Integration in Stroop Interference | |
| Abstract | 14 |
| 2.1. Learning and switching | 15 |
| 2.2. Colour and word integration | 18 |
| 2.3. Experiment 1 | 19 |
| 2.3.1. Method | 19 |
| 2.3.2. Results | 21 |
| 2.3.3. Discussion | 27 |
| 2.4. Experiment 2 | 29 |
| 2.4.1. Method | 29 |
| 2.4.2. Results | 31 |
| 2.4.3. Discussion | 40 |
| 2.5. General Discussion | 42 |
| Chapter 3: IQ not EI correlates with the Task switching | 45 |
| Abstract | 45 |
| 3.1. Face Categorization | 47 |
| 3.2. Intelligence (IQ) and Emotional Intelligence (EI) | 48 |
| 3.3. Experiment 1: Gender-emotion task switching | 52 |
| 3.3.1. Method | 52 |
| 3.3.2. Results | 55 |
| 3.3.3. Discussion | 61 |
| 3.4. Experiment 2: Emotion-occupation task switching | 63 |
| 3.4.1. Method | 63 |
| 3.4.2. Results | 64 |
| 3.4.3. Discussion | 70 |
| 3.5. Experiment 3: Gender-occupation task switching | 71 |
| 3.5.1. Method | 71 |
| 3.5.2. Results | 72 |
| 3.5.3. Discussion | 79 |
| 3.6. General Discussion | 81 |
| 3.6.1. Relative magnitudes of task switching costs | 81 |
| 3.6.2. Effects of EI and IQ | 82 |
| 3.6.3. Conclusion | 84 |

Chapter 4: Cultural effects in Gender and Emotion Recognition 85
Abstract 85
4.1. Experiment 1: High saliency emotion 90
4.1.1. Method 90
4.2. Experiment 2: Low saliency emotion 92
4.2.1. Method 92
4.2.2. Results 93
4.2.3. Discussion 99
4.3. General Discussion 102
4.3.1. Cultural differences in face categorization 102
4.3.2. Switching effects for face categorization 104
4.3.3. Conclusion 104

Chapter 5: Explicit and Implicit Task switching between Facial attributes 106
Abstract 106
5.1. Functional Independence of Facial Attributes 107
5.2. Asymmetric Interference between Facial Features 108
5.3. Experiment 1: Gender and occupation decisions 110
5.3.1. Method 110
5.3.2. Results 111
5.3.3. Discussion 116
5.4. Experiment 2: Gender and emotion decisions 117
5.4.1. Method 117
5.4.2. Results 118
5.4.3. Discussion 121
5.5. Experiment 3: Occupation and emotion decisions 122
5.5.1. Method 122
5.5.2. Results 123
5.5.3. Discussion 126
5.6. General Discussion 127
5.6.1. Conclusion 129

Chapter 6: General Discussion 131
6.1. Learning and switching 131
6.2. Individual differences in task switching 133
6.3. Switch cost asymmetries 135
6.4. Cultural effects in categorization 137
6.5. Implicit processing of emotion 138
6.6. Implications 140

Appendix A 143
Appendix B 145
Appendix C 147
Appendix D 149
References 151

## LIST OF TABLES


| Table | Page No. |
|---|---|
| Table 2.1. Mean percentage errors (standard deviations) of errors on switch and repeat trials in experiment 1 and 2 | 23 |
| Table 2.2. Mean percentage errors (standard deviations) of errors for congruent and incongruent words in experiment 1 and 2 | 27 |
| Table 3.1. Mean switch cost for the emotion-gender task, for the NAART VIQs, and the BarOnEQ-i scores | 60 |
| Table 3.2. Mean percentages (standard deviations) of errors in the emotion and gender task | 60 |
| Table 3.3. Mean percentages of errors rate in the emotion-occupation task | 66 |
| Table 3.4. Mean switch cost for the emotion-occupation task, for the NAART VIQs, and the BarOnEQ-i scores | 68 |
| Table 3.5. Mean switch cost for the gender-occupation task, for the NAART VIQs, and the BarOnEQ-i scores | 76 |
| Table 3.6. Mean percentages of errors rate in the gender-occupation task | 77 |
| Table 4.1. Mean percentage errors (standard deviations) for switch and repeat trials in experiment 1 (high saliency emotion) and experiment 2 (low saliency emotion) | 99 |
| Table 5.1a. Mean error rate (standard deviations) for the explicit task switch in the gender and occupation task | 115 |
| Table 5.1b. Mean error rate (standard deviations) for the effect of implicit emotion switch in the gender and occupation task | 116 |
| Table 5.2a. Mean error rate (standard deviations) for the explicit task switch in the emotion and gender task | 120 |
| Table 5.2b. Mean error rate (standard deviations) for the implicit occupation switch in the emotion and gender task | 121 |
| Table 5.3a. Mean error rate (standard deviations) for the explicit task switch in the emotion and occupation task | 125 |
| Table 5.3b. Mean error rate (standard deviations) for the effect of implicit gender switch in the emotion and occupation task | 126 |

## LIST OF FIGURES


| Figure | Page No. |
|---|---|
| Fig. 2.1. Word/Colour identification tasks with the congruent and incongruent words stimuli in alternate run | 21 |
| Fig.2. 2a. Mean reaction times in the word identification task | 24 |
| Fig.2.2b. Mean reaction times in the colour identification task | 24 |
| Fig.2.3a. Mean reaction times on congruent and incongruent words in the word identification task | 26 |
| Fig.2.3b. Mean reaction times on congruent and incongruent words in the colour identification task | 26 |
| Fig.2.4a. Mean reaction times on switch and repeat trials in the word identification task in colour-word constant condition. | 33 |
| Fig.2.4b. Mean reaction times on switch and repeat trials in colour identification task in colour-word constant condition. | 33 |
| Fig.2.4c. Mean reaction times on switch and repeat trials in the word identification task in alternating colour-word condition. | 34 |
| Fig.2.4d. Mean reaction times on switch and repeat trials in the colour identification task in alternating colour-word condition. | 34 |
| Fig.2.5a**.** Block wise mean reaction times on congruent and incongruent words in the Word identification task. | 36 |
| Fig.2.5b**.** Block wise mean reaction times on congruent and incongruent words in the colour identification task. | 37 |
| Fig.2.6a. Mean reaction times on congruent and incongruent words in constant colour-word condition | 38 |
| Fig.2.6b. Mean reaction times on congruent and incongruent words in alternating colour-word condition | 38 |
| Fig.2.7a. Block wise mean reaction times on congruency for the constant colour-word condition | 41 |
| Fig.2.7b. Block wise mean reaction times on congruency for the alternating colour-word condition | 42 |
| Fig. 3.1. Stimulus and displays for the emotion and gender task | 53 |
| Fig. 3.2a. Mean reaction times for switch and repeat trials in the emotion task in experiment 1 | 56 |
| Fig.3.2b**.** Mean reaction times for switch and repeat trials in the gender task in experiment 1 | 56 |
| Fig.3.3a. Correlation between the switch cost for the emotion task in experiment 1 and EI scores | 58 |
| Fig.3.3b. Correlation between the switch cost for the gender task in experiment 1 and EI scores | 58 |
| Fig.3.4a. Correlation between the switch cost for the emotion task in experiment 1 and IQ scores | 59 |
| Fig.3.4b. Correlations between the switch cost for the gender task in experiment 1 and IQ scores | 59 |

Fig.3.5a. Mean reaction times for switch and repeat trials in the emotion task in experiment 2 65
Fig.3.5b. Mean reaction times for switch and repeat trials in the occupation task in experiment 2 65
Fig.3.6a. Correlations between the switch cost for the emotion task in experiment 2 and EI scores 67
Fig.3.6b. Correlations between the switch cost for the occupation task in experiment 2 and EI scores 67
Fig.3.7a. Correlations between the switch cost for the emotion task in experiment 2 and IQ scores 68
Fig.3.7b. Correlations between the switch cost for the occupation task in experiment 2 and IQ scores 69
Fig.3.8a. Mean reaction times for switch and repeat trials in the gender task in experiment 3 73
Fig.3.8b. Mean reaction times for switch and repeat trials in the occupation task in experiment 3 73
Fig.3.9a. Correlations between switch cost for the occupation task in experiment 3 and EI scores 75
Fig.3.9b. Correlations between the switch cost for the gender task in experiment 3 and EI scores 75
Fig.3.10a. Correlations between the switch cost for the occupation task in experiment 3 and IQ scores 76
Fig.3.10b. Correlations between the switch cost for the gender task in experiment 3 and IQ scores 77
Fig.4.1. Emotion-gender task stimuli 93
Fig.4.2. Mean reaction times on the switch and repeat trials in the emotion and gender task 95
Fig.4.3a. Mean reaction times of Asian and British participants on the switch and repeat trials in experiment 1 (high saliency emotion). 97
Fig.4.3b. Mean reaction times of Asian and British participants on the switch and repeat trials in experiment 2 (low saliency emotion). 97
Fig.4.4a. Mean reaction times of Asian and British participants in the emotion and gender task in experiment 1 (high saliency emotion). 98
Fig.4.4b.Mean reaction times of Asian and British participants in the emotion and gender task in experiment 2 (low saliency emotion). 98
Fig.5.1. Mean reaction times on the switch and repeat trials for the gender and occupation task. 113
Fig.5.2a. Mean reaction times for the emotion switch and emotion repeat trials in the task switch condition. 114
Fig.5.2b. Mean reaction times for the emotion switch and emotion repeat trials in the task repeat condition. 115
Fig. 5.3. Mean reaction times on switch and repeat trials for the emotion and gender task 119

Fig. 5.4. Mean reaction times on the task switch and task repeat trials for the occupation switch and occupation repeat trials. 120
Fig. 5.5. Mean reaction times on the task switch and task repeat trials for the emotion and occupation task. 124
Fig.5.6. Mean reaction times on the task switch and task repeat trials for the gender switch and gender repeat trials. 125

# CHAPTER 1

# INTRODUCTION

Human behavior needs to be highly flexible in order to cope with environmental challenges. This flexibility is based on complex cognitive control mechanisms that are required not only to filter information but also to operate appropriately to achieve task goals. The exploration of the cognitive mechanisms underlying flexible task performance has been an area of interest for researchers since the beginnings of cognitive psychology, and task switching has frequently been used as an experimental paradigm to explore the mechanisms of cognitive control.

In task switching experiments, the participants perform two different tasks. Performance is generally slower on those trials when a task changes (switch trials), and it is faster when the task repeats (repeat trials), compared to when a trial is started for the first time – producing a switch cost (larger latencies and higher error rates for switch vs. repeat trials). This switch cost is generally asymmetric when the tasks are of unequal difficulty, producing the counter-intuitive finding of larger switch costs for the easier task. For example, with Stroop stimuli, reading the word RED printed in *blue* (response- red) is typically easier (faster & less error prone) than naming the colour in which the word is written (response-blue) (Stroop, 1935). Allport, Styles, and Hsieh (1994) presented *Stroop words* (e.g., RED printed in blue colour), *neutral words* for word reading (words printed in black colour), and *neutral words* for colour naming (strings of xs printed in five colours) and required participants to either read the word or name it's colour, repeating or switching between two tasks on different trials. The results showed larger switch costs for word

reading than colour naming (Allport, Styles, & Hsieh, 1994, experiment 5) despite word reading being the easier task.

Jersild (1927) reported the first task switching experiment. He presented a list of 2-digit numbers in an alternating run to the subjects and the task was to subtract 3 from the first number, to add 6 to the next number, and so on down to the list in ABABAB...run (in an experimental/mixed list condition). In a control condition participants had to "subtract 3 from every number" or "add 6 to every number" in AAAA/BBBB runs (the pure list condition). Switch costs were computed by subtracting the time taken to perform the non-alternating lists from the time required to perform with the alternating list. The results showed that the participants took much longer to complete mixed lists than pure lists (i.e., there was a switch cost) which was 34% of the baseline time per item in the pure blocks. Applying the same paradigm, Spector and Biederman (1976) found switch costs of over 400 ms per item while switching between adding 3 and subtracting 3 from two-digit numbers.

In certain situations when the task switches and the participant has to respond to stimuli on the basis of changed stimulus-response rules [so called "task set rules" (Meiran, 2000; Rogers & Monsell, 1995)], a cost on reaction times can arise from the subsequent delay in selecting the appropriate (new) task-set rules (Mayr & Keele, 2000). Views on how flexible set rules can be instantiated and changed vary – from the idea that there is simply activation of the relevant rule (Rubinstein, Evans, & Meyer, 2001) through to the proposal that there need to be extra inhibitory processes, which minimize interference from competing "task-sets" (Mayr & Keele, 2000). There is evidence from neurological and neuroimaging studies that different mechanisms contribute to task-set selection and they are functionally independent: For example patients with focal lesions of the left inferior frontal cortex show

normal inhibition in the form of larger RTs to recently abandoned tasks but are still impaired at imposing new task sets; patients with right frontal cortex lesions can show the opposite pattern (Mayr, Diedrichsen, Ivory, & Keele, 2006). Such results suggest a neurocognitive dissociation between selection and inhibition of task-sets in the prefrontal cortex - the activation of task-sets operates through the left prefrontal cortex (e.g., Brass & von Cramon, 2002; Rogers et al., 1998) while the process of task-set inhibition involves the right prefrontal cortex (Aron, Monsell et al., 2004).

### 1.1. Practice effects in task switching

This experimental paradigm of Jersild (1927) had confounds several factors. For instance, in addition to having switch tasks in an *alternating run* block, the participants were also required to perform two tasks while in a *pure run*, only one task was performed. Rogers and Monsell (1995) introduced an "alternating run" paradigm (AABBAABB...) to avoid such confounds, with switch costs now being measured within blocks (reaction times on alternating/switch trials minus reaction times on non-alternating/repeat trials) as the subjects were required to alternate between runs of two/more trials of each task – so avoiding overall differences in the number of tasks being performed. This study is of particular interest to the present thesis because it highlighted the effects of practice on task switching performance. Rogers and Monsell presented classification tasks in which a *letter* had to be categorized as a consonant or a vowel and the other task required odd or even classification of a *digit* stimulus. Switching costs between repeat and switch trials were compared, over 2 days of practice. The results showed an average task switching cost of 224 ms which fell from 262 ms on the first day to 186 ms on the second day. The notion that switch costs can be reduced as a function of practice was further strengthened by Meuter and Allport (1999). They presented single digits ranging from 1 to 9 in the centre of a coloured rectangle to bilinguals

and with the instructions that the colour of the rectangle would serve as a cue as to which language to name the numeral in (e.g., for an English and French speaker "blue" might indicate "name the numeral in English" and "yellow" name the numeral in French). Vocal responses were made to 200 items. The results showed that switch trials were slower than repeat trials for each language and language-switching costs were regularly greater when switching from the weaker second language into the stronger first language (again, switch costs here being larger for the easier, first language, mimicking the results with Stroop stimuli noted above). To explore the effects of practice, Meuter and Allport selected the first 15 and last 15 correct trials in each condition over the list of 200 numerals. The analysis showed a benefit from practice on repeat trials for both of the languages, with the second language showing a larger practice effect than the first (41 vs. 27 ms). Conversely on switch trials, RTs in the dominant language showed larger reductions with practice compared to the second language (65 vs. 30 ms).

**1.2. Asymmetric switch cost between different tasks**

As already mentioned, asymmetries in switch costs have been found when participants switch between different tasks (see also Campbell, 2005; Cherkasova, Manoach, & Intriligator, 2002; Koch, Prinz, & Allport, 2005; Schneider & Anderson, 2010). This has been examined most thoroughly using the Stroop task. Stroop colour naming is one of the most widely studied paradigms for examining selective attention as it requires a person to selectively attend to one component of a multidimensional stimulus while ignoring another (Stroop, 1935; for review see MacLeod, 1991). In the classic version, participants are asked to name the colour of the ink in which the word is written. Typically, reaction times (RTs) to name the ink colour are slower when word's name is incongruent (word RED in blue ink) relative to when it is congruent (RED in red ink).

Wylie and Allport (2000, experiment 1) presented Stroop stimuli (six words: red, green, blue, yellow, pink, and brown, word and colour always incongruent), neutral stimuli for colour naming (string of "x" three to six characters long of the six colours used in Stroop stimuli) or word reading (six words in black) in the top two quadrants of a computer screen as the task cue for "word reading" and the bottom two quadrants as the task cue for "colour naming". In block 1 all-neutral words were presented, then in block 2 colour –neutral stimuli, followed by block 3, with presentation of all-Stroop words.. The results in block 1, 2 and 3 showed slower performance on switch than repeat trials and word reading faster than colour naming. Comparisons of performance across the initial blocks in the *word reading task* (block 1 and 2) showed only a reliable effect of switch- longer latencies on switch than repeat trials. Comparisons between block 2 and 3 showed reliable effects of switch- slower performance on switch than repeat trials and block- and longer latencies when the task involved Stroop stimuli than when it involved neutral stimuli. In the *colour naming task*, participants exhibited longer latencies on colour switch trials in the colour-neutral than in the all-neutral block (block 1 vs. block 2) and the comparison between blocks 2 and 3 revealed a reliable effect of switching - slower performance on switch than repeat trials and block- with longer latencies when the task involved Stroop stimuli than when it involved neutral stimuli.

These data on task switching suggest that there can be asymmetric costs, depending on task difficulty, and that switch costs reduce with practice at the tasks. In chapter 2 of this thesis, I evaluate factors that may influence the effects of practice on task switching with Stroop stimuli, manipulating (e.g.) whether the same colours are assigned to the same words across trials, as participants practice on the task. Repeating a common binding of colour and identity across trials may lead to stronger associations of colours and words which might

make it more difficult to ignore the irrelevant dimension of the stimulus and it may counteract general benefits to performance as tasks are repeated.

### 1.3. Asymmetric switch cost between attributes of face

Most studies of switch costs have either used different stimuli or had participants respond to different dimensions of the same stimulus (e.g., word identity and colour). In present studies, I will present novel experiments examining task switching when responses are required to similar attributes of stimuli on repeat and switch trials – facial emotion, gender and occupation/identity. There is evidence that all of these tasks depend on configural information (relation among features) that is coded from faces – an ability which appears to develop early in life (see Carey and Diamond, 1994). Evidence for configural processing of faces comes from studies showing that face processing, perhaps more than the processing of other objects, is disrupted when the spatial relations between the features is manipulated (see Kaloscai & Biederman, 1997). The importance of configural information in face processing is further highlighted by Young et al. (1987) using a facial composite technique in which photographs of the top and bottom halves of different famous faces fused to form unfamiliar faces when aligned with each other. The perception of a novel configuration in such composite faces made identification of the constituent parts harder than when the faces were misaligned. Baudouin and Humphreys (2006) reported a decline in performance (slower and more error prone) for classifying the gender of composite faces when the top half and the bottom half of faces with different genders were aligned relative to when they were non-aligned or same gender face. In addition, gender discrimination was also disrupted when salience of the configural information was reduced (by inversion). Similarly, Calder et al. (2000) prepared composite facial expressions by aligning the top half of one expression (e.g., anger) with the bottom half of another expression (e.g., happy), and this made the

identification of expression slower relative to when non-composite images were presented where two halves were misaligned.

Neuropsychological studies suggest that the different components of face processing are functionally independent, for example, gender classification dissociates from emotion discrimination following brain injury (Humphreys, Donnelly, & Riddoch, 1993). Patients with prosopagnosia, and poor retrieval of occupation and name information, may still successfully perform gender categorization, suggesting that the process relies on different information to that required for face recognition (see e.g., Clarke et al., 1997; Tranel, Damasio & Damasio, 1988; Sergent & Villemure, 1989; Flude, Ellis, & Kay, 1989). In addition, face identification and emotion discrimination can also dissociate (e.g., Campbell, Landis, & Regan, 1986; Parry, Young, Saul, & Moss, 1991). Given the differing patterns of dissociation, I predict that substantial effects of task switching may occur, when participants have to shift from one classification task to another (e.g., gender to emotion or identity). Also it has been noted (e.g., Wang et al., 2007; Schneider & Anderson, 2010; Koch, Prinz, & Allport, 2005) that there can be asymmetrical effects of task switching where there is a greater switching cost on the easier of two tasks (e.g., Allport et al., 1994; Meuter & Allport, 1999). These asymmetrical effects may reflect the inhibition of the easier of two tasks to enable the more difficult to be performed, at least when both tasks may be cued by the same stimulus. In the present thesis facial stimuli were used and it is possible that one form of classification may need to be inhibited if it is applied more easily than the other. I will report data on gender, emotion and occupation decisions. Emotions may be categorized automatically, even when participants can not consciously report on the presence of the face (Driver & Vuilleumier, 2001). In contrast to this, gender information is not automatically categorized at least with famous faces (Quinn, Mason, & Macrae, 2009); however equivalent

data on the retrieval of occupation information from faces has not been derived making it difficult to predict performance in this case. Nevertheless, we may predict that emotion classification may have to be inhibited to enable the other classifications to occur, generating asymmetric switch costs.

Alongside this, there are cultural variations in the allocation of attention to configural information in visual stimuli. For example, some data suggest that East Asians rely more on configural than feature based processing compared to Americans for stimuli including natural scenes (e.g., Masuda et al., 2008; Masuda & Nisbett, 2001, 2006) and geometric figures (e.g., Kitayama, Duffy, Kawamura, & Larsen, 2003). In addition, East Asians are more affected by contextual surround cues than Western participants. For example when participants were presented with a square frame with a printed line within it, followed by the presentation of another square frame of the same/different size and were asked to draw a line- identical to the first line either in absolute length or in to proportion to the height of the surrounding frame, Japanese participants were more accurate in the relative task while Americans performed more accurate on the absolute task (Kitayama, Duffy, Kawamura, & Larsen, 2003). In addition, when viewing naturalistic scenes containing a focal object on a complex background, Eastern participants (Chinese) report more details in the background compared with Western observers. This suggests Eastern participants process scenes in a more holistic manner (Chua, Boland, & Nisbett, 2005). East Asians found to be more sensitive towards changes to the contextual background while Americans detected more changes in the focally presented object (Nisbett & Masuda, 2003). These cultural variations extend to face perception. For instance, when asked to choose a prototypic face for a set of exemplars, Japanese choose faces that are more 'configural' (where configurations are created by blending the facial features of four faces defined by ethnicity and gender)

compared to Americans - suggesting that Japanese participants place more reliance on overall resemblance than featural matching. In a speeded identity matching task, when the configural changes were manipulated by altering the spaces between individual features, Japanese participants have been shown to identify spacing differences between facial features more accurately than Americans (Miyamoto, Yoshikawa, & Kitayama, 2011). Blais et al. (2008) monitored eye movements of Western and Asian observers when they categorized own and other race faces. The results demonstrated a differential strategy between Asian and Western participants. East Asians focused more on the central face region which is instrumental in the integration of information holistically while Western Caucasian observers focused more across facial features in more peripheral regions.

Although both emotion and gender discrimination appear to depend on facial configurations, they have also been found to generate asymmetric effects under task switching conditions. For example, Reimers and Maylor (2005) had participants performed speeded face categorization tasks to facial emotion and gender, comparing performance across trials where the tasks repeated and when they switched. Within a *switching block* (NSw RT minus Sw RT), switch costs for the emotion task were larger than for the gender task. In the present thesis I conduct a similar comparison, but also including a further task (occupation decisions) which requires access to facial identity. I assess whether there are baseline differences between these tasks, and whether there are asymmetric switching costs. To the extent that the two tasks require access to the same information, then strong switch costs may not be expected. On the other hand, some tasks may be more attentionally engaging than others – for example, emotion judgments more than gender, which may be based on relatively superficial characteristics of faces. If this is the case then asymmetric switch costs may emerge since attention may be engaged more easily to facial emotion than

to (say) facial gender. In addition, I examine any cultural effects when Asian and Western participants switched between emotion and gender categorization responses to faces (chapter 4). To the extent that Western and Asian participants may put differential 'weight' on emotion and gender judgments, and to the extent that there are differences in configural processing in relation to the judgments, then a differential ease of switching to and from facial attributes may arise between the Western and Asian participants.

### 1.4. Individual differences in Task switching

Previous work (Salthouse et al., 1998) revealed that there are individual differences in the ability to switch between different tasks, particularly, the ease to switch to and from a task, with the efficiency of performing a specific task being modulated by intelligence. In particular, faster switchers had higher fluid intelligence. In addition to this, factor analysis revealed that measures of task switching were highly correlated (i.e., -.85 and -.88) with tasks related to IQ (cube assembly, geometric matrices adapted from Ravens progressive matrices, Rey auditory verbal learning). Similarly mixing costs under dual task conditions have an inverse correlation with IQ (Yehene & Meiran, 2007). In chapter 3, my aim is to investigate whether intelligence can predict task switching performance. I also investigate effects of emotional intelligence (EI). Self-report measures of emotional intelligence (EI) do not correlate with general intelligence (IQ) (Barchard and Hakstian, 2004), with EI being specifically related to skills in emotion perception (people high in EI are better at perceiving emotional expressions from faces than individuals low in EI; Ciarrochi, Chan, & Bajgar, 2001). Given that high EI individuals show beneficial processing of emotion, then there is the possibility that high EI individuals may be better able to switch to emotion decisions to faces than individuals low in EI. This issue is further taken up in chapter 3 of this thesis.

Various definitions of EI exist in the literature; According to the *trait model* by Goleman (1998), EI reflects the operation of four broad areas: self-awareness, motivation, empathy and adeptness in relationships. Salovey and Mayer (1990), in contrast, define EI as the ability to perceive and express emotion, the ability to regulate emotion, and the ability to utilize emotions when solving problems. BarOn (1997) proposes that EI is an umbrella term reflecting multiple non-cognitive capabilities, competencies, and skills required in coping with environmental demands and pressures. In a comprehensive analysis of different EI measures, Barchard and Hakstian (2004) reported that self-report measures of EI do not correlate with general intelligence (IQ), but rather provide measures of the self-perception of emotional sensitivity. Ability-based measures of EI have two factors: emotional congruence and social perceptiveness. Emotional congruence refers to the perceived affective quality of the stimulus and is relatively independent of traditional cognitive abilities, while social perceptiveness refers to the understanding of interpersonal relations and the relationship between emotion and behaviour in various situations, and has moderate correlation with verbal ability and inductive reasoning.

The five composite factors capturing EI are: (1) *Intrapersonal EQ*, which assesses the inner self. High scores on this factor indicate individuals who feel positive about themselves and feel good what they are doing in their lives. (2) *Interpersonal EQ* which reflects empathy, interpersonal relationships, and social responsibility. High score on this factor indicate responsible and dependable individuals who understand and interact well with others. (3) *Adaptability EQ,* which measures the ability to cope with environmental demands and to solve problems effectively. (4) *Stress management EQ*, which indicates the skill to withstand stress without losing control. (5) *General mood EQ*, which consists of happiness and optimism factors. High scores on this factor indicate cheerful, positive and optimistic

individuals who know how to enjoy life (BarOn, 1997). EI and IQ have both been shown to affect cognitive performance, for example, people with higher EI have been shown to solve more problems on anagrams (scrambled words) than individuals with lower EI, at least in part because they persist in their performance even when encountering frustrating and difficult sets of problems (Schutte, Schuettpelz, & Malouff, 2001). There is also a positive correlation ($r$=.36) between EI and grades of high school students (Marquez, Martin, & Brackett, 2006). However, in some studies, when IQ has been partialled out, the correlation between EI and IQ drops to non-significance (Lam & Kirby, 2002). Though EI and IQ are not synonymous, EI is more closely related to crystallize compared to fluid abilities (see e.g., Farrelly & Austin, 2007; MacCann et al., 2004; Zeidner et al., 2005). Fluid intelligence refers to skills associated with logical thinking and problem solving whereas crystallized intelligence reflects the ability to use knowledge and experience (Cattell, 1971). In chapter 3, I assessed whether different aspects of EI could predict switching performance between contrasting face classification tasks.

In the final empirical chapter in the thesis (chapter 5), I examine task switching between different face judgment tasks again, but this time using the within-block switching procedure of Rogers and Monsell (1995), where tasks are switched across alternating pairs of trials. This procedure enables manipulations to be made where an irrelevant feature of the stimulus is allowed to vary or stay constant as tasks repeat or switch, so that effects of an irrelevant change on the main repeat and switch task can be measured. This then provides a novel measure of implicit processing of different face dimensions. I compare effects of changing emotion, gender and occupation, to evaluate if some but not all aspects of faces are processed implicitly.

In this thesis, I report four empirical chapters examining task switching in relation to the effects of practice and the regular or more varied pairing of stimulus properties (chapter 2), individual differences in responses to faces for gender, emotion, and occupation decisions (chapter 3), responses to these properties as a function of the race of the participant (chapter 4), and the effects of implicit changes in faces on different explicit face judgments (chapter 5). In addition, I examine task switching using both blocked trials (chapters 2-4) and a within block switching procedure (chapter 5), which can respectively assess the decrease in switching effects across trials under blocked conditions (see Allport & Wylie, 1999) and switching when dual task loads are equated (in the within-block procedure). The results have implications for understanding: (i) how practice, along with the learning of attribute-specific bindings, influences task switching (ii) how switching operates between different facial attributes (iii) how aspects of face processing and task switching differ across individuals varying in IQ, EI and races/culture and (iv) the implicit processing of different facial attributes.

# CHAPTER 2

# PRACTICE, SWITCHING AND COLOUR-WORD INTEGRATION IN STROOP INTERFERENCE


## Abstract

Colour and word identification were examined to colour-word names in different hues using a manual response task in which participants switched tasks across different trial blocks. In addition, either hue-word relations were kept constant on incongruent trials across trial blocks, or they varied randomly across different pairings within the stimulus set. Symmetric patterns of switch-cost interference were found for word and colour identification. In addition, while switch costs generally decreased with practice, Stroop interference increased in the condition in which the incongruent hue-word relations were maintained. The data suggest that switch-costs reduce as more resources become released due to practice. However, Stroop effects can increase when words and hues become bound by learning, which can make it more difficult to ignore the word when responding to the hue. The implications for understanding switch costs and Stroop interference are discussed.

Stroop colour naming is one of the most widely studied paradigms for examining human selective attention as it demonstrates that striking problems that can arise when we have to selectively attend to one component of a multidimensional stimulus and ignore a highly overlearned response to another (Stroop, 1935; for a review see MacLeod, 1991). In the classic version of the test, participants are asked to name the colour of the ink in which the word is written while ignoring the word. Typically, reaction times (RTs) to name the ink colour are slower when word‘s name is incongruent (word RED in blue ink) relative to when it is congruent with the colour name (RED in red ink). In contrast, at least for naming tasks, the effects of colour congruence on word naming are small (White, 1969). However, this result changes when participants make manual responses, when congruency effects are more equitable for colour and word naming (McClain, 1983 a,b). The data on Stroop interference are typically attributed to an alternative response competing with the required response when the stimuli are incongruent relative to when they are congruent (Sichel & Chandler, 1969; Regan, 1979; Dunbar & MacLeod, 1984). For naming, word reading is the dominant response and so there is more competition from the word’s name for colour naming than from the colour’s name for word reading. However, as there is not a dominant manual response to words or colours, this asymmetric interference effect disappears.

### 2.1. Learning and switching

The differential effects of interference on colour and word naming suggest that Stroop effects can be modulated by the amount of practice people have on tasks. There is evidence that practice on the Stroop task itself changes the magnitude of interference effects. With practice, people gain in attentional control as shown in a classic Stroop experiment (1935), when subjects were presented conflicting word stimuli (incongruent words- RED written in green ink) to colour name the words. After eight days of practice (200 reactions per day),

interference was reduced for conflicting words. Ellis et al. (1989) instructed their subjects to practice the Stroop colour-naming task over three or four daily sessions. The results showed a significant decrease in interference over practice trials. Similarly, Ellis and Dulaney (1991) instructed normal adults to read Stroop words, followed by practice in colour naming with Stroop words, then reading Stroop words. The results demonstrated reduced Stroop interference after practice. MacLeod (1998) also had participants practice on both word and colour naming with Stroop stimuli across 5 consecutive days and reported that interference on colour naming decreased by 49%.

In addition to the effects of practice, there is also considerable evidence that switching between colour and word naming can impact on Stroop interference. This switching ability may improve as it gets repeated more often. Wylie and Allport (2000, Experiment 1), presented Stroop stimuli (incongruent words) and neutral stimuli (a string of "xs" 3-6 characters long) for colour naming and word reading. Though they found that word reading was faster than colour naming. RTs were slowed on the initial trials in a block after a task switch occurred, relative to when the task was maintained.

Interestingly, there were asymmetrical effects of task switching between colour and word naming where word naming (the usually easier task) was differentially slowed on switch trials. Furthermore, on switch trials, there was large 'reverse' Stroop interference where an incongruent colour now disrupted word naming. Allport, Styles, and Hsieh (1994) argued that, in addition, to any differential effects of long-term learning on word and colour responding, there can be more transient effects reflecting (for example) the temporary inhibition of an over-learned task (word naming) to enable switching to occur to the less well-learned task. Alongside this, long-term learning could reduce general costs from any effortful inhibition processes by increasing stimulus-response mappings for colour relative to

word responses. The inter-play between long-term learning and more temporary factors influencing Stroop interference across trials and trial blocks have not been examined; however, there have been studies of long-term effects of learning on task switching. More generally, it has been consistently shown that switching costs decrease across trials as subjects practice. For example, Cepeda, Kramer, and Gonzalez (2001) reported decreased switch costs after practice in digit identification-digit counting task. Sohn and Anderson (2001) found reduced switch costs as a result of practice when participants switched between letters and digits. Similarly, Strobach, Liepelt, and Schubert (2011) found reduced switch costs as a result of practice from session 2 to 8, as participants responded to visual and auditory stimuli.

Here I assessed effects of long-term learning on task-switching effects on Stroop interference. Participants underwent four blocks of trials, and within each block, participants received a sub-block of trials where they responded to colour and another where they responded to word identity. I compared performance on the initial trials in a sub-block (trials 1-4) after a switch, with the later (non-switch) trials (5-16). In contrast to prior studies examining task switching in a Stroop task, participants made manual rather than verbal responses. Manual responses typically do not yield asymmetrical interference effects (Flowers & Stoup, 1977). I assessed whether in the absence of any asymmetrical interference effects, any differential effects of task switching emerged on colour and word response trials. In addition, I evaluated whether there were changes in Stroop interference as participants became more practiced on the task. With practice, I might expect Stroop interference in general, and effects of task switching in particular to decrease. However, I also manipulated the relations between the specific colours and words being used. Experiments 1 and 2 used a small set of items where, on incongruent trials, a specific word was always and uniquely

paired with a specific colour. In this case across trials, specific colours and words should become strongly linked. In experiment 2, the incongruent trials were formed by random re-pairings of all the colours and the words so that a given colour could be paired with several words. In this case, it may be more difficult to establish specific linkages between a given colour and a given word. I evaluated whether this would then modulate the effects of practice on both Stroop interference and task switching.

### 2.2. Colour and word integration

Prior studies have shown that Stroop interference is greater when colours are integrated with colour words compared with when the stimuli are presented in a non-integrated fashion. Besner and Stolz (1999) for example, presented stimuli where, instead of the whole word, only one of the letters was coloured. Stroop interference decreased in the single-letter-cued condition compared to al1 letters-cued condition. Risko, Stolz, and Besner (2005, Experiment 1) similarly presented displays of either colour words (i.e., *green*, *red*, *blue*, and *yellow*) or colour-neutral words (e.g., *house*) in 16 different locations for visual search. In the integrated condition, the target colour and the coloured word were spatially integrated together while in the separated condition, the target colour and the coloured word were spatially separated. Participants were instructed to classify the colour of the target item among the four different display colours. When the target colour and the colour word were *integrated*, the participants responded more quickly on congruent than incongruent trials. When the target colour and the coloured word were separated, responses on congruent and incongruent trials were equivalent.

In the present study, the consistent pairing of one colour and one word on colour blocked incongruent trials in experiments 1 and 2 may lead, across the sub-blocks in the experiment, to the word and the colour forming an integrated representation. Based on prior

experiments on the effects of perceptual integration on Stroop interference, I predict that congruity effects will increase as representations become more integrated. The congruity effects will then increase with practice in the experiment. In contrast, when consistent pairings are not used (in experiment 2), only beneficial effects of practice may emerge, since integrated colour/word representations are not being formed. In this instance, congruity effect should decrease with (general) practice.

## 2.3. Experiment 1

### 2.3.1. Method

*Participants*

A total of 18 undergraduate and postgraduate students who responded to the advertisement at University of Birmingham (11 females and 7 male, ages 20-27 years, mean 23.68 years) with self-reported normal colour vision were recruited for the study and paid £6/hr. As a precondition, none smoked cigarettes or drank caffeine beverages within 3 hr before testing session. None had participated in a similar experiment. No participant reported any injury, disease or eye surgery. Of the participants, 4 had eyesight corrected to normal with contact lenses, and the remaining reported normal vision. Two participants were rejected because of excessive eye closure during the experiment. The final sample included 16 students.

*Stimuli and displays*

*Word/Colour Identification task stimuli and block structure.* The stimuli consisted of eight coloured words. The stimuli were depicted in the colour corresponding to the coloured word for four words: ‘Blue’, ‘Green’, ‘Red’, and ‘Yellow’ (*congruent*) and one specific mismatch for each word in incongruent trials (e.g., the word ‘Red’ was always presented in blue). All the stimuli were same for the two tasks except they were either presented against a pink or

aqua colour background to signal either word or colour identification (counter-balanced across participants). The RGB breakdowns for the stimuli were: blue= 0,0,255, green= 128,255,128, red= 255,0,0, and yellow= 255,255,128. The experiment was designed in E-prime software (Schneider, Eschman, & Zuccolotto, 2002, version 1.2). The participants responded by pressing different keys set on a keyboard. Each trial began with the presentation of a central fixation (+) cross in 18 point, Courier New font, black = {(0,0,0)} against gray background for 1,000 ms, followed by a blank screen (grey, with an RGB breakdown of 192, 192,192) for 1,000 ms, then the word until the response. The words were written in courier new font, 38 point, bold, with height and width 100% (fig.2.1). Subjects were presented with eight alternating blocks of the word and colour identification tasks with 16 trials in each block. For half of the participants, the experiment started with the presentation of the word identification task. This was counterbalanced across participants, for the other half of the participants, the colour identification task was carried out at first.

*Apparatus*

All the stimuli were presented in the center of a 14 inch laptop screen.

*Design and procedure*

The experiment was conducted in a single session and was performed in a dark room. Participants were given an informed consent form and a description of the experiment. They were told that this was a reaction time experiment, and that they must respond by pressing the fixed keys on the keyboard as quickly as possible without sacrificing accuracy. The participants were instructed to "*identify the word"* in the word identification task and "*identify the colour in which the word is printed*" in the colour identification task. They were told that the response keys were: 1=blue, 2=green, 3=red, 4=yellow and any questions were

answered. The participants completed 128 experimental trials of the word/colour identification task. Following this, they were debriefed and thanked for their participation.

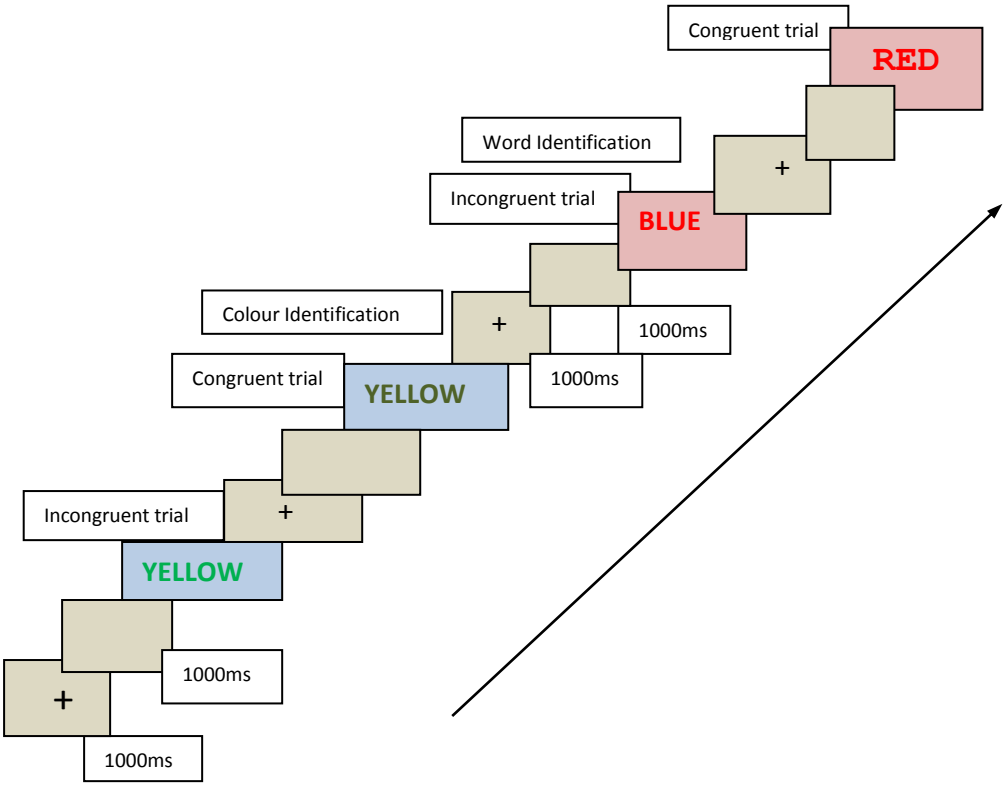


**Fig 2.1**. *Word / Colour Identification tasks with the congruent and incongruent word stimuli in alternate run.*

### 2.3.2. Results

The data from first two blocks were discarded because no task switch took place for block 1, then outliers were removed and response times (RTs) were excluded above 2.5 standard deviations from each participants' mean. Responses longer than 3,000 ms or shorter than 100 ms were also omitted. Mean RTs on trials 1-4 were taken as reflecting performance

following a switch and responses on trials 5-16 were taken as task-repeat trials[1]. The data are reported in two sections. First, the effect of task switching was assessed with the data averaged across congruent and incongruent trials since there were insufficient trials per sub-block (switch vs. repeat trials) to treat congruent and incongruent trials separately. Second, the effects of congruency were examined with the data averaged only across repeat trials. Note that this second analysis examines the basic Stroop effect during a stable period of task performance (when the task was repeated across trials).

*Switching effect*

Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (*switch* vs. *repeat*) x block (*second* vs. *third* vs. *fourth*) x task (*word identification* vs. *colour identification*) as within subject factors. The main effect of task switch was significant $F$ (1, 13) =54.54, $p$<0.001, $MSE$=82384.99, ηp2=.80. RTs were slower on switch ($M$=1453.31 ms) than repeat ($M$=1126.20 ms) trials. The effects of block ($F$<2) and task failed to reach significance ($F$<1). None of the interactions were significant ($F$<2) (fig. 2.2). The error rate was low and there was no evidence of a speed-accuracy trade-off. The results are presented in table 2.1.

[1] This was done in order to accumulate stable numbers of switch trials and was supported by inspection of the pattern of RTs across the trials within a block, which asymptoted after 4 trials. In addition, congruency effects were only evaluated across repeat trials because only these trials provided sufficient data.

**Table 2.1**

***Mean percentage errors (PE) and standard deviations (SD) of errors on switch and repeat trials in experiment 1 and 2***

| | **Experiment 1** | | **Experiment 2** | | | |
|---|---|---|---|---|---|---|
| | | | **Constant Colour-Word** | | **Alternating Colour-Word** | |
| Task | **Switch** PE (*SD*) | **Repeat** PE (*SD*) | **Switch** PE (*SD*) | **Repeat** PE (*SD*) | **Switch** PE (*SD*) | **Repeat** PE (*SD*) |
| Word Identification | | | | | | |
| Block 2 | 3 (.02) | 4 (.02) | 3 (.02) | 4 (.07) | 1 (.01) | 2 (.04) |
| Block 3 | 2 (.03) | 4.5 (.02) | 2 (.02) | 3 (.07) | 2 (.02) | 1 (.02) |
| Block 4 | 1 (.01) | 4.5 (.03) | 3.5 (.03) | 3.5 (.06) | 5 (.02) | 2 (.04) |
| Colour Identification | | | | | | |
| Block 2 | 2 (.02) | 3 (.03) | 2 (.01) | 2 (.04) | 3 (.02) | 1.5 (.03) |
| Block 3 | 2 (.03) | 2 (.01) | 3 (.02) | 1 (.02) | 1 (.01) | 2.5 (.04) |
| Block 4 | 1 (.01) | 2 (.02) | 3.5 (.04) | 2 (.04) | 3 (.04) | 3.5 (.04) |

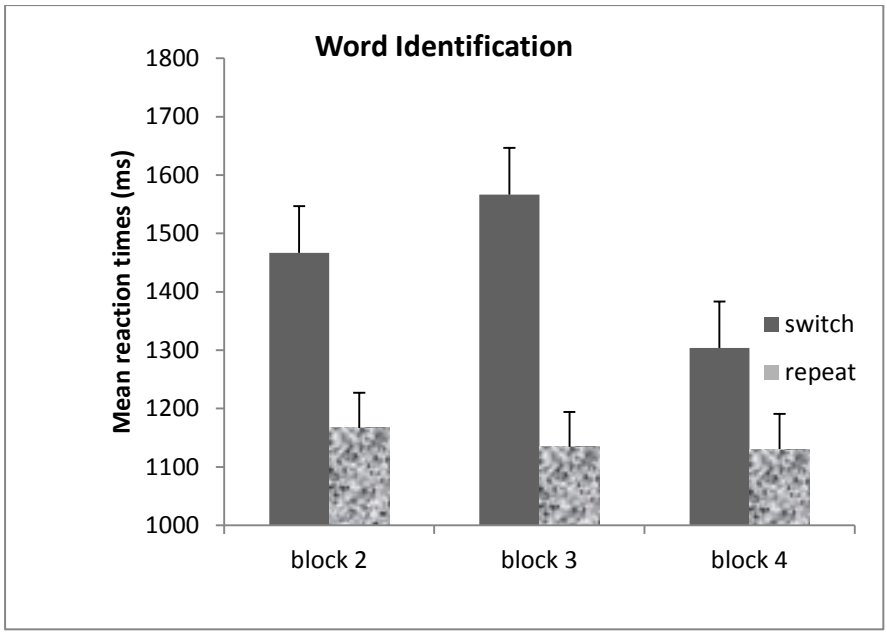


**Fig.2.2a.** Mean reaction times (ms) in the word identification task.

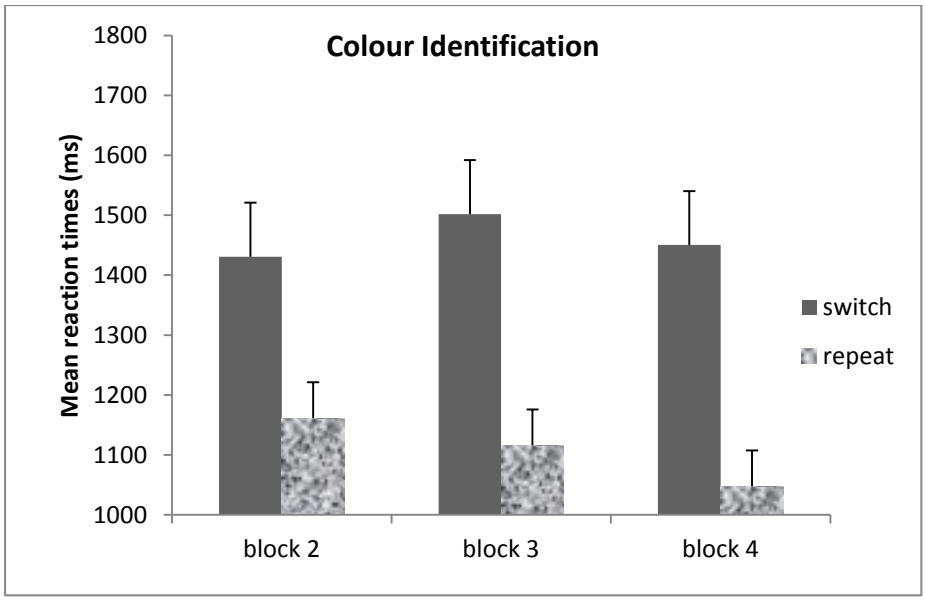


**Fig.2.2b.** Mean reaction times (ms) in the colour identification task.

*Congruency effect*

The mean RTs on repeat trials (5-16) were submitted to a repeated measures analysis of variance (ANOVA) with task (*word identification* vs. *colour identification*), block (*second* vs. *third* vs. *fourth*) and congruency (*congruent* vs. *incongruent*) as within subject factors.

The main effect of congruency was significant $F$ (1, 13) =51.16, $p$<0.001, $MSE$=57521.18, ηp2=.79 such that RTs were faster on congruent ($M$= 984.32 ms) than incongruent ($M$=1249.04 ms) stimuli. The effects of block ($F$ <3) and task ($F$ <1) failed to reach significance. There was one significant higher order interaction which was between task, block, and congruency $F$ (2, 26) =7.05, $p$<0.01, $MSE$=22026.72, ηp2=.35 (fig.2.3). This was decomposed by analysing the data separated for congruent and the incongruent trials, for the word and colour identification tasks. For the **word identification task**, there was no effects of block ($F$<1). There was main effect of congruency $F$ (1, 13)= 45.64, $p$<.001, $MSE$=29954.27, ηp2=.77. The interaction between block and congruency was failed to reach a significant level $F$<3. For the **colour identification** task, there was no effect of block $F$ <3. There was a main effect of congruency $F$ (1, 13)= 38.73, $p$<.001, $MSE$=40789.12, ηp2=.74, and there was a significant interaction between block and congruency $F$ (2, 26) = 5.40, $p$<.01, $MSE$=26260.19, ηp2=.29. The magnitude of the congruency effect (incongruent minus congruent trials) increased with practice $F$ (2, 26)= 5.40, $p$<.01, $MSE$=52520.73, ηp2=.29.

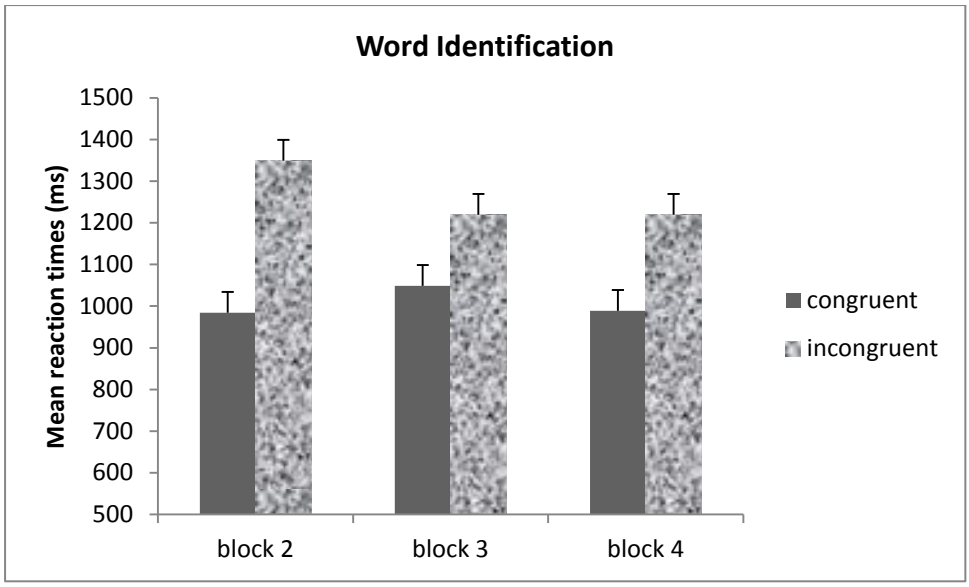


**Fig.2.3a.** Mean reaction times on congruent and incongruent words in the word identification task. Error bars represent average standard error.

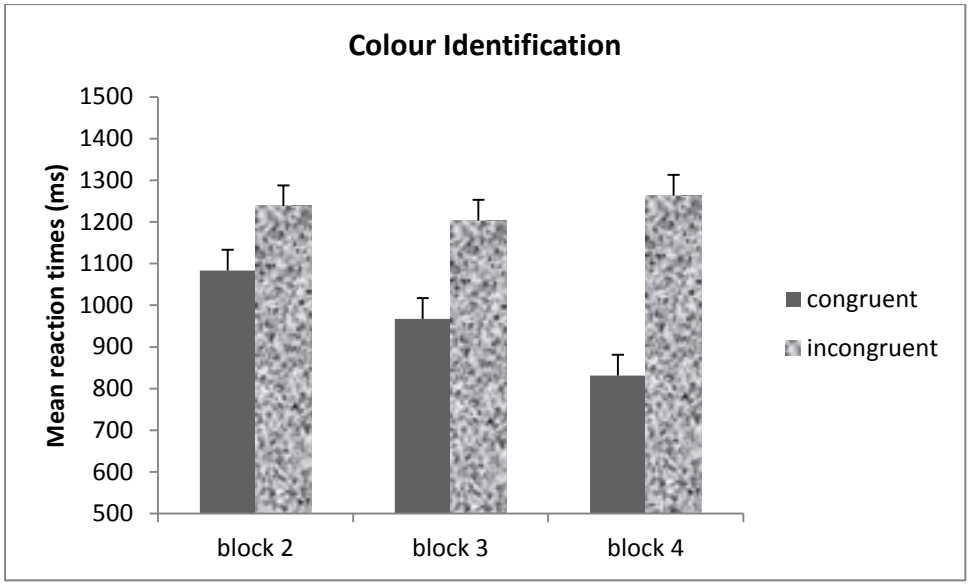


**Fig.2.3b.** Mean reaction times on congruent and incongruent words in the colour identification task. Error bars represent average standard error.

The error rate was low and there was no speed-accuracy trade-off (see table 2.2).

**Table 2.2**

***Mean percentage errors (PE) and standard deviations of errors (SD) for congruent and incongruent words in experiment 1 and 2***

| | **Experiment 1** | | **Experiment 2** | | | |
|---|---|---|---|---|---|---|
| | | | **Constant Colour-Word** | | **Alternating Colour-Word** | |
| Task | **Congruent** PE (*SD*) | **Incongruent** PE (*SD*) | **Congruent** PE (*SD*) | **Incongruent** PE (*SD*) | **Congruent** PE (*SD*) | **Incongruent** PE (*SD*) |
| Word Identification | | | | | | |
| Block 2 | 3 (.03) | 5 (.02) | 3 (.06) | 5 (.08) | 1 (.03) | 3 (.06) |
| Block 3 | 4 (.02) | 5 (.02) | 2 (.04) | 4 (.10) | 1 (.03) | 1 (.02) |
| Block 4 | 5 (.05) | 4 (.03) | 2 (.04) | 5 (.09) | 1 (.03) | 3 (.06) |
| Colour Identification | | | | | | |
| Block 2 | 3 (.04) | 3 (.02) | 1 (.03) | 5 (.06) | 2 (.04) | 1 (.02) |
| Block 3 | 3 (.02) | 1 (.01) | 1 (.01) | 2 (.04) | 1 (.02) | 4 (.06) |
| Block 4 | 3 (.03) | 1 (.02) | 1 (.02) | 5 (.08) | 2 (.04) | 5 (.04) |

### 2.3.3. Discussion

*Switching effect*

Performance on switch trials was slower than on repeat trials but there was no asymmetry with the task (no larger effect for word than colour identification). This stands in contrast with previous reports (Wylie and Allport, 2000; Allport, Styles, and Hsieh, 1994) where larger switch costs have been reported for word reading tasks. This difference can be attributed to the response mode which varied across the studies. Here manual responses were made while vocal responses were made in the previous studies. Manual responses are known to reduce asymmetry effects in Stroop interference (e.g., Keele, 1972; Pritchatt, 1968). I

show that the lack of asymmetry also extends to task switching. There was also no change in the switching effect across blocks.

*Congruency effect*

Overall, there was an equal congruency effect for both the word and colour identification tasks. This fits with prior studies using manual responses (e.g., Keele, 1972; Pritchatt, 1968). Congruency interacted with block and task. For colour identification only, there was a differential effect of congruency across the blocks as RTs on congruent trials decreased while on incongruent trials RTs tended to increase. If this is a general practice effect, why did RTs on incongruent trials not decrease too? An alternative account can be proposed based on the idea of colour and word binding. Risko, Stolz, and Besner (2005), for example, reported faster RTs on congruent trials and slower RTs on incongruent trials relative to neutral trials when the colour word and the colour target were integral. With a small set of colours and words, and with certain words always paired with the same colour here, then integrated word-colour representations may be formed. Due to these integrated representations, then it may prove more difficult to select the relevant and ignore the irrelevant representations as practice proceeds. Hence the congruency effects increased with practice. This still leaves open questions such as why the practice effect was evident on colour rather than word identification, and why RTs were speeded on congruent trials rather than being slowed to the same degree on incongruent trials. These points are taken up in the general discussion.

This idea of learned colour-word bindings was further tested in experiment 2. In this study, I directly contrasted performance when the bindings were kept constant (on incongruent trials one word was assigned to one colour) with performance when the bindings

varied (where participants received all colour-word pairings, so one word was not consistently paired with one color). Did congruency effects change with practice, for the constant colour-word condition only?

## 2.4. Experiment 2

### 2.4.1. Method

*Participants*

24 undergraduate and postgraduate students were used, each having responded to an advertisement at University of Birmingham (9 females and 15 male, ages 21-25 years, mean 22.62 years). All had self-reported normal colour vision. As a precondition, none smoked cigarettes or drank caffeine beverages within 3 hour before testing session. None had participated in a similar experiment. None had reported any injury, disease or eye surgery. The experiments were designed in E-prime software (Schneider, Eschman, & Zuccolotto, 2002, version 1.2). Participants were divided in three groups (8 participants per group) and they performed constant colour-word and alternating colour-word conditions with an interval of 1 week between, and the order of these two conditions was counterbalanced across participants.

*Stimuli and displays*

The stimuli and displays were same as in experiment 1, but with varied block presentation, described as follows.

*Block Presentation for Constant Colour-Word*

Each group of participants was administered the same congruent words along with a varied presentation of incongruent words, which remained constant in all four blocks of the

experiment. Participants saw the colour words RED, YELLOW, BLUE and GREEN in the congruent colours. For one subgroup of participants, incongruent trials were formed by writing the word RED in blue, YELLOW in green, BLUE in yellow and GREEN in red colour. For second subgroup of participants, incongruent trials were formed by the words written as RED in yellow, YELLOW in red, BLUE in green, and GREEN in blue colour. For another subgroup, incongruent words were presented as RED in green, YELLOW in blue, BLUE in red, and GREEN in yellow colour.

*Blocked Presentation with Alternating Colour-Word Pairings.*

The words were same as in the constant colour-word condition, but incongruent words alternated across progressive blocks (i.e., there was one colour-word assignment for incongruent words on block 1 and 2, another for block 3 and a third for block 4). For subgroup 1, the words RED, BLUE, YELLOW and GREEN were assigned the colours blue, yellow, green, and red on block 1 and 2; the colours on block 3 were yellow, green, red, and blue, and the colours in block 4 were green, red, blue, and yellow.

For subgroup 2, the words RED, BLUE, YELLOW and GREEN were assigned the colours yellow, green, red and blue on block 1 and 2; green, red, blue, and yellow on block 3 and blue, yellow, green, and red on block 4.

For subgroup 3, the words RED, BLUE, YELLOW and GREEN were assigned the colours green, yellow, green, and red on block 1 and 2; yellow, green, red, and blue on block 3, and red, blue, yellow, and green on block 4.

*Apparatus and Procedure*

Apparatus and procedure was same as in experiment 1.

### 2.4.2. Results

As for experiment 1, the data are reported in two sections. First, effect of task switching was assessed with the data averaged across congruent and incongruent trials since there were insufficient trials per sub-block (switch vs. repeat trials) to treat congruent and incongruent trials separately. Second, the effects of congruency were examined, with the data averaged across repeat trials since there was not sufficient data on switch trials to enable the contrast between congruent and incongruent trials to be assessed. As before, this second analysis examined the basic Stroop effect during a stable period of task performance (when the task was repeated across trials). The data from first two blocks were discarded because no task switch took place for block 1. After this, outliers were removed and response times (RTs) were excluded above 2.5 standard deviations from each participants' mean. Responses longer than 3,000 ms or shorter than 100 ms were omitted. Mean RTs on trials 1-4 were taken as switch and 5-16 as repeat.

*Switching effects*

Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with colour-word (*constant* vs. *alternating*), task switch (*switch* vs. *repeat*), task (*word reading* vs. *colour naming*) and block (*second* vs. *third* vs. *fourth*) as within subject factors.

The RT analysis revealed a reliable main effect of colour-word $F$ (1, 23) =4.82, $MSE$= 170103.27, $p$<0.05, ηp2=.17, such that RTs were slower in the constant colour-word ($M$=1117.17 ms) condition than the alternating colour-word condition ($M$= 1041.65 ms). The effect of task switch was highly significant $F$ (1, 23) =199.69, $MSE$= 28827.61, $p$<0.001, ηp2=.89. RTs were slower on switch ($M$=1179.38 ms) than repeat trials ($M$=979.44 ms). The effect of task was significant $F$ (1, 23) =10.57, $MSE$= 39131.12, $p$<0.01, ηp2=.31. Colour

identification was faster (*M*=1052.61 ms) than word identification (*M*=1106.22 ms). There was also a significant effect of block $F$ (2, 46) = 13.87, *MSE*= 60044.19, $p<0.001$, ηp2=.37. RTs decreased from block 2 to 4 (1152.98 *vs.* 1059.39 *vs.* 1025.87 ms, respectively).

There were two significant higher order interactions between colour-word, task switch, and task $F$ (1, 23) = 8.57, *MSE*= 6294.07, $p<0.01$, ηp2=.27 and task switch, task, and block $F$ (2, 46) = 14.03, *MSE*= 14655.43, $p<0.001$, ηp2=.37.

**Colour-Word, Task Switch, and Task**

The interaction between colour-word, task switch, and task was decomposed by submitting the switch costs (switch minus repeat trials) in the word and colour identification tasks for constant and alternating colour-word conditions to separate repeated measure ANOVAs.

For the **constant colour-word** condition, there was a reliable effect of task on task switch $F$ (1, 23) = 11.85, *MSE*= 11765.73, $p<0.01$, ηp2=.34. For the **alternating colour-word** condition, there was no effect of task on task switch $F<1$.

Pair wise comparisons were made of the switch costs (switch minus repeat trials) separately for the constant and alternating colour-word conditions for the word and colour identification tasks respectively. The switch cost was larger for colour (*M*=250.10 ms) than word identification (*M*=142.28 ms; $t$ (23) =3.44, $p<.01$) when the colour and the word relations were constant, but not when they alternated $t<1$. The contrast between the constant and alternating colour-word conditions itself was only reliable for word identification $t$ (23) =2.60, $p<.01$. The effect on word identification was due to reduced switch costs when the colour-word relations were constant (fig. 2.4).

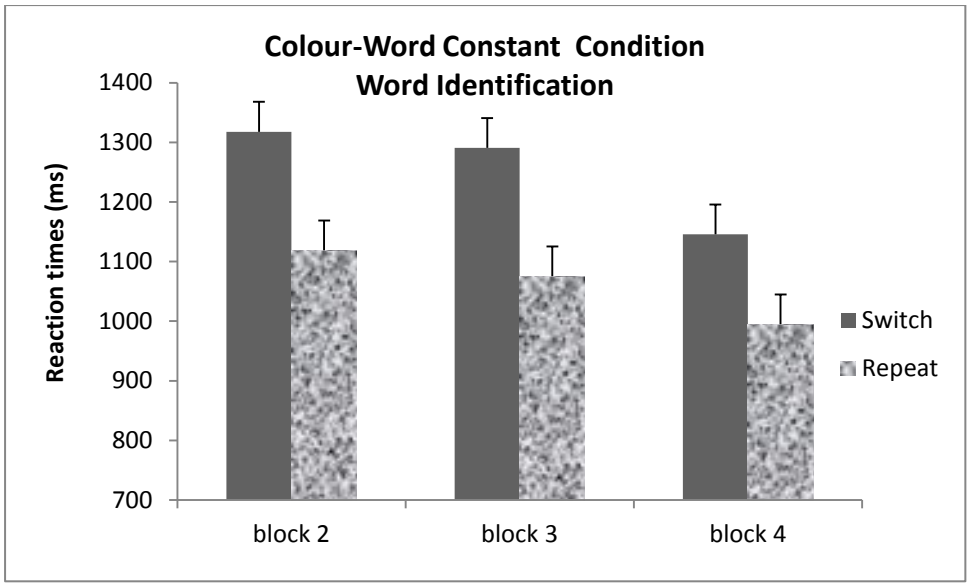


**Fig.2.4a**. Mean reaction times on switch and repeat trials in the word identification task in colour-word constant condition. Error bars represent average standard error.

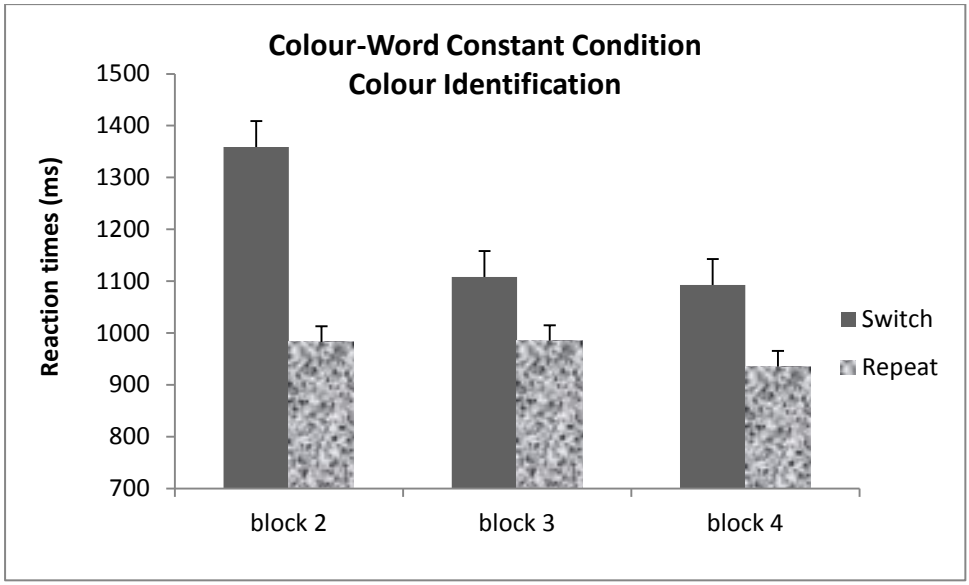


**Fig. 2.4b**. Mean reaction times on switch and repeat trials in colour identification task in colour-word constant condition. Error bars represent average standard error.

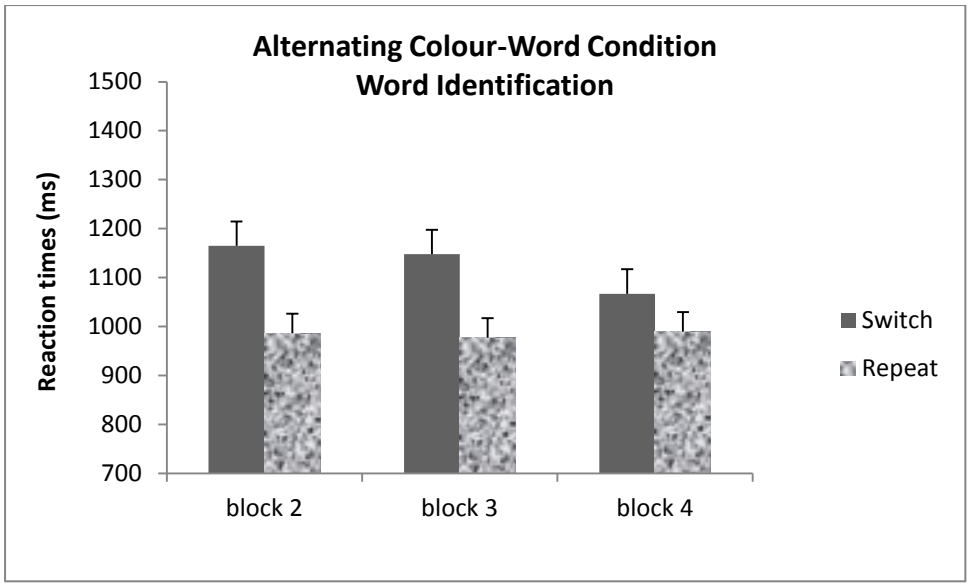


**Fig. 2.4c**. Mean reaction times on switch and repeat trials on the word identification task in alternating colour-word condition. Error bars represent average standard error.

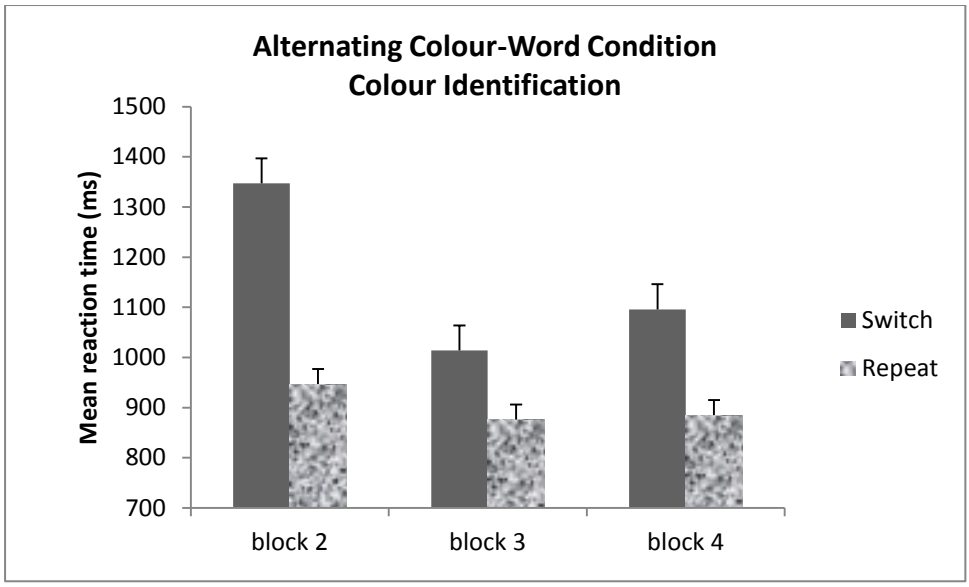


**Fig.2.4d**. Mean reaction times on switch and repeat trials on the colour identification task in alternating colour-word condition. Error bars represent average standard error.

## Task Switch, Task, and Block

The interaction between task switch, task, and block was decomposed by submitting the switch costs (switch minus repeat trials) for word and colour identification to separate repeated measure ANOVAs with block as a within subject factor.

The analyses for word and colour identification tasks both showed significant effects of block - on word identification $F$ (2, 46) = 3.34, $MSE$= 14148.04, $p$<0.05, ηp2=.12, and on colour identification $F$ (2, 46) = 26.09, $MSE$= 17007.78, $p$<0.001, ηp2=.53. Pair wise comparisons on switch costs in the word identification task between block 2 and 3 failed to reach a significant level $t$ <1. For the **word identification**, there was a drop in switch cost from block 3 to block 4 $t$ (23)= 3.41, $p$< 0.01, For the **colour identification**, there was a drop in switch costs from block 2 to 3 $t$ (23) = 7.21, $p$< 0.001, but switch costs remained larger in block 4 than block 3 $t$ (23)= 2.13, $p$< 0.5. The error rate was low and there was no speed-accuracy trade-off (see table 2.1).

*Congruency effect*

Mean RTs on repeat trials (5-16) were submitted to a repeated measures analysis of variance (ANOVA) with task (*word identification* vs. *colour identification*), block (*second* vs. *third* vs. *fourth*), congruency (*congruent* vs. *incongruent*), and colour-word (*constant* vs. *alternating*) as within subject factors. The main effect of task was significant $F$ (1, 23) =18.80, $p$<0.001, $MSE$=59514.84, ηp2=.45; colour identification was faster than word identification (935.36 vs. 1023. 52 ms, respectively). There was a significant main effect of congruency $F$ (1, 23) =94.33, $p$<0.001, $MSE$=88103.95, ηp2=.80. RTs on congruent trials were faster than on incongruent trials (859 vs. 1099 ms, respectively). There was a significant main effect of block $F$ (2, 46) =4.67, $p$<0.01, $MSE$=33868.11, ηp2=.16. RTs decreased from block 2 to 4 (block 2 = 1008.65 ms vs. block 3 = 978.40 ms vs. block 4= 951.27 ms). There was also a significant main effect of colour-word $F$ (1, 23) =5.67, $p$<0.05, $MSE$=130651.61, ηp2=.19. RTs were faster in the constant colour-word ($M$=943.56) than the alternating colour-word condition ($M$=1015.32).

There were three significant higher order interactions between task, congruency, and block $F$ (2, 46) =7.37, $p$<0.01, $MSE$=21492.74, ηp2=.24; colour-word, task, and congruency $F$ (1, 23) =5.49, $p$<0.05, $MSE$=14173.81, ηp2=.19; and colour-word, block, and congruency $F$ (2, 46) =3.53, $p$<0.05, $MSE$=20767.84, ηp2=.13.

**Task, Congruency x Block**

The interaction between task, congruency, and block was decomposed by submitting RTs on congruent and incongruent trials in the word identification and colour identification tasks to separate repeated measure ANOVAs with block as within subject factor. For **word identification**, there was no effect of block on either congruent ($F$ <1) or incongruent ($F$ <2) trials. For **colour identification**, there was a significant effect of block on congruent trials $F$ (2, 46) =55.53, $p$<0.01, $MSE$=1745.63, ηp2=.70. RTs decreased from block 2 to 3 $t$ (23)= 6.06, $p$<0.001 and from block 3 to block 4 $t$ (23)= 9.91, $p$<0.001. The effect of block on incongruent words failed to reach significance level ($F$ <1) (fig.2.5).

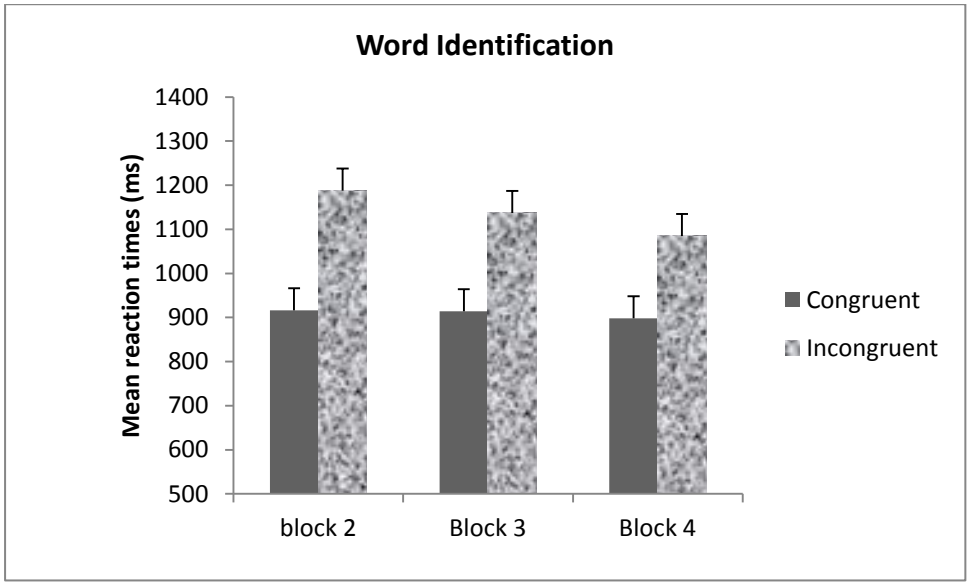


**Fig. 2.5a.** Block wise mean reaction times on congruent and incongruent words in the word identification task. Error bars represent average standard error.

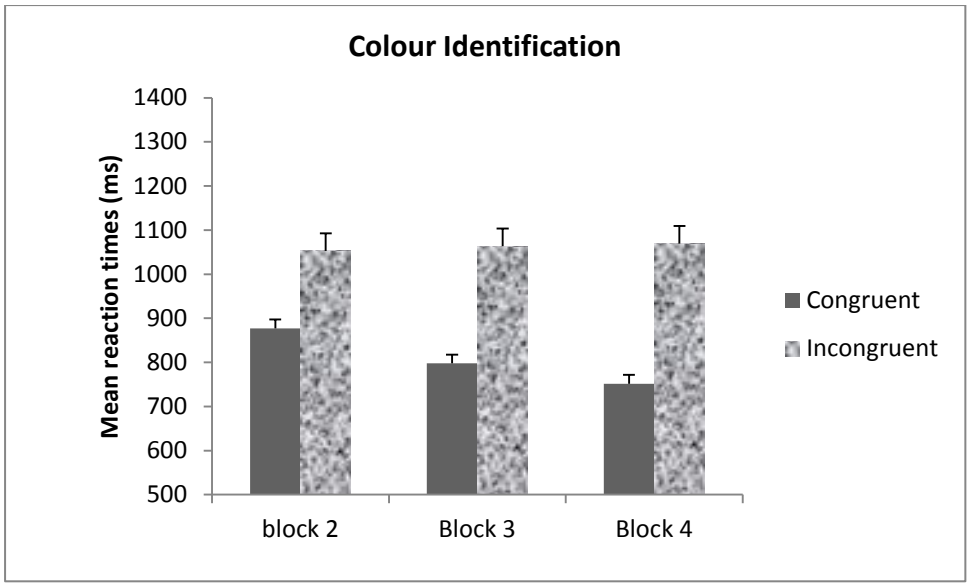


**Fig.2.5b.** Block wise mean reaction times on congruent and incongruent words in the colour identification task. Error bars represent average standard error.

### Colour-word, Task x Congruency

The interaction between colour-word, task, and congruency $F$ (1, 23) =5.49, $p$<0.05, $MSE$=14173.81, ηp2=.19 was decomposed by assessing RTs separated for the constant and alternating colour-word conditions. For the **constant colour-word condition**, there were main effects of congruency $F$ (1, 23) =95.92, $p$<0.01, $MSE$=14101.70, ηp2=.80, and task $F$ (1, 23) =14.37, $p$<0.01, $MSE$=22350.97, ηp2=.38. RTs showed an advantage for congruent trials and colour identification task. There was no interaction between congruency and task $F$<3. For the **alternating colour-word condition**, again there were reliable main effects of congruency $F$ (1, 23) =42.83, $p$<0.01, $MSE$=35752.69, ηp2=.65 and task $F$ (1, 23) =8.61, $p$<0.01, $MSE$=25248.76, ηp2=.27. Again, RTs showed an advantage for congruent trials and for the colour identification task. There was no interaction between congruency and task $F$<1. These analyses indicated that the data patterns were similar for the constant and alternating conditions, but the congruency effects on word identification tended to be smaller than when the colour-word relations varied (see fig.2.6).

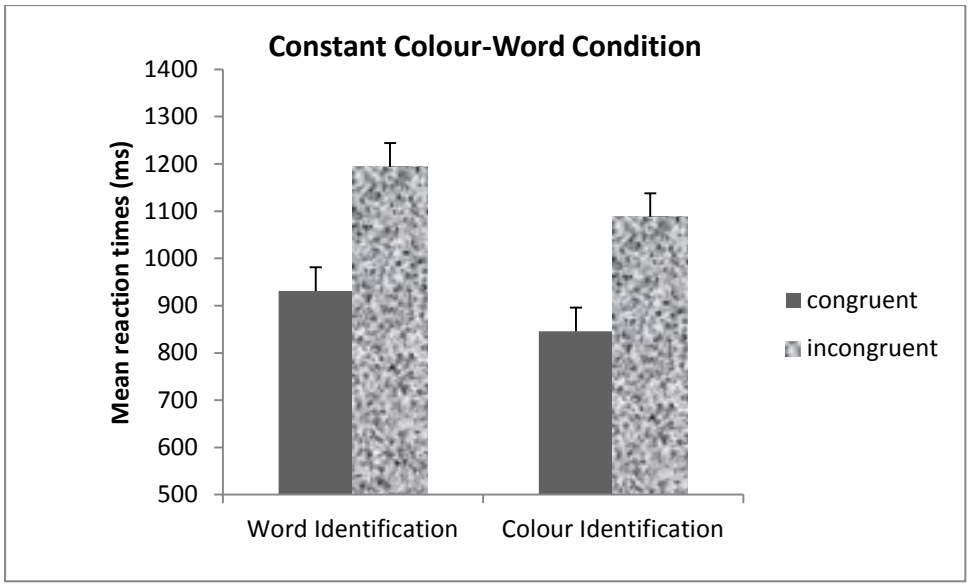


**Fig.2.6a.** Reaction times on congruent and incongruent words in constant colour-word condition. Error bars represent average standard error.

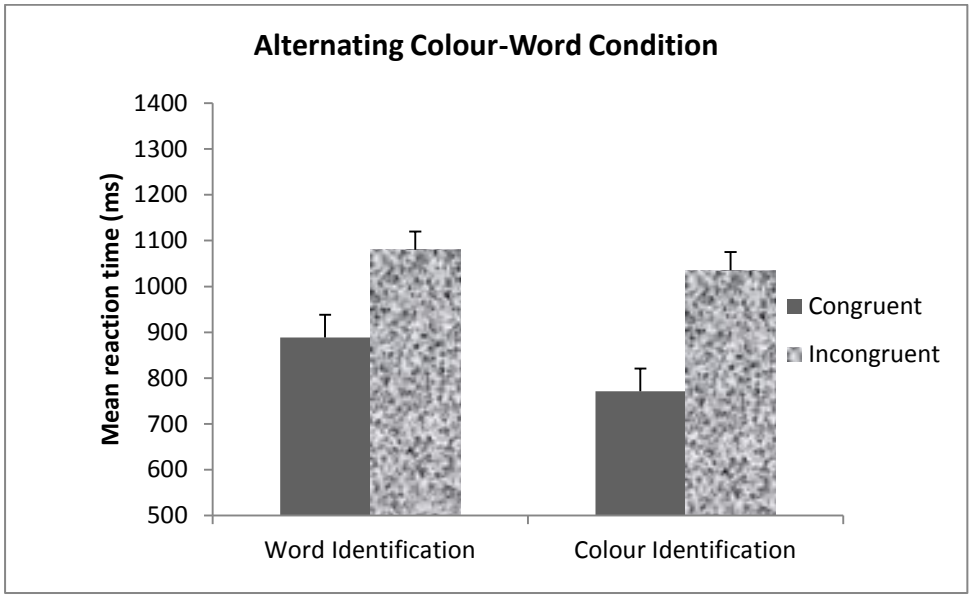


**Fig. 2.6b.** Reaction times on congruent and incongruent words in alternating colour-word condition. Error bars represent average standard error.

## Colour-Word, Block x Congruency

The third interaction between colour-word, block, and congruency $F$ (2, 46) =3.53, $p$<0.05, *MSE*=20767.84, ηp2=.13, was decomposed by testing for the effect of block for constant and

alternating colour-word conditions for congruent and incongruent trials. For the **constant colour-word condition**, there were main effects of block $F$ (2, 46) =36.27, $p$<0.01, $MSE$=14789.76, ηp2=.61 and congruency $F$ (1, 23) =88.35, $p$<0.01, $MSE$=3019.57, ηp2=.79 and a significant interaction between block and congruency $F$ (2, 46) =35.12, $p$<0.01, $MSE$=9010.76, ηp2=.60. For congruent trials, RTs decreased with blocks $F$ (2, 46) =8.50, $p$<0.01, $MSE$=4522.71, ηp2=.27, while for incongruent trials, there was no effect of block $F$ <1. For the **alternating colour-word condition**, again there were significant main effects of block $F$ (2, 46) =4.64, $p$<0.01, $MSE$=20721.44, ηp2=.16, and congruency $F$ (1, 23) =42.83, $p$<0.01, $MSE$=53629.04, ηp2=.65, but no significant interaction $F$ (2, 46) =0.83, $p$=0.43, $MSE$=12504.16, ηp2=.03 (see fig.2.7).

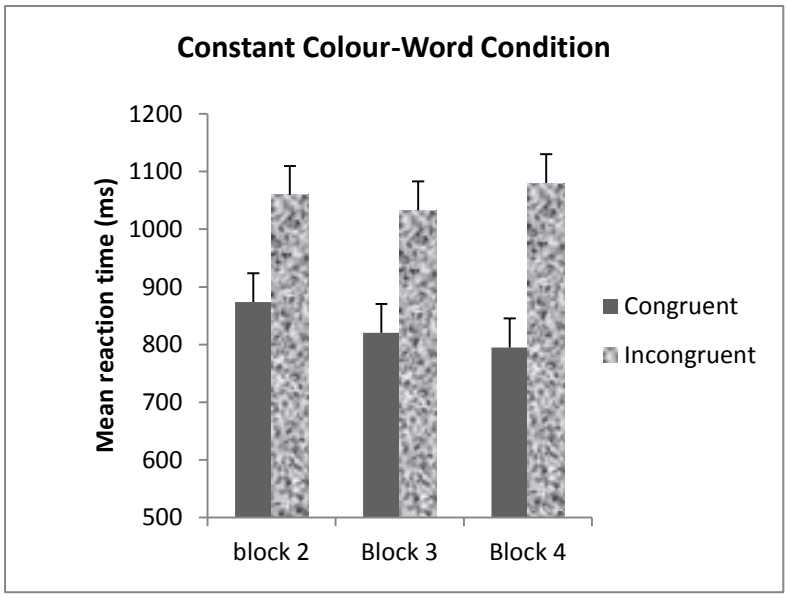


**Fig.2.7a.** Block wise reaction times on congruency for the constant colour-word condition. Error bars represent average standard error.

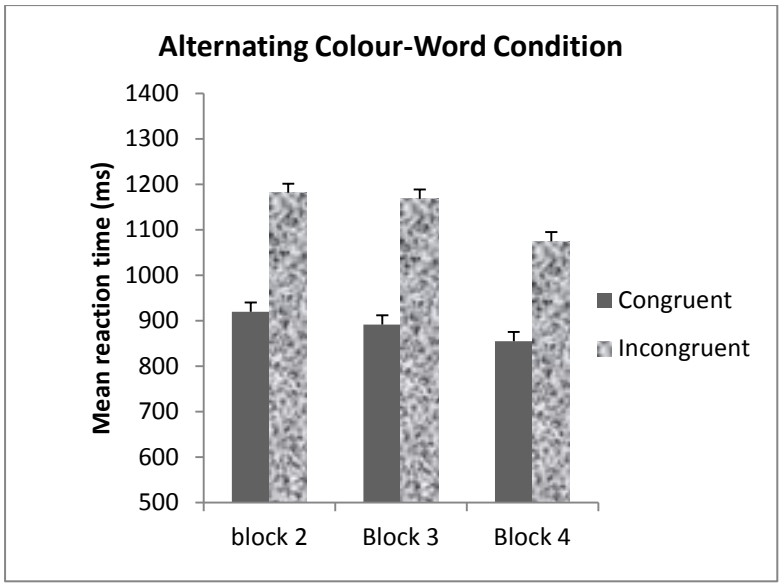


**Fig.2.7b.** Block wise reaction times on the congruency for the alternating colour-word condition. Error bars represent average standard error.

The error rate was less and there was no speed-accuracy trade-off (table 2.2).

### 2.4.3. Discussion

Experiment 2 was designed to investigate (1) switching effects when the colour-word relationship is constant/alternating (2) general practice effects on the word/colour identification according to whether the colour-word relationship on the incongruent trials was constant or varying.

*Switching effects*

**Colour-Word, Task Switch x Task**

Asymmetries in interference across the tasks were observed only when the colour-word relationship stayed constant (when there emerged a larger switch cost for the colour than the word identification tasks). For the alternating colour-word condition the switch cost was equal for both the colour and the word identification tasks.

**Task Switch, Task x Block**

Switch costs deceased as a function of practice. For the word identification task, the decrease in switch costs appeared in the final block (as participants moved from block 3 to block 4). In contrast, for the colour identification task, the drop in switch costs emerged earlier in the experiment (from block 2). Reductions in switch costs as a result of practice have been well-documented (e.g., Sohn & Anderson, 2001; Cepeda, Kramer, & Gonzalez de Sather, 2001), though the tasks used in those studies were different: for example, Strobach et al. (2012) observed a reduction in switch costs when participants practiced visual-auditory tasks where, in visual task, participants judged the location of the visual stimuli (white circles) while in auditory task they judged the intensity of the tone. Kramer, Hahn and Gopher (1999) found similar pattern of results in a number-digit value task (in the number task participants were presented with rows of digits and had to indicate the number of the digits; in the digit task they indicated the value of the digits).

Here there was evidence for faster emergence of learning effects on the colour task, which was also more subject to effects of learning in relation to congruency effects (see below). Perhaps the retrieval of the colour name – perhaps still involved despite a manual response being required– remains less practiced than word identification, and so amenable to stronger effects of learning.

*Congruency effect*

**Colour-Word, Block x Congruency**

As in experiment 1, there was an interaction between block and congruency for the colour identification task, with congruency effects increasing across the blocks. In this case RTs were particularly speeded up only for congruent trials, whilst there was no reliable slowing

of incongruent trials. Note that any slowing, on incongruent trials, would have to work against general effects of practice on the task. Nevertheless the reliable interaction fits with the argument that colour selection becomes more difficult when the word and the colour have a consistent relationship, enabling colour-word binding to take place. For the **alternating colour-word condition**, there was a general speeding of responses across blocks for congruent and incongruent trials alike, indicating a general practice effect in this case. My data on effects of practice with specific colour-word pairings match the data previously reported by Risko et al. (2005), where Stroop congruency effects were larger when colours were perceptually integrated with words.

## 2.5. GENERAL DISCUSSION

Across two experiments, I have found that the Stroop congruency effect increases across trials under conditions when a small constant-set of incongruent colour-words are used. The effects emerged through increasing benefits to colour identification on congruent trials, while RTs on incongruent trials either tended to increase or they remained constant. I suggest that there were two effects of practice on constant, incongruent colour words which traded-off against each other to reduce any overall changes on performance: (1) there were overall beneficial effects of practice, pitted against (2) increased interference as integrated colour-word representations developed. The increased congruency effects were most apparent on colour identification trials, consistent with it being more difficult to focus attention on colour and to ignore word identity when the colour and the word are strongly integrated. On congruent trials, colours and words might be attended as single perceptual unit due to the correct relation between colours and words by the visual system. These stimulus properties might cooperate towards their faster responding and afford no

competition against each other. Practice might modulate the ability to retrieve the stored presentations of the relationship between stimulus properties. I suggest with practice, the retrieval of perceptual units becomes easier from its' stored presentations in the visual system.

Critically, these results only arose when particular colours and words were paired through an experiment, and they were not apparent when colours and words were re-paired across trials. This points to the critical role of learning specific colour-word pairings. Along with the effects of congruency I also found that practice reduced switch costs. This replicates prior findings (e.g., Sohn & Anderson, 2001; Cepeda, Kramer, & Gonzalez de Sather, 2001). There was no evidence, however, that switch costs were larger on word identification than colour identification. This does not match with the previous finding by Allport, Styles, & Hsieh (1994). However, unlike that study, first, I used a manual response task rather than a naming task. Standard asymmetrical Stroop interference effect is typically reduced under manual response conditions (e.g., Keele, 1972; Pritchatt, 1968), presumably because manual responses to words are not over learned when compared to manual responses to colours. Second, the use of inter-trial interval (ITI) of 1000 ms reflected benefits of anticipatory task preparation rather than the no manipulation of ITI here. However, the preparation time may be manipulated in future studies to examine any preparatory effects in task-set reconfiguration.

The most important result here concerns the learning specific word-colour pairings and the related increase in Stroop congruency effects. This fits with prior evidence that Stroop interference is stronger for stimuli that form integrated representations, presumably because it is then more difficult to attend to the colour dimension relative to the word.

Previously word-colour integration has been manipulated by varying the perceptual relations between the colour and the whole word (e.g., Besner, Stolz, & Boutilier, 1997). Here the data suggest that learning a specific word colour relation is also critical. This is consistent with prior work showing that learning can modulate the binding between stimulus attributes (e.g., Humphreys, Riddoch, & Fortt, 2006). This learning leads to facilitated responses to colours on congruent trials. On incongruent trials I suggest that the potentially negative consequences of attending to a word strongly integrated with the colour was balanced by the benefits of overall practice. This meant that performance on incongruent trials did not vary across the blocks (whereas substantial improvements were observed in other conditions, for example when the colours and words were not consistently related). It is also of interest that the results were strongest on colour identification relative to word identification, despite the fact that overall RT differences between the tasks were minimized by the use of manual responding. This indicates that there can remain a residual difference in the ease of attending to colour and to word identity, while is highlighted when the word and colour are strongly integrated. Attention to colour remains vulnerable to the effects of word identity even under manual response conditions.

In addition to the specific effects of learning colour-word pairings, I also found that switch costs reduced as participants practiced across trials. This may reflect a number of factors including stronger coding of the rule set across the blocks, increased practice at stimulus-response mapping and practice at switching from one task to the other. The important result, however, is that switching can improve even though selective attention to colour can become more difficult through the learning of colour-word bindings. The results suggest that the mechanisms of switching are independent of those of colour-form binding

# CHAPTER 3

# IQ NOT EI CORRELATES WITH TASK SWITCHING


## Abstract

This chapter examines the ease with which individuals perform various face processing tasks, and switch between the tasks, as a function of both their general intelligence (IQ) and their emotional intelligence (EI). The results indicate that the ability to switch between all combinations of emotion, gender and occupation decision tasks is related to IQ, with smaller switching costs found in individuals with higher IQ. Switching costs were also related to EI when the task involved emotional decision making, with costs for emotional decision making reduced for individuals with high EI. I discuss why high IQ can preserve individuals from switch costs and the relations between EI and the processing of emotions.

The social identification of the self and others is highly dependent on the social groups to which we belong (Brewer & Gardner, 1996; Bennett & Sani, 2003; Bigler & Liben, 1993). We belong to multiple social groups simultaneously and extract varying degrees of meaning from these group identities. A person can be categorized in multiple ways for example according to their gender, occupation, ethnicity, etc. (Fiske, 1993). How we might switch between these different forms of categorization has rarely been assessed, so we do not know whether certain categorizations have a more prolonged impact on subsequent processing than others and/or whether it is easier to switch into making one kind of categorization than others. This was examined here. I had participants switch between different categorization tasks performed on faces. These different forms of categorization are likely to draw-on contrasting processes. The multi-stage model of face processing, proposed by Bruce and Young (1986), for example, suggests that gender and emotion classifications can be based upon structural properties of faces separated from access to stored knowledge of the faces (required to classify someone's occupation). The neuroanatomical model of Haxby, Hoffman and Gobbini (2000) suggests that occupation decisions to faces are mediated by a ventral face recognition route, while gender and emotion decisions involve more dorsal and sub-cortical brain structures. At present, however, we have little understanding about how we might switch from one form of classification to another, and what individual difference factors might moderate this ability. The present study is aimed at elucidating the ease of switching to and from gender and emotion, gender and occupation, and emotion and occupation decision tasks. In addition, the ease of switching between the different tasks was assessed in relation to individual difference measures reflecting (i) general intelligence (IQ) and (ii) emotional intelligence (EI). Given that high EI might reflect the ability to "read" the

nonverbal attributes of participants. Participants high in EI might also find it easier to move from one aspect of facial categorization to another.

### 3.1. Face categorization

One task required here was gender classification. Gender is a core category that is used to classify people with this classification taking place in individuals as early as late toddlerhood (e.g., Katz & Kofkin, 1997; Martin & Ruble, 2004). The classification processes are likely to draw on face prototypes. Freeman et al. (2008) presented participants with faces judged to be prototypical or non-prototypical for their gender, with the task being to categorize the gender of each face. Gender classification was faster for the more prototypical faces than for the faces that were atypical. In neuropsychological studies, patients with prosopagnosia, and poor retrieval of occupation and name information, may still successfully perform gender categorization, suggesting that the process relies on different information to that required for face recognition (see e.g., Clarke et al., 1997; Tranel, Damasio & Damasio, 1988; Sergent & Villemure, 1989; Flude, Ellis, & Kay, 1989). In addition, gender classification dissociates from emotion discrimination following brain injury (Humphreys, Donnelly, & Riddoch, 1993). Alongside this, face identification and emotion discrimination can also dissociate (e.g., Campbell, Landis, & Regan, 1986; Parry, Young, Saul, & Moss, 1991). These differing patterns of dissociation suggest that substantial effects of task switching may occur, when participants have to shift from one classification task to another. In other studies (e.g., Wang et al., 2007; Schneider & Anderson, 2010; Koch, Prinz, & Allport, 2005) asymmetrical effects of task switching have been reported where there is a greater switching cost on the easier of two tasks (e.g., Allport et al., 1994; Meuter & Allport, 1999). These asymmetrical effects may reflect the inhibition of the easier of two tasks to enable the more difficult to be performed, at least when both tasks may be cued by the same stimulus. Here

the same facial stimulus was used and it is possible that one form of classification may need to be inhibited if it is applied more easily than the other. As a candidate for this is emotion classification, since prior work indicates that facial emotion can be categorized automatically, even when participants can not consciously report on the presence of the face (Driver & Vuilleumier, 2001). In contrast to this, there is evidence that gender information is not automatically categorized at least with famous faces (Quinn, Mason, & Macrae, 2009). Equivalent data on the retrieval of occupation information from faces has not been derived making it difficult to predict performance in this case. Following these results, then I may predict that switch costs may be relatively large on emotion classification, when compared with the gender and occupation classification tasks, due to the need to suppress emotion classification when one of the other tasks is being performed. One prior experiment has been conducted explicitly comparing two of the tasks used here, gender and emotion classification to faces. Reimers and Maylor (2005) found that switch-costs were smaller for gender than for the emotion classification. In their study, emotion classification was performed faster than the gender classification under baseline conditions, so that the differential switch costs may reflect the relative ease of the two tasks rather than the automaticity and need to inhibit emotion classification. Whether this necessarily holds was tested here using stimuli for which, if anything, emotion classification was the easier task.

### 3.2. Intelligence (IQ) and Emotional Intelligence (EI)

Various definitions of EI exist in the literature; According to the *trait model* by Goleman (1995) EI reflects interplay of five domains: knowing one's own emotions; motivation; recognising and understanding other people's emotion; managing one's own emotions; managing other's emotions. Salovey and Mayer (1990), in contrast, define EI as the ability to perceive and express emotion, the ability to regulate emotion, and the ability to

utilize emotions when solving problems. BarOn (1997) proposes that EI is an umbrella term reflecting multiple non-cognitive capabilities, competencies, and skills required in coping with environmental demands and pressures. Whichever model holds, EI is known to correlate with performance on a range of everyday life tasks. For example, high EI is associated with greater confidence in career decision making (Brown, George-Curran, & Smith, 2003), self-integrated personal goals (Spence, Oades, & Caputi, 2004), and managing positive relationship with others (Lopes, Salovey, & Straus, 2003). In contrast, low EI is associated with alcohol related problems (Schutte, Malouff, & Hine, 2011), disordered eating (Costarelli & Demerzi, 2009), borderline personality disorders (Leible & Snell, 2004), and lower gambling self-efficacy (Kaur, Schutte & Thorsteinsson, 2006).

In a comprehensive analysis of different EI measures, Barchard and Hakstian (2004) reported that the self-report measures of EI do not correlate with IQ, rather seen as measures of self-perceptions of emotional abilities. The ability-based measures of EI have two factors: emotional congruence and social perceptiveness. Emotional congruence refers to the perceived affective quality of the stimulus and is relatively independent of the traditional cognitive abilities while social perceptiveness refers to the understanding of interpersonal relations and the relationship between emotion and behaviour in various situations, has moderate correlation with the verbal ability and the inductive reasoning. Here I assessed whether different aspects of EI could predict switching performance between face classification tasks. EI and IQ affects cognitive based performance, for example, high E/IQ is an advantage for cognitive based performance (see e.g., Lam & Kirby, 2002; Schutte, Schuettpelz, & Malouff, 2001). In contrast to EI, IQ refers more specifically to cognitive processes – specifically those dealing with the ability to reason, solve problems, think abstractly, comprehend complex ideas and learn quickly from experience (Gottfredson,

1994). Spearman (1904) proposed a general form of intelligence (g factor) underlying the success of different cognitive activities. IQ can be fractionated into fluid and crystallized intelligence (Cattell, 1971). *Fluid IQ* is ability to think logically, to solve problems, and reasoning with novel material, whereas *Crystallized IQ* is the ability to use acquired skills, knowledge, and experience. There is evidence that the factor of EI *understanding of emotions* (MSCEIT; Mayer-Salovey-Caruso EI test, 1999) correlates positively with the *Crystallized IQ* as measured by vocabulary and esoteric analogies tasks (Gf/Gc Quickie test battery; Stankov, 1997) among university students (Farrelly & Austin, 2007).

EI and IQ are not synonymous; EI is more closely related to crystallized compared with fluid ability (see e.g., Farrelly & Austin, 2007; MacCann et al., 2004; Zeidner et al., 2005). In contrast, fluid intelligence is related to executive functions (Duncan, Burgess, & Emslie, 1995; Unsworth & Engle, 2008), and higher fluid intelligence leads to reduced switch costs (Salthouse, 1998). Here I set out to assess differences in making face emotion, gender, and occupation categorization tasks in relation to IQ and EI measures taken on the same participants. It may be predicted that participants with higher IQs would be able to switch between face dimensions more easily than those with lower IQs, given that task switching might generally be easier for high IQ participants. On the other hand, given the evidence that EI can affect the processing of emotion, it can be predicted that participants high in EI may process facial emotion more easily than those low in EI, and consequently that they may switch more easily from emotion decisions into other decisions about faces, and perhaps more easily from the gender and occupation decision tasks into the face emotion decision task. Also prior work on task switching has demonstrated there can be asymmetrical performance where, counter-intuitively, there is slower switching from the harder into the easier of the two tasks (Allport et al., 1994). If emotion processing is facilitated for high EI

individuals, then it is possible that they may have to inhibit emotion processing when other properties of faces are discriminated. If this is the case then individuals high in EI may show relatively slow switching into the emotional decision tasks from other decisions. We can also make some neuroanatomical predictions. The processes of inhibition and activation of task-sets are functions of the prefrontal cortex. For example, patients with left prefrontal lesions show impairments in task-set activation while patients with right frontal lesions show difficulty in task-set inhibition (e.g., Mayr, Diedrichsen, Ivry, & Keele, 2006; see also Aron, Monsell et al., 2004). Given that frontal lobe functions are linked to aspects of intelligence (Duncan, Burgees, & Emslie, 1995) - we would expect IQ to link to task switching ability. The neural basis of EI has not been investigated in detail, so neuroanatomically-motivated predictions are difficult to make in this case.

In addition, I investigated whether there is differential switching performance when contrasting aspects of faces have to be classified and whether task switching effects with faces correlate with EI and IQ? I report three experiments which were carried out under the same general paradigm. The tasks were self-paced and each task was performed in 4 blocks of 16 trials (8 blocks in total), where the task to be performed was cued by the background colour which stimuli were presented on. The stimuli were comprised of 16 photos of 8 famous singers and actors with each depicting a happy and a neutral facial expression. Half of these photos were of women. The 4 singers were Robbie Williams, Paul McCartney, Britney Spears, Madonna; while the 4 actors were Daniel Radcliffe, Rowan Atkinson, Kate Winslet, and Elizabeth Taylor. In different experiments, participants were asked to make emotion, gender or occupation decisions. Pilot testing ensured that the famous faces were recognizable by the sample population, and efforts were made to equate the famous faces in terms of stimulus quality (e.g., resolution) as well as face angle, race (white), facial

expression (positive & neutral), and attractiveness. Half of the pictures portrayed smiling faces with obvious teeth.

### 3.3. Experiment 1: gender-emotion task switching

#### 3.3.1. Method

*Participants.* 16 undergraduate and postgraduate students from Cadbury College and the University of Birmingham took part in the study. There were 10 female and 06 males; ages 16-25 years (mean 20.43 years). All had with normal colour vision. None had participated in a similar experiment. None had reported any injury, disease or eye surgery.

*Materials and displays*

The stimuli were 16 facial photographs which were same for the two tasks except that they were presented against blue and grey backgrounds while backgrounds related to the task (gender or emotion classification) were counterbalanced over the participants. The experiment was designed in E-prime software (Schneider, Eschman, & Zuccolotto, 2002, version 1.2). All stimuli were presented in the center of a 14 inch laptop screen. The participants responded by pressing keys set on the keyboard: 1=male; 2=female; happy=3; neutral=4. The display consisted of a fixation cross (+), presented in 18 point, courier new font, black= (0,0,0) against a white background followed by the blank white screen for 1000 ms appeared before the presentation of each picture for an indefinite time (until the response). The participants were presented with alternating blocks of the gender and the emotion classification tasks. For half of the participants, the experiment started with the presentation of emotion task. This was counterbalanced across participants.

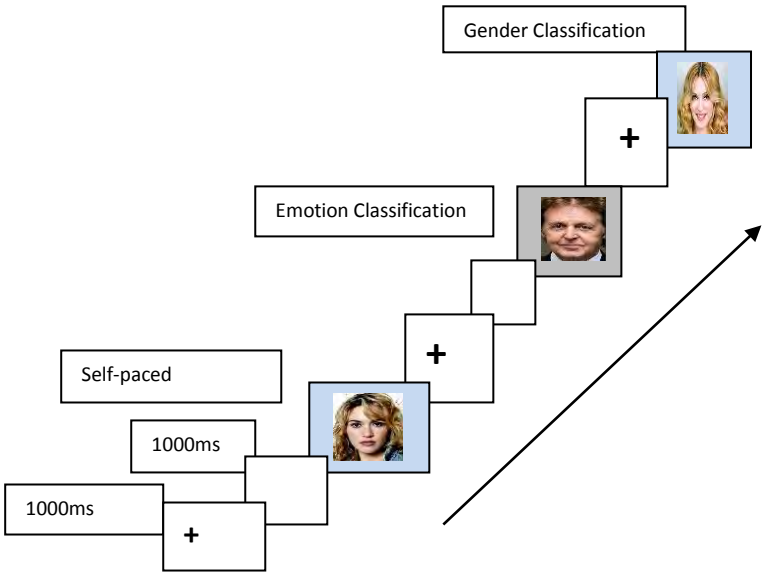


**Fig. 3.1**.Stimuli and displays for the emotion and gender task.

*BarOn Emotional Quotient Inventory.* The BarOn Emotional Quotient Inventory (BarOn EQ-*i)* is a measure of EI. It is composed of 133 brief statements such as "I believe in my ability to handle most upsetting problems" and employs a five-point response set ranging from 1 (not true of me) to 5 (true of me). The completion time generally is 30-40 minutes. The Total EI score is a general indication of how emotionally intelligent the respondent is and how successful the individual is in coping with environmental demands. The overall EI score is based on five EI composite scale scores: Interpersonal EI, Intrapersonal EI, Adaptability EI, Stress management EI, and General mood EI. Interpretation of scores are 130+ = atypically well-developed emotional capacity, 120-129= extremely well developed emotional capacity, 110-119= well-developed emotional capacity, 90-109 = adequate emotional capacity, 80-89= underdeveloped emotional capacity, 70-79= extremely underdeveloped emotional capacity, under 70= atypically underdeveloped emotional capacity. The alpha reliability of BarOn EQ-i is between .60 and .70. There is a low correlation with IQ (e.g., as measured by Wechsler Adult Intelligence Scale; WAIS,

Wechsler, 1958) and it fails to correlate with the Factor B of 16PF (thought to tap verbal, numerical, and logical reasoning aspects of cognitive intelligence) (BarOn, 1997).

*National Adult Reading Test*. NART (Nelson & Willison, 1991) is a measure of verbal intelligence based on a 50-item, single word reading test. All the words are irregular and violate grapheme-phoneme correspondence rules. The participant is required to read out loud these irregularly pronounced words, which become progressively more difficult (for example, 'chord', 'superfluous' and' demesne'). The NART VIQ estimate was calculated using Blair and Spreen 's original equation [NART VIQ estimate = 128.7-.89 (NART errors)].

Procedure

Each participant arrived at the experimental room individually, and was given an informed consent form to review and sign. Upon consent, participants were given a description of the procedure. Each participant was administered the BarOn EQ inventory and the NART. Next, participants were seated before the computer screen at a comfortable viewing distance (approximately 60 cm). They were told that this was a reaction time experiment, and that they must respond by pressing the fixed keys on keyboard as quickly as possible without sacrificing accuracy. The stimuli and the tasks were then explained as gender and emotion classification. They were told that on each trial, participants were presented with facial photographs and they were required to classify the gender (male/female) or the emotion (happy/neutral) of the face by pressing fixed keys on the keyboard. The participants completed 128 trials of the gender and emotion task. Following the experiment, the results were saved and participants were debriefed and thanked for their participation.

### 3.3.2. Results

The data from first two blocks were discarded because there was no task switch for the block 1 and there would have been unequal numbers of trials per switching block if we had included block 2. Response times (RTs) were excluded above 2.5 standard deviations from each participants' mean along with responses longer than 3,000 ms or shorter than 100 ms. Participants' mean RTs were calculated on switch (1-4) and repeat (5-16) trials of each block in both tasks. Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with trial (*switch* vs. *repeat*) and task (*emotion* vs. *gender*) as within subject factors. The main effect of trial $F$ (1, 15) =113.86, $MSE$= 20447.44, $p$<0.001, ηp2=.88 was significant. RTs on switch trials ($M$=1124 ms) were slower than on repeat trials ($M$= 743 ms). The main effect of the task $F$ (1, 15) =13.23, $MSE$= 10259.92, $p$<0.01, ηp2=.46 was significant. RTs for the emotion ($M$=888 ms) task were faster than RTs for the gender task ($M$=980 ms). The interaction between trial and task failed to reach significance $F$< 1 (fig.3.2). Across both switch and repeat trials the emotion task was performed faster than the gender task ($t$ (15) = 3.17 and 3.12 respectively; both, $p$<0.01).

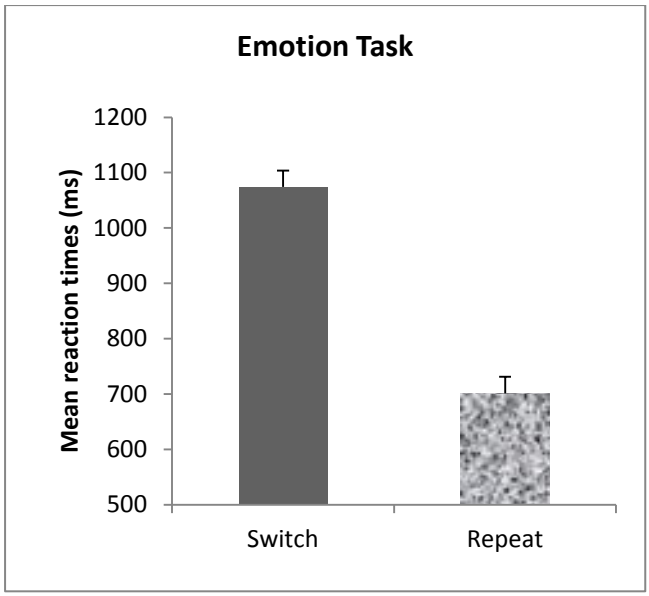


**Fig. 3.2a**. Mean reaction times (ms) for the switch and repeat trials in the emotion task in experiment 1. Error bars correspond to the average standard error.

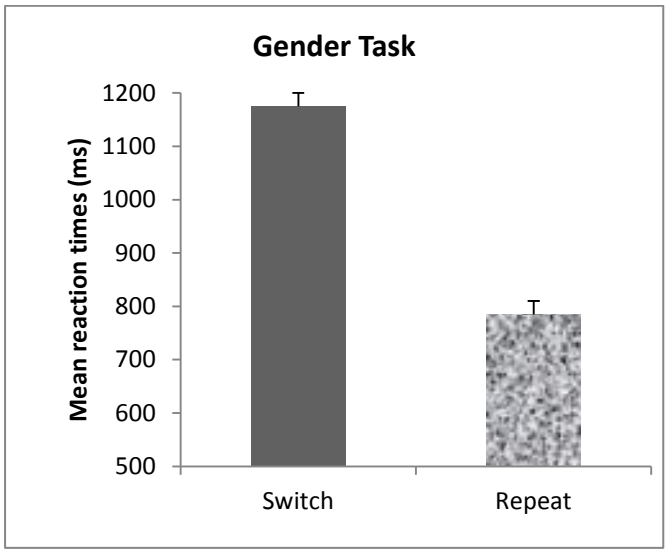


**Fig. 3.2b**. Mean reaction times (ms) for the switch and repeat trials in the gender task in experiment 1. Error bars correspond to the average standard error.

To assess the effects of EI partial correlations were carried out based on the mean switch cost across the emotion and gender tasks (RT switch minus RT repeat trials) and the total EI scores, controlling for the NART VIQ scores[1] because of the high inter-correlations.

This was reliable ($r$ = -.77, $p$<0.001). For the emotion task alone there remained a correlation between the switch cost and the total EI scores ($r$ = -.72, $p$<0.001). However, for the gender task this failed to reach significance ($r$ = -.45, $p$=.08) (see fig.3.3 and table 3.1 for mean scores).

1. Similar correlations were run against the different sub-scores of the EI measure. Essentially, similar results occurred across all scores and therefore only the data on the amalgamated score are reported here - see the tables of the additional correlations in Appendix A.

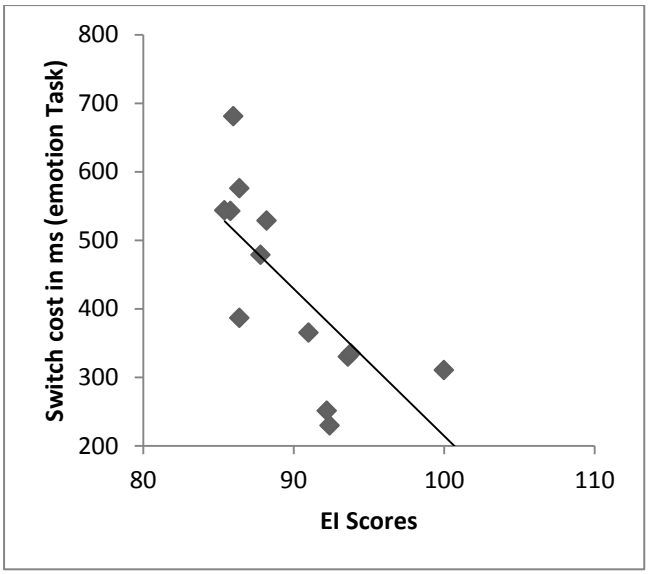


**Fig. 3.3a**.Correlation between the switch cost for the emotion task and EI scores in experiment 1 (controlling for IQ).

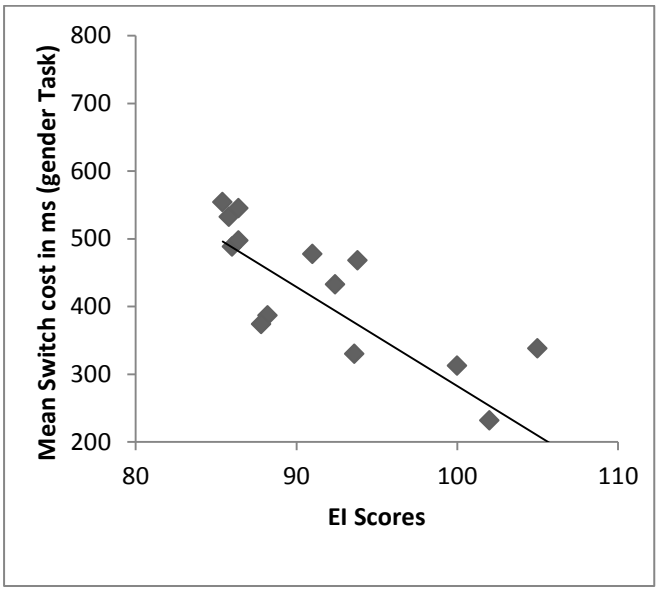


**Fig. 3.3b**.Correlation between switch cost for the gender task and the EI scores in experiment 1 (controlling for IQ).

Partial correlations were also conducted between the mean switch cost for the emotion and gender tasks and NART VIQ score because of the high inter-correlations,

controlling now for variation in EI scores. The correlation was reliable for both the emotion task and the gender task ($r$ = -.63, $p$<0.01, and $r$ = -.53, $p$<0.05, respectively) (see fig.3.4).

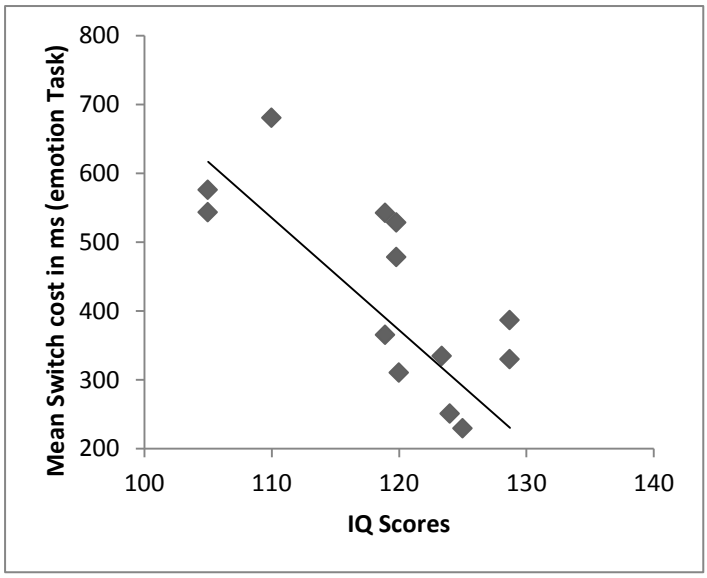


**Fig. 3.4a**.Correlation between the switch cost for the emotion task in experiment 1 and the IQ scores (controlling for EI).

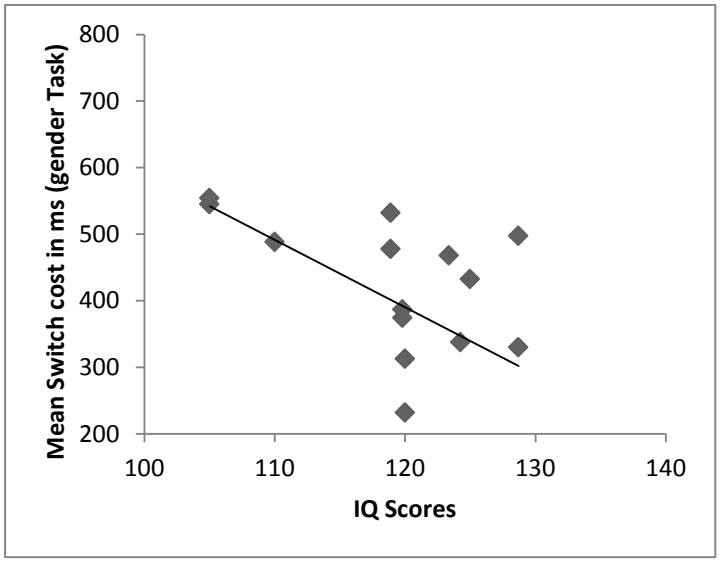


**Fig. 3.4b**.Correlation between the switch cost for the gender task in experiment 1and the IQ scores (controlling for EI).

**Table 3.1**

*Mean switch costs for the emotion-gender task, for the NART VIQs and the BarOn EQ-i scores*

| **Switch cost emotion-gender task** *M* (*SD*) | **NART VIQ** *M* (*SD*) | **BarOn EQ-*i*** *M* (*SD*) |
|---|---|---|
| 382 (143.00) | 120 (7.47) | 92.62 (7.03) |

The error rate was low and there was no evidence of speed-accuracy trade-off. The results are presented in table 3.2.

**Table 3.2**

*Mean percentages (and standard deviation) of errors in the emotion and gender task*

| **Emotion** | | **Gender** | |
|---|---|---|---|
| % (*SD*) Switch | % (*SD*) Repeat | % (*SD*) Switch | % (*SD*) Repeat |
| 4 (.02) | 5 (.03) | 4 (.02) | 3 (.04) |

*Switching Effects and IQ*

The high and low IQ groups were separated on the basis of median split for IQ scores (median value= 110) and participants' mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with trial (*switch* vs. *repeat*), task (*emotion* vs. *gender*), and IQ (*high* vs. *low*) as within subject factors. The main effect of trial $F$ (1, 6) =148.64, $MSE$ = 1991725.39, $p$<0.001, ηp2=.96 was significant. Switch trials ($M$=1124 ms) were slower than repeat trials ($M$= 746 ms). The main effect of task was also reliable $F$ (1, 6) =7.94, $MSE$ = 127455.35, $p$<0.05, ηp2=.57. Emotion classification ($M$=887 ms) was faster than the gender

classification (*M*=983 ms). The main effect of IQ *F* (1, 6) =29.88, *MSE* = 310112.60, *p*<0.01, ηp2=.83 was significant. RTs for the low IQ group (*M*=1009.85 ms) were slower than the high IQ group (*M*= 861 ms). The interaction between trial and IQ was significant *F* (1, 6) =22.29, *MSE* = 176554.69, *p*<0.01, ηp2=.78. The switch cost for the high IQ group was less than the low IQ group [*t* (6) = 4.72, *p*<0.01, *M*=264.88 vs. 489.48 ms].

*Switching Effects and EI*

The high and low EI groups were separated on the basis of median split for EI scores (median value= 91) and participants' mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with trial (*switch* vs. *repeat*) x task (*emotion* vs. *gender*), and EI (*high* vs. *low*) as within subject factors. The main effect of trial *F* (1, 7) =979.37, *MSE* = 232861.0, *p*<0.001, ηp2=.99 was significant. Switch trials (*M*=1124 ms) were slower than repeat trials (*M*= 746 ms). The main effect of task was also reliable *F* (1, 7) =16.23, *MSE* = 135754.4, *p*<0.01, ηp2=.69. Emotion classification (*M*=887 ms) was faster than the gender classification (*M*=983 ms). The main effect of EI *F* (1, 7) =9.84, *MSE* = 222030.6, *p*<0.01, ηp2=.58 was significant. RTs for the low EI group (*M*=992 ms) were slower than the high EI group (*M*= 874 ms). The interaction between trial and IQ was significant *F* (1, 7) =19.89, *MSE* = 214566.9, *p*<0.01, ηp2=.74. The switch cost for the high EI group was less than the low EI group [*t* (7) = 4.46, *p*<0.01, *M*=265.65 vs. 497.26 ms].

### 3.3.3. Discussion

The emotion task was performed overall faster than the gender task here, presumably reflecting the ease of detecting facial emotion in these stimuli. This did not interact with task switching. It is also consistent with prior results suggesting that the facial emotion is classified automatically (Driver & Vuilleumier, 2001) while face gender is not, at least for

famous faces (Quinn, Mason, & Macrae, 2009). The emotion and gender classification tasks were nevertheless matched for their switch costs, suggesting that asymmetric switch costs do not necessarily arise simply because tasks differ in difficulty. Asymmetric switch costs may arise when one stimulus is easy to engage attention on. For example, the increased ease of selecting one stimulus may require that it is suppressed to enable the more difficult stimulus to be selected (as with asymmetric switch costs for Stroop stimuli; see Allport & Wylie, 1994). In the present case there may not be any differential ease of selecting facial emotion rather than gender even though the emotions were easier to discriminate.

Over and above this, I found that there were reliable correlations between the task switch costs and both EI and IQ- the higher the EI and IQ scores, the lower the switch costs. For the EI measure, switch costs tended to be more related to performance in the emotion task relative to the gender task. EI is positively associated with the skill in emotion recognition in faces (Ciarrochi, Chan & Bajgar, 2001). This might be reflected by increased attention/an increased ability to select emotional cues and this may reduce switch costs in individuals high in EI.

The correlation between the switching data and IQ is also of interest. Dumotheil, Thompson, and Duncan (2011) argued that aspects of IQ are related to cognitive processes typically associated with operations of the frontal lobes of the brain, including task switching. Although Duncan's argument primarily relates to 'fluid' as opposed to 'crystallized' intelligence, the crystallized measure provided by the NART may in turn reflect some underlying differences in fluid intelligence across individuals. To the extent that such differences reflect frontal lobes/executive processes, we may expect task switching to be easier in individuals with increased IQ. The results also fit with the argument that

individuals with greater executive resources are better able to re-configure task sets, when switches take place (Salthouse et al., 1998).

### 3.4. Experiment 2: emotion-occupation task switching

Experiment 2 tested whether the previous results generalized to the pairing of emotion judgments with tasks requiring face recognition – in this case occupation decisions. To judge the occupation of a face requires that participants access stored knowledge about the person – and the underlying cognitive processes may different from those involved in gender classification (in experiment 1). Do task switching effects remain equivalent, are switches generally influenced by IQ and are emotion judgments in particular modulated by EI?

#### 3.4.1. Method

Method was the same as in experiment 1 except where noted.

*Participants.* 16 undergraduate and postgraduate students from Cadbury College and University of Birmingham took part in the study. There were 10 females and 6 males with ages between 16 and 23 years (mean 20.70 years). All had normal colour vision. None had participated in a similar experiment. None had reported any injury, disease or eye surgery.

*Materials and displays*

The materials and the displays were the same as in experiment 1 except that the participants were presented with eight alternating blocks of the emotion and occupation tasks. For half of the participants, the experiment started with the emotion task. This was counterbalanced across participants.

Procedure

The procedure was same as in experiment 1 except that the tasks involved emotion and occupation decision. On each trial, participants were presented with facial pictures and they were required to classify the emotion (happy/neutral) or the occupation (actor/singer) of the individual photographed. There were 128 experimental trials for each of the emotion and occupation tasks.

**3.4.2. Results**

The data from first two blocks were discarded in order to equate the numbers of trials in the two tasks given that there was no task switch for block 1 (and so these data could not be included in the design). For each remaining block outliers were removed and response times (RTs) were excluded above 2.5 standard deviations from a participant's mean. Responses longer than 3,000 ms or shorter than 100 ms were also omitted. Participants' mean RTs were calculated for the switch (1-4) and the repeat (5-16) trials of each block in both tasks.

The mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with trial (*switch* vs. *repeat*) and task (*emotion* vs. *occupation*) as within subject factors. The main effect of trial $F$ (1, 15) = 112.63, $p$<0.001, $MSE$ = 5914.73, ηp2=.88 was significant. RTs on switch trials ($M$ = 958 ms) were slower than those on the repeat trials ($M$ = 754 ms). The main effect of task $F$ (1, 15) =12.59, $MSE$ = 9329.14, $p$<0.01, ηp2=.45 was significant. RTs for the emotion ($M$ =813 ms) task were faster than for the occupation ($M$ = 899 ms) task. The interaction between trial and task failed to reach significance $F$ (1, 15) = .28, $p$=.59, $MSE$ = 4462.54, ηp2=.01. The data are depicted in figure 3.5.

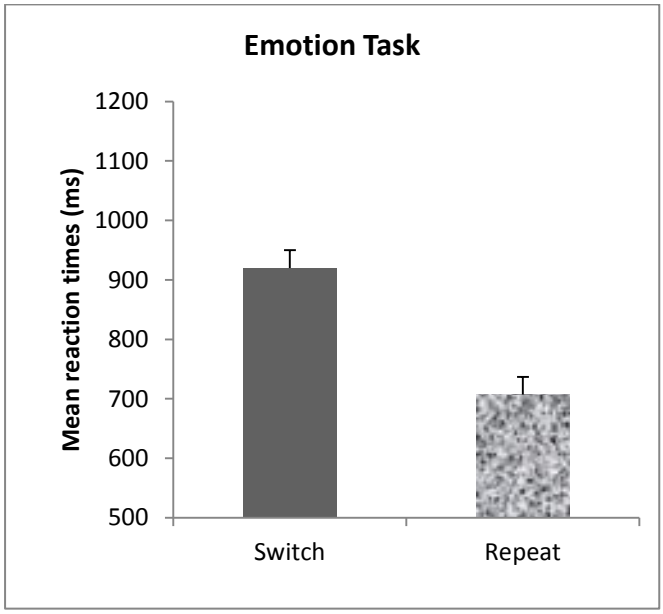


**Fig. 3.5a.** Mean reaction times (ms) for the switch and repeat trials in the emotion task in experiment 2. Error bars correspond to the average standard error.

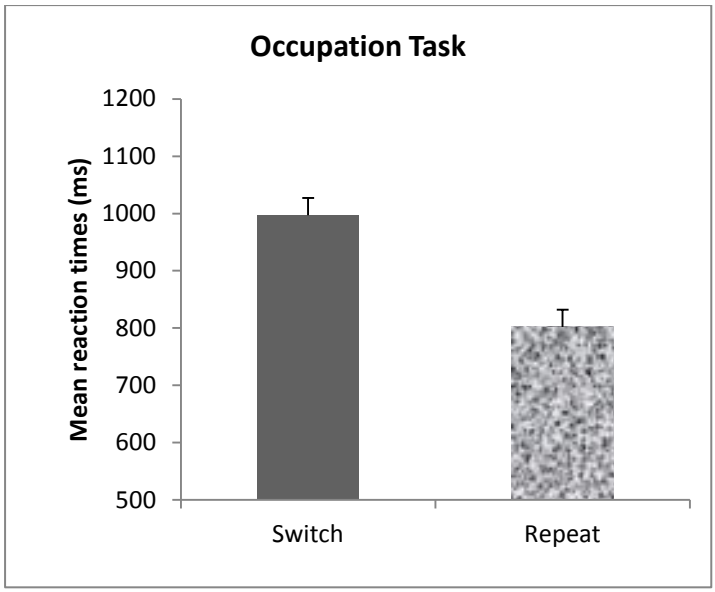


**Fig.3.5b.** Mean reaction times (ms) for the switch and repeat trials in the occupation task experiment 2. Error bars correspond to the average standard error.

The error rate was low and there was no evidence of speed-accuracy trade-off. The error data are presented in table 3.3.

**Table 3.3**

*Mean Percentages (standard deviation) of error rate in the emotion-occupation task*

| **Emotion** | | **Occupation** | |
|---|---|---|---|
| % (*SD*) Switch | % (*SD*) Repeat | % (*SD*) Switch | % (*SD*) Repeat |
| 5 (.02) | 3 (.03) | 5 (.02) | 4 (.04) |

Partial correlations were carried out comparing the relations between the switch costs and IQ and EI, with EI and IQ respectively accounted for because of the high inter-correlations. There was a reliable relation between the mean switch cost for the emotion task and the total EI scores ($r$ = -.67, $p$<0.01). In contrast, the correlation between the switch cost for the occupation task and the total EI score was not reliable ($r$ = -.10, $p$ =.69) (in both cases controlling for the NART VIQ scores[2]). These data are presented in figure 3.6 (for the mean scores see table 3.4).

2. Similar correlations were run against the different sub-scores of the EI measure. Essentially similar results occurred across all scores and therefore the data on the amalgamated score are reported here - see the tables of the additional correlations in the Appendix B.

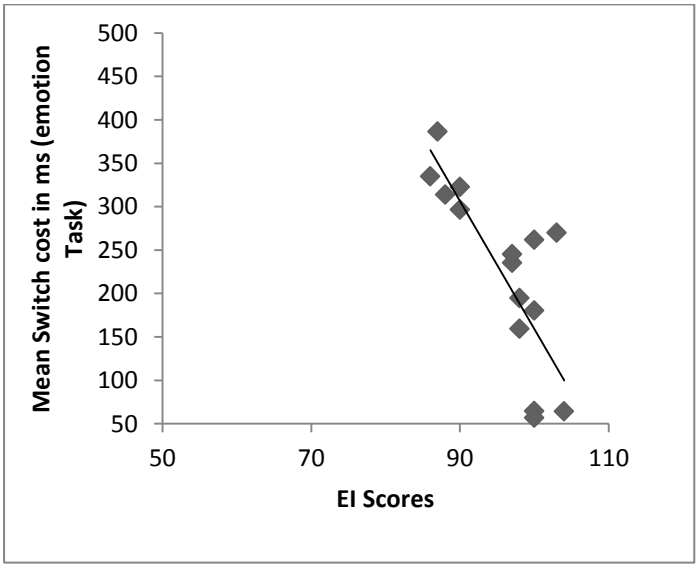


**Fig. 3.6a**.Correlation between the Switch cost for the emotion task in experiment 2 and EI scores (controlling for IQ).

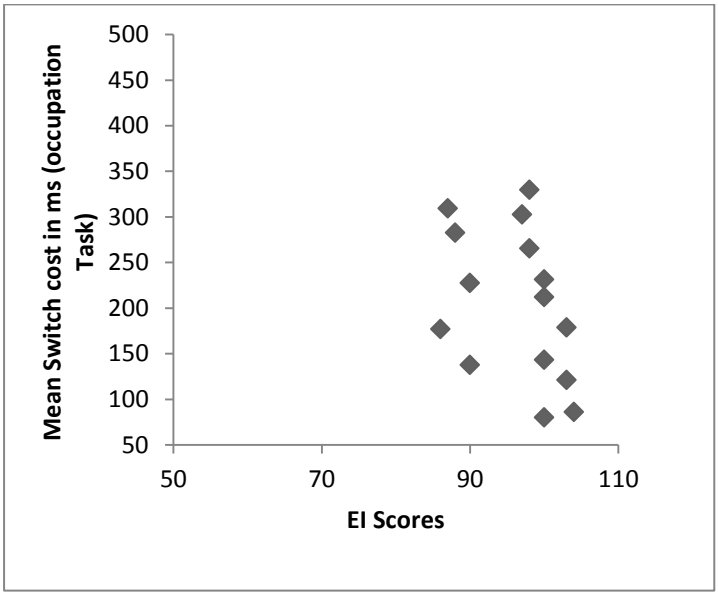


**Fig. 3.6b**.Correlation between the Switch cost for the occupation task in experiment 2 and EI scores (controlling for IQ).

Similar partial correlations were carried out between the mean switch cost for the emotion and occupation tasks and NART VIQ scores (in this case controlling for differences in EI because of the high inter-correlations) ($r$ = -.63, $p$<0.05). The relation between the

switch cost for the occupation task and the NART VIQ scores was reliable ($r$ = -.62, $p$<0.01) while there was no reliable relation between NART VIQ scores and the switch costs for the emotion task ($r$ = -.08, $p$=.77) (with EI scores controlled) (fig. 3.7).

**Table 3.4**

*Mean switch cost for the emotion-occupation task, NART VIQ and BarOn EQ-i scores*

| **Switch cost emotion-occupation task** *M* (*SD*) | **NART VIQ** *M* (*SD*) | **BarOn EQ-*i*** *M* (*SD*) |
|---|---|---|
| 205 (76.90) | 124.87 (2.46) | 96.31 (6.06) |

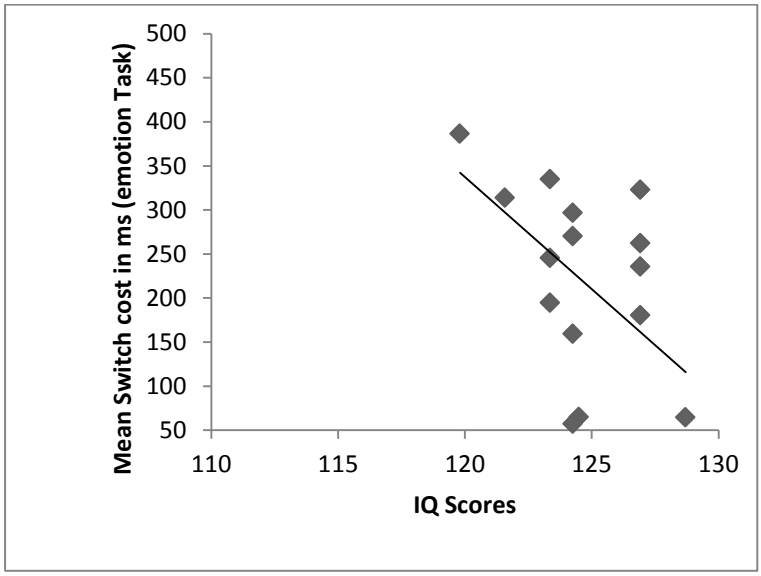


**Fig. 3.7a**.Correlation between the switch cost for the emotion task in experiment 2 and IQ scores (controlled for EI).

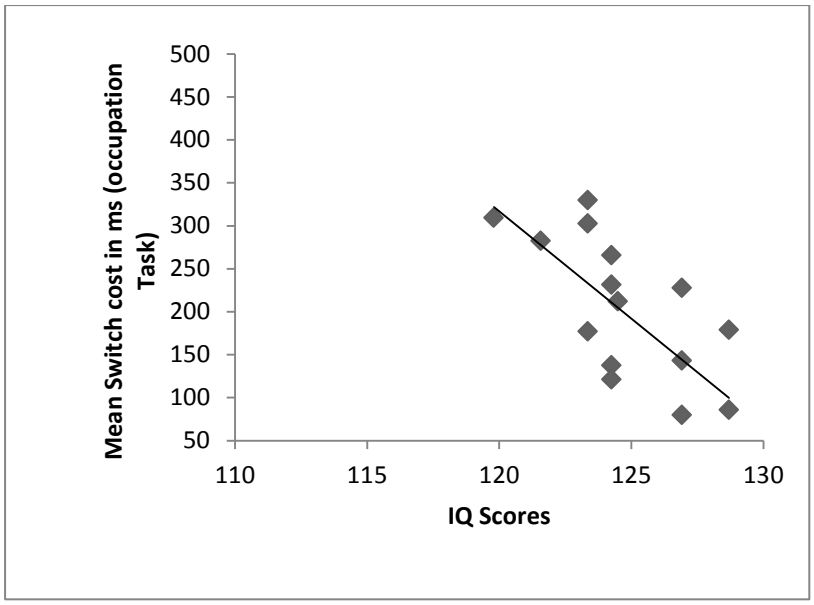


**Fig. 3.7b**.Correlation between the switch cost for the occupation task in experiment 2 and IQ scores (controlled for EI).

*Switching Effects and IQ*

The high and low IQ groups were separated on the basis of median split for IQ scores (median value= 124) and participants' mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with trial (*switch* vs. *repeat*) x task (*emotion* vs. *occupation*), and IQ (*high* vs. *low*) as within subject factors. The main effect of trial $F$ (1, 5) =80.42, $MSE$ = 493629.40, $p$<0.001, ηp2=.94 was significant. Switch trials ($M$=963 ms) were slower than repeat trials ($M$= 760 ms). The main effect of task was also reliable $F$ (1, 5) =37.90, $MSE$ = 58937.98, $p$<0.01, ηp2=.88. Emotion classification ($M$=793 ms) was faster than the occupation task ($M$=1194 ms). The interaction between trial x IQ was significant $F$ (1, 5) =7.50, $MSE$ = 29584.94, $p$<0.05, ηp2=.60. The switch cost for the high IQ group was less than the low IQ group $t$ (5) = 4.77, $p$<0.01, $M$=150 vs. 230 ms respectively].

*Switching Effects and EI*

The high and low EI groups were separated on the basis of median split for EI scores (median value= 98) and participants' mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with trial (*switch* vs. *repeat*) x task (*emotion* vs. *occupation*), and EI (*high* vs. *low*) as within subject factors. The main effect of trial $F$ (1, 6) =274.46, $MSE$ = 549531.3, $p$<0.001, ηp2=.97 was significant. Switch trials ($M$=945 ms) were slower than repeat trials ($M$= 746 ms). The main effect of task was also reliable $F$ (1, 6) =9.72, $MSE$ = 69644.84, $p$<0.05, ηp2=.61. Emotion classification ($M$=801 ms) was faster than the occupation task ($M$=881 ms). The interaction between trial x IQ was significant $F$ (1, 6) =10.95, $MSE$ = 45965.48, $p$<0.05, ηp2=.64. The switch cost for the high EI group was less than the low EI group $t$ (6) = 21.51, $p$<0.001, $M$=132 vs. 275 ms respectively].

**3.4.3. Discussion**

The results broadly match those found in experiment 1. The emotion decision task was easier than the occupation decision task, but the two tasks did not differ in terms of the overall task switching costs. There was no overall evidence for easier task switching to emotion or for harder disengagement of attention from emotion. Over and above this, there were interesting differences in the pattern of switch costs for the two tasks in relation to the measures of IQ and EI. Only the switch cost for the emotion task had reliable correlation with the EI scores, which matches with earlier findings that the EI is positively correlated with the ability to recognize emotion in faces (Ciarrochi, Chan, & Bajgar, 2001; see also experiment 1). In this case, though, there was no reliable correlation between switch costs and EI for the occupation decision task. This result indicates that EI does not strongly modulate the ability to access stored semantic knowledge about people from their face. In contrast, there were correlations between IQ and switch costs for the occupation task but not

for the emotion task. The relation between switching in the occupation task and IQ matches with earlier report of reduced switch costs in individuals with higher IQ (Salthouse et al., 1998). The lack of an effect here with the emotion tasks suggests that emotion decision used somewhat different cognitive processes (related to EI not IQ) than occupation recognition, and the cognitive processes mediating emotion recognition are not necessarily related to general IQ. I return to discuss this result in the General Discussion.

### 3.5. Experiment 3: gender-occupation task switching

In experiment 3, I examined the relations between task switching in the gender and occupation decision tasks. Since emotion-based responses were not required here, I can predict that EI may play a less influential role.

#### 3.5.1. Method

Method was the same as in experiment 1 except where noted.

*Participants.* 16 undergraduate and postgraduate students from Cadbury College or the University of Birmingham took part in the study. There were 9 females and 7 male; ages 18-23 years (mean 20.00 years). All had normal colour vision. None had reported any injury, disease or eye surgery. None had participated in a similar experiment before.

*Materials and displays*

The materials and displays were same as in experiment 1. The participants were presented with eight alternating blocks of the gender and the occupation task. For half of the participants, experiment started with the presentation of gender block. This was counterbalanced across participants.

Procedure

The procedure was same as in experiment 1 except that the tasks were gender and occupation decision. On each trial, participants were presented with the photographs and they were required to classify either the gender (male/female) or the occupation (actor/singer) of the face. There were 128 trials in each task.

### 3.5.2. Results

The mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with trial (*switch* vs. *repeat*) x task (*occupation* vs. *gender*) as within subject factors. The main effect of trial $F$ (1, 15) =130.78, $MSE$ = 17631.77, $p$<0.001, ηp2=.89 was significant. Switch trials ($M$=1184 ms) were slower than repeat trials ($M$= 804 ms). The main effect of task was also reliable $F$ (1, 15) =69.04, $MSE$ = 37160.32, $p$<0.001, ηp2=.82. Gender classification ($M$=793 ms) was faster than the occupation task ($M$=1194 ms). The interaction between the trial and task was significant $F$ (1, 15) =8.32, $MSE$ = 11026.85, $p$<0.05, ηp2=.35 (fig.3.8). For both the occupation and gender tasks, there were reliable switch costs. The switch cost was greater for the occupation than the gender task $t$ (15) = 2.54, $p$<0.05. Switch trials were slower on the occupation than the gender task $t$ (15) = 6.89, $p$<0.001, while repeat trials were faster on gender compared to the occupation task $t$ (15) = 9.20, $p$<0.001.

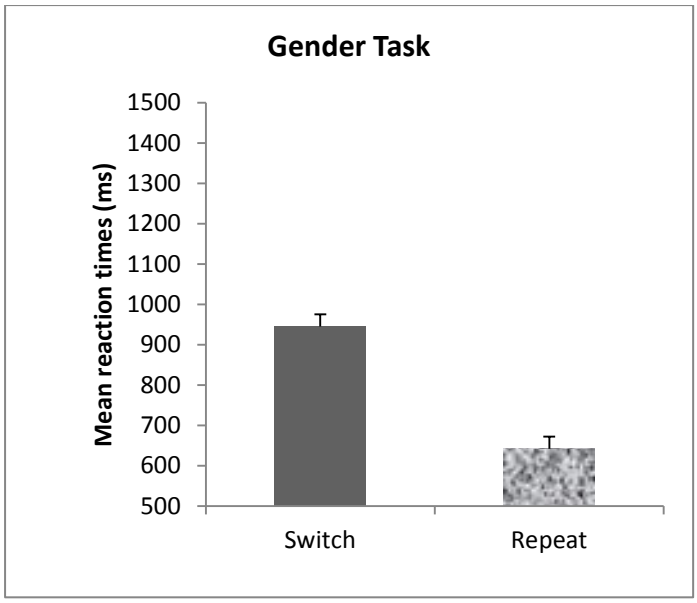


**Fig.3.8a**. Mean reaction times (ms) for the switch and repeat trials in the gender task in experiment 3. Error bars correspond to the average standard error.

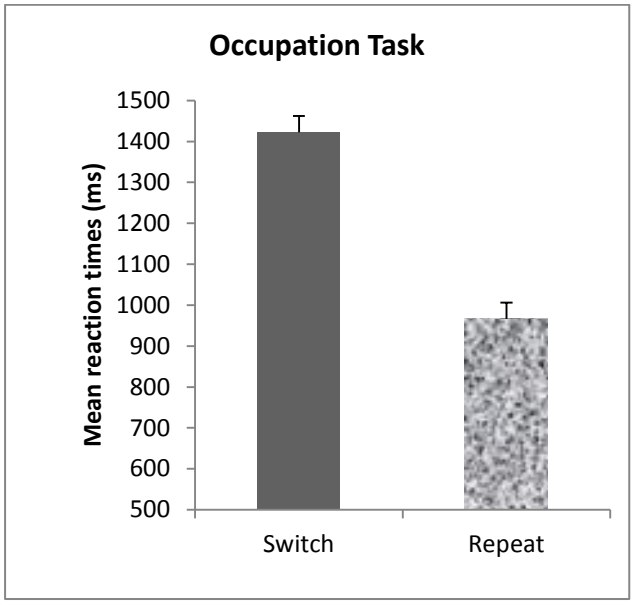


**Fig. 3.8b**. Mean reaction times (ms) for the switch and repeat trials in the occupation task in experiment 3. Error bars correspond to the average standard error.

As for experiments 1 and 2, partial correlations were conducted to assess the relations between task switching and EI and IQ (controlling for each factor in turn) because

of the high inter-correlations. There were no reliable relations between EI and task switching in either the occupation or gender task ($r$ = -.08, $p$=.77, and $r$ = -.05, $p$=.86)] with NAART VIQ scores controlled for.[3] These data are presented in figure 3.9 (for mean scores, see table 3.5).

3. Similar correlations were run against the different sub-scores of the EI measure with, essentially, similar results occurring across all scores. Therefore the data were reported on the amalgamated score only - see the tables of the additional correlations in the Appendix C.

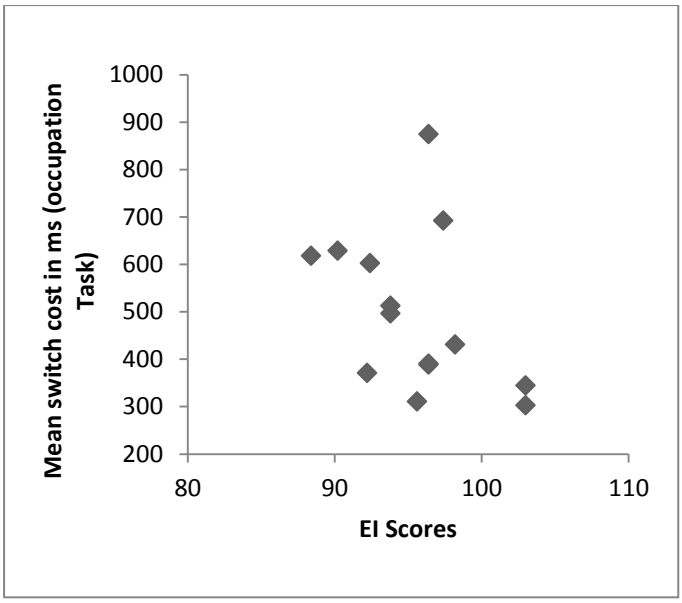


**Fig. 3.9a**.Correlation between the switch cost for the occupation task in experiment 3and EI scores (controlled for IQ).

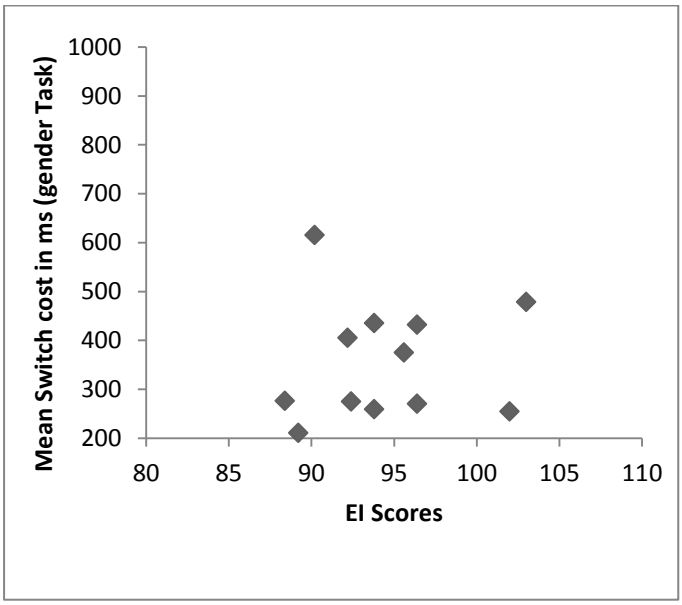


**Fig. 3.9b**.Correlation between the switch cost for the gender task in experiment 3and EI scores (controlled for IQ).

**Table 3.5**

*Mean switch cost for the gender-occupation task, NART V IQ and BarOn EQ-i scores*

| **Switch cost gender-occupation task** *M* (*SD*) | **NART VIQ** *M* (*SD*) | **BarOn EQ-*i*** *M* (*SD*) |
|---|---|---|
| 380 (132.78) | 112.43 (9.79) | 95.52 (4.56) |

The partial correlation between the mean switch cost for the occupation and gender tasks and the NART VIQ scores (with EI scores controlled) was $r = -.66$ and $r = -.51$, $p<.05$, respectively) (fig.3.10).

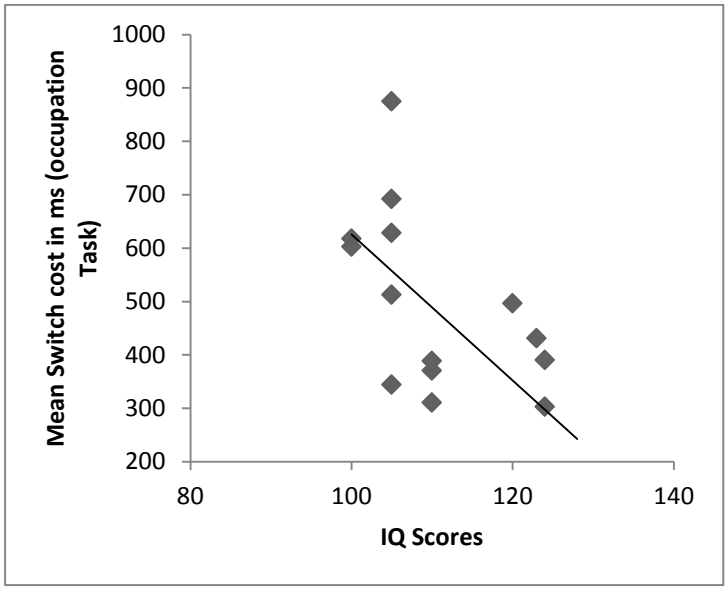


**Fig. 3.10a**.Correlation between switch cost for the occupation task and IQ scores (controlled for EI).

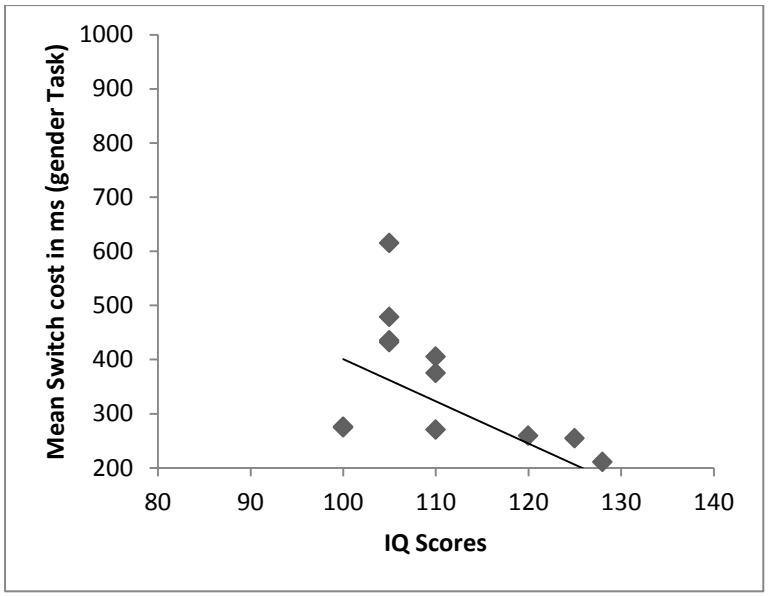


**Fig. 3.10b**.Correlation between switch cost for the gender task and IQ scores (controlled for EI).

The error rate was low and there was no evidence of speed-accuracy trade-off. The results are presented in table 3.6.

**Table 3.6**

*Mean percentages (standard deviation) of errors in gender-occupation tasks*

| **Gender** | | **Occupation** | |
|---|---|---|---|
| % (*SD*) Switch | % (*SD*) Repeat | % (*SD*) Switch | % (*SD*) Repeat |
| 5 (.03) | 2 (.04) | 4 (.02) | 5 (.03) |

*Switching Effects and IQ*

The high and low IQ groups were separated considering median splits on IQ scores (median value=110) and participants' mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with trial (*switch* vs. *repeat*) x task (*occupation* vs. *gender*), and IQ (*high* vs. *low*) as within subject factors. The main effect of trial $F$ (1, 7) =339.96, $MSE$ =

2305992.37, $p<0.001$, ηp2=.98 was significant. Switch trials (*M*=1184 ms) were slower than repeat trials (*M*= 804 ms). The main effect of task was also reliable $F$ (1, 7) =100.16, *MSE* = 2565857.28, $p<0.001$, ηp2=.93. Gender classification (*M*=793 ms) was faster than the occupation task (*M*=1194 ms). The interaction between the trial and task was significant $F$ (1, 7) =5.73, *MSE* = 91798.78, $p<0.05$, ηp2=.45 (fig.3.8). For both the occupation and gender tasks, there were reliable switch costs. The switch cost was greater for the occupation than the gender task $t$ (15) = 2.54, $p<0.05$. Switch trials were slower on the occupation than the gender task $t$ (15) = 6.89, $p<0.001$, while repeat trials were faster on gender compared to the occupation task $t$ (15) = 9.20, $p<0.001$. The interaction between the task and IQ was significant $F$ (1, 7) =5.571, *MSE* = 167552.38, $p<0.05$, ηp2=.44. For both groups, gender categorization was faster than the occupation categorization [high IQ group, $t$ (7) = 25.28, $p<0.001$, *M*=804 vs. 1102 ms; low IQ group, $t$ (7) = 8.17, $p<0.001$, *M*=783 vs. 1286 ms respectively].

*Switching Effects and EI*

The high and low EI groups were separated by considering median splits on EI scores (median value=98) and participants' mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with trial (*switch* vs. *repeat*) x task (*occupation* vs. *gender*), and EI (*high* vs. *low*) as within subject factors. The main effect of trial $F$ (1, 2) =135.5, *MSE* = 932941.8, $p<0.01$, ηp2=.98 was significant. Switch trials (*M*=1222 ms) were slower than repeat trials (*M*= 828 ms). The main effect of task was also reliable $F$ (1, 2) =123.18, *MSE* = 1203808.84, $p<0.01$, ηp2=.98. Gender classification (*M*=801 ms) was faster than the occupation task (*M*=1249 ms). The only reliable interaction was between task and EI [$F$ (1, 2) =31.89, *MSE* = 352330.02, $p<0.05$, ηp2=.94]. For both groups, gender categorization was

faster than the occupation categorization [high EI group, $t$ (2) = 7.84, $p$<0.01, $M$=782 vs. 988 ms; low IQ group, $t$ (12) = 8.65, $p$<0.001, $M$=795 vs. 1240 ms respectively].

### 3.5.3. Discussion

As in experiments 1 and 2, I found reliable switch costs when participants carried out different classification tasks to faces. Unlike the results when one task was emotion decision making, there was an asymmetry in the switch costs here, with occupation classification yielding larger switch costs than the gender classification. This result runs counter to the argument that switch costs reflect the automaticity of classification (with the automatic task showing larger switch costs due to the need for it to be inhibited; see Allport & Wylie, 1998), since, occupation classification is less likely to be an automatic procedure than the gender classification (though see Quinn, Mason, & Macrae, 2009 for evidence against automatic gender classification of famous faces). In the present case, the results may reflect the relative ease of the two tasks, with gender classification being easier than the occupation classification. It may be easier to switch to the easier of two tasks at least when the easier task does not require inhibition to prevent it from operation (cf. Allport et al., 1994). Against this argument though, I found no asymmetric switch costs when emotion decisions were involved, even though emotion decisions were easier than gender and occupation decisions (experiments 1 and 2). The magnitude of the switch costs then may not only reflect relative task difficulty but also whether similar processes are in operation across the tasks. Differential switch costs, disrupting the more difficult of two tasks, may be generated when the task configurations are similar so that one has to be dismantled to avoid interference when the other task is required. Switch costs then may reflect the time taken to reconfigure the task set, which takes longer for the more difficult task. In contrast, emotion decisions

may call on different processes than gender and occupation decisions, and switching need not entail dismantling and reconfiguring new task sets. In this case, the more difficult of the two tasks does not suffer differentially.

The argument that different processes may be involved in emotion relative to gender and occupation decisions is also supported by the results from the correlations with IQ and EI. EI correlated reliably with the switch costs to the emotion decision task, whereas EI showed weak or non-reliable correlations with switch costs in the gender and occupation tasks. This suggests that EI is not related to all aspects of task switching, but rather it more specifically links to the task switching and emotional judgments-participants with a high EI are better able to switch attend to and from facial emotions, compared with the participants with a low EI. This fits with the idea that EI relates to how well individuals can process facial emotions. For example, it may be that the task set to process facial emotion is in a consistently primed state for individuals with a high EI – with the result that there is fast switching to emotion decisions. As this applies only to emotion judgments, though, then individuals with a high EI are not advantaged in switching in other face processing tasks (gender and occupation decisions).

In contrast to the null effect of EI here, there were reliable effects of IQ, with again (as in experiments 1 and 2), participants with a higher IQ better able to switch tasks than those with a lower IQ. Since this result occurred across all the current task pairings, it appears to reflect a general factor independent of the specific task. The result is consistent with the participants with higher IQs having more executive control and so they are better able to reconfigure a new task-set, and to discard the previous task-set, to enable the new task to be performed.

### 3.6. General Discussion

There were two main aspects of the present study. The first was the relative ease of switching from one face classification task to another. The second was the relation between task performance, IQ and EI.

#### 3.6.1. Relative magnitudes of task switching costs

In experiments 1 and 2, task switching costs were equal when emotion decisions were paired with gender and occupation decision tasks, although the emotion task was overall easier. In experiment 3, when the gender and occupation decision tasks were paired, switch costs were larger for the more difficult task (occupation decision).

Switching between tasks of unequal difficulty is often not symmetric (e.g., Allport, Styles, Hsieh, 1994; Wang et al., 2007; Koch, Prinz, & Allport, 2005), with in many cases larger switching costs being found for the easier of two tasks. This has been attributed to the easier task being more automatically engaged by the stimuli, and with participants then having to inhibit that task to engage with the more difficult task (Allport et al., 1994). My data do not fit with this picture however. If I take the results for the gender and occupation tasks, it was the more difficult task (occupation decision) that suffered under switching conditions. I link this to two factors. One is that the tasks involve similar processes. When this is the case, participants may have to dismantle one task set in order to enable the similar task set to be instantiated when switching takes place. The second factor is that the task set takes longer to configure for more difficult tasks. Hence, when switching involves setting up a new task configuration, the more difficult task suffers.

As well as finding asymmetric effects with gender and occupation decisions, I found additive effects of switching and task when emotion decisions were paired with both gender and occupation decision tasks. This occurred even though emotion decisions were easier than the other decision tasks. To explain this I suggest that emotion decisions engage separate cognitive processes to gender and occupation decisions, and that task configurations that are distinct can be maintained in parallel (without the need to dismantle each configuration when a switch is required). There may then be switch costs due to having to stop one task, but the effects of this can be equal across tasks that differ in difficulty (as I observed). One caveat here is that the only emotion task examined was to decide whether faces are happy or not. Decisions about whether faces depict a happy emotion are typically efficient and easier than many other types of emotion judgment. It may be that the advantage for the emotion task, and the particular pattern of task switching effects, are limited to decisions about whether faces are or are not happy. The generality of the present results need to be assessed across a broader range of emotions.

### 3.6.2. Effects of EI and IQ

The second aim of the study was to assess any differential affects of EI and IQ on task switching performance. There was a reliable relationship between task switching and IQ - participants with a higher IQ were better able to switch between tasks than those with a lower IQ with the exception of the emotion decision task in experiment 2, where a non-reliable trend was apparent). This fits with the idea that people with higher IQ have greater executive control (Salthouse et al., 1998) and with previous results showing that measures of IQ have an inverse correlation with mixing costs in task switching procedures (Yehene & Meiran, 2007). Though it has been argued that executive control processes are better linked to fluid than crystallized IQ (Duncan, & Burgess, & Emslie, 1995), and though I used a

crystallized IQ measure (the NART), it is nevertheless the case that fluid and crystallized IQ are closely related and that individuals with higher fluid IQ will likely achieve high crystallized IQ scores too.

The pattern of performance in relation to EI differed from that in relation to IQ. EI correlated reliably with switch costs to the emotion decision task but not with switch costs in the other tasks – individuals with a higher EI showed reduced switch costs for emotion decisions. EI scores have previously been shown to be positively associated with skill at identifying emotional expressions in faces (Ciarrochi, Chan, & Bajgar, 2001). To account for the present results, I suggest that emotion decisions are in a primed state for individuals with a high EI, and so these decisions are readily engaged in when participants must switch from either a gender or occupation decision task into the emotion decision task. The different patterns of correlation for the emotion decision task compared with the gender and occupation decisions also supports the argument made above that emotion decisions rely on different cognitive processes to gender and occupation decisions, and so there can be contrasting patterns of relationship with trait factors such as EI. There are neurological dissociations between face recognition, gender decision and emotion decision making, for example patients following brain injury can judge emotion but no other information from the faces (see e.g., Humphreys, Donnelly, & Riddoch, 1993). There is functional imaging data indicating the emotion decisions can be mediated through specific sub-cortical pathways (through the amygdala) whereas occupation and gender decisions engage cortical processes in the ventral visual stream (see Sergent, Ohta, MacDonald, 1992; Sergent, Ohta, MacDonald, Zuck, 1994; also Haxby, Hoffman, and Gobbini, 2000) – all of which would indicate that emotions rely on different neural and cognitive processes to occupation and gender decisions. An interesting direction for future research would be to examine the neural

substrates of EI in emotion decisions – is there greater amygdala activity for individuals high in EI?

### 3.6.3. Conclusion

I conclude that the asymmetric switch costs between different attributes of a face represent the relative ease of the task, not the automaticity, when task sets are similar. However, emotion decision tasks seem separable from gender and occupation decisions and so not subject to asymmetric switch costs. In addition, while switching between different tasks seems related to IQ, only switching to emotion decisions seems related to EI.

### 3.6.4. Limitations

The current study focused on switching mechanisms related to happy emotion only which potentially limits the generalizability given that the happy faces are the fastest to detect. The comparisons to gender and occupation are therefore constrained by this. The use of crystallized IQ measure limits is a constraint on drawing the conclusions about the contribution of IQ in the switching ability. The sample size is low which limits the interpretation of null effects of the EI in relation to the gender and occupation categorizations.

# CHAPTER 4

# CULTURAL EFFECTS IN EMOTION AND GENDER RECOGNITION


## Abstract

Chapter 4 examines task switching between emotion and gender decisions to faces for individuals drawn from Western (White UK citizens) and Asian (Pakistani) cultures. These cultures differ in how they respond to emotion and gender information. There were 3 main results of interest. (1) There was a double dissociation between gender and emotion classifications across the participant populations – Western participants were faster to make gender than emotion classifications while Asian participants were faster to make emotion than gender classifications. It is argued that the different patterns of results reflect the greater attentional weight given to contrasting face dimensions in the different cultures, plus also the dependence on using different attributes to make gender discriminations in individuals from varying cultures. (2) Asian participants showed smaller switch costs overall than White British participants. This result may be attributed to effects of bilingualism in the Asian participants, which results in their having greater executive resource. (3) Emotion decisions showed larger switch costs than gender decisions but essentially because emotion decisions benefitted from priming on switch trials. It is argued that emotion decisions benefit from the activation of a specific processing module across consecutive trials.

People from different cultural backgrounds and races may classify faces in different ways. There is much work on the so-called “own race” effect, which arises when people show better performance when required to discriminate faces from their own race relative to faces from different races (e.g., Meissner & Brigham, 2001; Meissner, Brigham, & Butz, 2005; Correll, Lemoine, & Ma, 2005). This own-race advantage has been explored most thoroughly in studies where facial identity has had to be discriminated (Ge et al., 2009), but it has also been found in judgments of emotional expression (Pinkham et al., 2008) and gender (O’Toole, Peterson, Deffenbacher, 1996). Accounts of the own-race advantage differ. Some attribute it to differential perceptual sensitivity to own vs. other race faces: since we have more perceptual experience with faces from our own race compared with those of other races, so our perceptual system will be better tuned to own race faces (e.g., Brigham & Malpass, 1985; Goldstein & Chance, 1985; Kelly et al., 2007). An alternative account attributes the effects not to perceptual experience but to differential motivation (e.g., Hugenberg & Sacco, 2008).

In addition to the differences in perceiving own and other race faces, a substantial research literature shows that there are clear cultural differences in cognitive and perceptual processes (e.g., Nisbett et al., 2001; Lewis, Goto, & Kong, 2008; Gutchess, Welsh, Boduroglu, & Park, 2006; Hedden, Ketay, Aron, Markus, & Gabrieli, 2008). The results of these studies consistently show that East Asians tend to be more sensitive to contextual information whereas Westerners pay more attention on focal processes (e.g., objects in a a scene rather than the whole scene itself). Nisbett et al. (2001) suggest that East Asians pay attention to the entire field (holistically) whereas Westerners are more analytical and pay attention primarily to individual objects. Similar line of studies demonstrates cultural differences in cognitive style. For example, when participants were asked to report what they

observed in a water scene. Japanese participants reported more background related information focusing on the colour of the water, small non-moving objects, rocks etc. while Americans noticed more attributes (rapid movement, bright colour, etc.) related to the focal objects (Masuda & Nisbett, 2001). In other studies it has been shown that Chinese attend to the background in a scene more than the Americans while Americans fixate more on focal objects (Chua, Boland, & Nisbett, 2005). These data are supported by electrophysiological results. Western participants display greater target P3 amplitudes (which serve as an index of the attention paid to target events) while East Asians displayed greater novelty-based P3 amplitudes, which are considered as markers of the attention paid to contextually deviant events (Lewis, Goto, & Kong, 2008). There is evidence of cultural variation in how people attend to faces –face perception is based on more configural processing among Easterners than in westerners. These cultural variations extend to the face perception, when asked to choose a prototypic face for a set of examplars, Japanese choose more configural faces (configurations created by blending of facial features of the four faces defined by ethnicity and gender while maintaining overall gestalt) compared to the Americans suggesting more reliance of Japanese on overall resemblance (overall gestalt) rather than featural matching. In a speeded identity matching task, when the configural changes were manipulated by the changes in spacing between individual features, Japanese identified spacing differences more accurately than the Americans (Miyamoto, Yoshikawa, & Kitayama, 2011). Blais et al. (2008) monitored eye movement of Western and Asian observers when observers categorized own and other race faces. The results demonstrated a differential strategy employed by the observers in Asian and western cultures to extract visual information from faces-East Asians focused more on the central face region which is instrumental to integrate

information holistically (nose) and is most advantageous to capture global face information while Western Caucasian observers focused more across facial features.

Essentially, participants are more motivated to process faces from their own race compared to other races, and for this reason are more sensitive to own-race faces. Though investigated much less than the effects of race on face identity judgments, people from different races and cultures may differ in other classifications performed on faces (e.g., Hugenberg, Young, & Sacco, 2010). Gender classification, in particular, may differ across individuals with different cultural backgrounds. For example, in Western cultures women can be distinguished from men on the basis of make-up and hairstyle, in addition to differences in facial structure. In contrast, women in Asian cultures may cover their hair and wear minimal makeup making gender discrimination dependent on different factors, such as facial structure. On a motivational level, Western and Asian participants may differ in the 'weight' they attach to gender-for example, gender may be weighted relatively strongly in Asian cultures, as it may be a critical dimension along which people are classified.

There may be several cognitive consequences of this. For example, weighting gender strongly may mean that it becomes more difficult to switch from gender classification to other classification tasks. This was tested here, with Western and Asian participants being examined when switching between gender and emotion judgments. Was there a selective slowing on emotion judgments for Asian participants following a gender classification trial, due to slow disengagement from the gender task? By examining emotion as well as gender classification I also evaluated whether emotion was discriminated in a universal fashion across cultures (Ekman et al., 1978; Izard, 1994), or whether cultural differences might again arise-for example, there may be slow classification of facial emotion for participants in cultures where the norm is to suppress emotions (Kim et al., 2011).

In 2 different experiments, participants classified facial emotion and gender in alternating trial blocks. Experiment 1 and 2 differed only in that the expressed emotions were chosen to be more salient in experiment 1, in order to assess whether this could help minimize cultural differences on emotion judgments as the contrasting emotional expressions should become easier to discriminate. Following Wylie and Allport (2000), task switching was examined across blocks of trials, with the first trials in the block classed as 'switch' trials and the remaining as 'non-switch' trials. I tested White English participants and South-Asian/Pakistani individuals, to contrast performance across two cultures where gender may be differentially weighted. In Western societies, gender is signaled by external features such as make-up in addition to differences in facial structure and hairstyle that may differentiate men and women (e.g., Bruce et al., 1993; Chronicle et al., 1993; Stephen & Mc Keegan, 2010). In South Asian/ Pakistani society, the presence of such external features may be less obvious so that gender recognition may need to be turned to less superficial differences. In addition, Western and South-Asian/Pakistani societies may differentially weight gender as an intrinsic aspect of individual identity. In Western societies, individuals are not necessarily classified by their gender - at least when they are familiar (Quinn, Mason, & Macrae, 2009). In contrast, south-Asian/Pakistani societies are closely stratified by gender, and this may mean that gender is an important aspect of face categorization. The consequence may be that the gender of a face is classified rapidly and/or that it is difficult to disengage attention from facial gender after gender has been categorized. The consequence may be that it is difficult to switch from classifying the gender of a face to classifying another attribute.

Along with differences in classifying facial gender, individuals from contrasting cultures may also vary in responsitivity to facial emotion. Following the early work of

Ekman (1978), there has been considerable interest in cross cultural differences in responding to facial emotion. Ekman argued that facial emotions were universally classified in terms of basic configurations of muscle responses. Other studies, however, have suggested differences in emotion identification across contrasting cultures (see e.g., Mandal et al., 2010; Matsumoto & Ekman, 1989; Matsumoto, 1992; Shioiri et al., 1999a) for example, among basic emotions, happiness is more accurately identifiable in Asian than in Western cultures (Shioiri et al., 1999b) possibly because Asian cultures encourage expression of positive emotions while discouraging the overt expression of negative emotions.

According to the idea that emotions are classified in a universally uniform manner there may be few differences across different races and cultures in the speed of emotion classification and in the ability to switch to and from emotion classification. On the other hand, if there are cultural variations in the weight placed on emotions, then variations between Western and South Asian/ Pakistani individuals may arise either in the speed of emotion classification compared with other classifications or in the disengagement from emotion judgments on task switching trials. Performance was examined with 2 sets of stimuli (Asian & White faces) where the saliency of the emotion was varied. It is possible that cultural differences might emerge most clearly when the salience of the dimension is less apparent and, when a dimension is highly salient, effects of cultural factors on judgments may be swamped.

## 4.1. Experiment 1: High saliency emotion

### 4.1.1. Method

*Participants.* 32 subjects (16 White- British, 16 South Asian-Pakistani) of age range 20-22 years (mean 21.07 years) from the Universities of Birmingham and Bahauddin Zikariya

respectively took part. Half of them were female. All had normal colour vision, right hand preference and none had participated in a similar experiment.

*Materials and displays*

In pilot study, participants were asked to rate the emotional expression of 2 sets of photographs (South Asian &White British) "how would you describe the salience of happy emotion, on a scale from 1 to 10 (1= very poor salience, 10= excellent salience). Selected photographs were with mean (standard deviation) rating as: high salience {happy 8.87 (0.83) low salience {happy 1.87 (0.83)}, based on a sample of 30 participants from both cultures with inter-rater reliability =.80.

The stimuli in each experiment were eight coloured photographs: '4 South- Asian' and '4 White- British'. Half of them were posed with a happy and other half with a neutral facial expression. Of these 8 pictures, 4 were female faces. The individual stimuli were same for the two tasks except that they were portrayed with a high saliency (experiment 1) or a low saliency positive emotion (experiment 2), and were presented against blue or grey backgrounds (counter balanced across participants) to indicate which task had to be performed. The experiments were designed in E-prime software (Schneider, Eschman, & Zuccolotto, 2002, version 1.2). All stimuli were presented in the center of a 14 inch laptop screen. The participants responded by pressing different keys set on the keyboard: 1=male, 2= female, 3= happy, 4= neutral. Each trial began with the fixation cross (+), in 18 point, Courier New font, black= 0,0,0 which appeared against a white background, followed by a blank white screen for 1000 ms, then a picture appeared until the response and participants judged either the emotion (happy/neutral) or the gender (male/female) of the face by pressing appropriate response keys (fig. 4.1). Participants were presented with eight

alternating blocks (4 block of each task) forming 128 experimental trials of the emotion and gender tasks. The tasks were counterbalanced across the participants. For half of the participants, the experiment started with presentation of the emotion block. This was counterbalanced across participants so that, for the other half of participants, the gender block was carried out first.

*Design and procedure*

The study received approval by the University of Birmingham Ethics Research Committee. Upon arrival, subjects were given an informed consent form and they were provided with a description of the procedure. Upon giving consent, they were seated before the computer screen at a comfortable viewing distance (approximately 60 cm). They were told that this was a reaction time experiment, and that they must identify emotion or gender of a face by pressing the fixed keys on keyboard as quickly as possible without sacrificing accuracy. The participants completed 128 experimental trials of the emotion and gender task. After testing, subjects were debriefed and thanked for their participation.

## 4.2. Experiment 2: Low saliency emotion

### 4.2.1. Method

Method was the same as in experiment 1 except where noted.

*Participants.* 32 subjects (16 White British, 16 South Asian-Pakistani) of age range 20-22 years (mean 22.07 years) from the University of Birmingham and from Bahauddin Zikariya took part in the study. Half of them were female. All had normal colour vision, right hand preference and none had participated in a similar experiment.

*Materials and displays*

The stimuli along with displays were same as in experiment 1 except that a low saliency (with less pronounced smile) positive emotion was presented.

*Design and procedure*

The design and procedure were the same as in experiment 1.

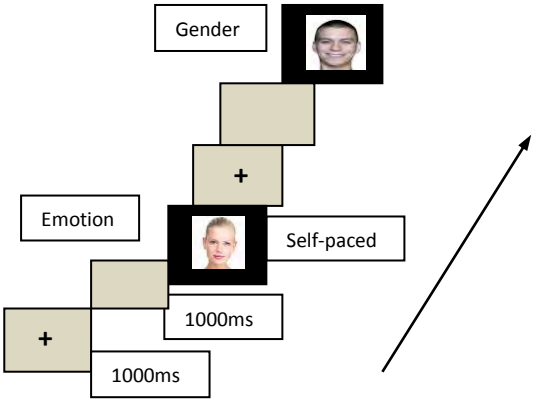


**Fig 4.1**. *Emotion- gender task stimuli.*

### 4.2.2. Results

The data from the first two blocks were discarded because there was no task switch for block 1 and omitting that block alone would lead to uneven trial numbers. I subsequently removed response times (RTs) above 2.5 standard deviations from the participants' mean. Responses longer than 3,000 ms or shorter than 100 ms were also omitted. Participants' mean RTs were calculated on switch (trials 1-4) and repeat trials (trials 5-16) of each block in both tasks.

Mean RTs were submitted to a mixed design analysis of variance (ANOVA) with trial (*switch* vs. *repeat*) and task (*emotion* vs. *gender*) as within subject factors and experiment (*salient* vs. *non salient*) and race (*Asian* vs. *British*) as a between subject factors.

The main effects of trial {$F$ (1, 60) =559.36, $p$< 0.001, ηp2=.91}, task {$F$ (1, 60) =4.02, $p$< 0.05, ηp2=.06} and experiment {$F$ (1, 60) =10.23, $p$< 0.01, ηp2=.01} were significant. Performance on switch trials ($M$=1034 ms) was slower than on repeat trials ($M$=746 ms). The emotion task ($M$=867 ms) was faster than the gender task ($M$= 904 ms). RTs in experiment 2 were faster than in experiment 1 (953 vs.827 ms respectively). The main effect of race failed to reach significance level {$F$ (1, 60) =2.05, $p$= 0.15, ηp2=.03}.

**Trial x Task**

There was a significant interaction between trial and task $F$ (1, 60) =11.96, $MSE$= 65121.86, $p$< 0.01, ηp2=.16 (fig.4.2). This interaction was further analyzed by separate repeated measures ANOVAs for both tasks with trial (*switch vs. repeat*; within subject) as a factor. There was a significant effect of trial on the emotion {$F$ (1, 63) =392.85, $MSE$= 8291.02, $p$< 0.001, ηp2=.86} and the gender task {$F$ (1, 63)= 265.79, $MSE$= 7843.43, $p$<0.001, ηp2=.80}. Switch trials were slower than the repeat trials for both tasks: **emotion task** {$t$ (63) = 19.82, $p$< 0.001}; **gender task** $t$ (63) = 16.30, $p$< 0.001. The switch cost (RT switch minus repeat trials) was larger for the emotion than the gender task $t$ (63) = 3.37, $p$< 0.01. **Repeat trials** were faster for the emotion than the gender task $t$ (63) = 4.08, $p$< 0.001; while there was no difference between the tasks on the **switch trials** $t$ < 1.

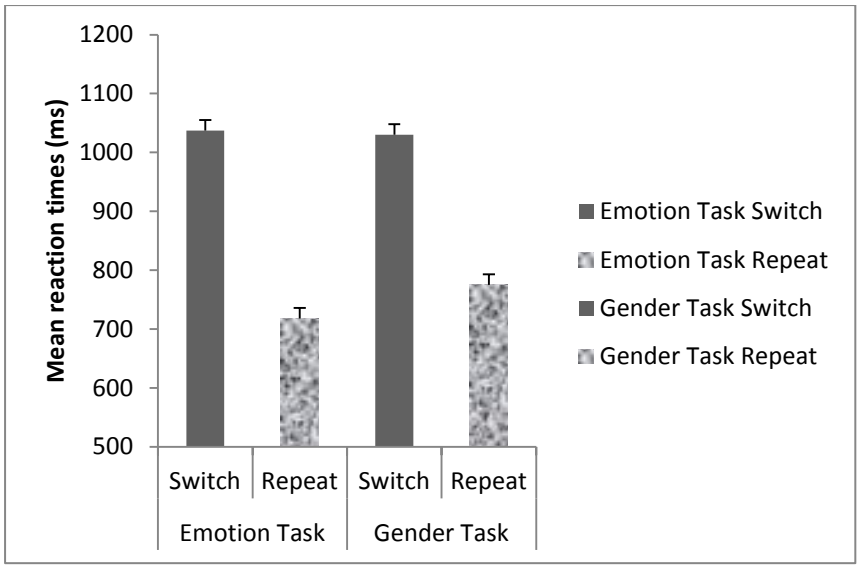


**Fig.4.2**. Mean reaction times on the switch and repeat trials in the emotion and gender task. Error bars correspond to the average standard error.

## Trial, Task, Experiment, and Race

There was a significant higher order interaction between trial, task, experiment, and race $F$ (1, 60) =4.18, $MSE$= 5443.16, $p$< 0.05, ηp2=.06. This interaction was further analysed by separate repeated measures ANOVAs for both experiments with the factors being trial (*switch vs. repeat*; within subject) and race (*Asian* vs. *British*; between subjects) and another separate repeated measures ANOVA for both experiments with factors task (*emotion* vs. *gender*; within subject) and race (*Asian* vs. *British*; between subjects). These data are depicted in figures 4.3 and 4.4. **For experiment 1** (high saliency emotion), there was significant interaction between trial and race $F$ (1, 30) =7.22, $MSE$= 4714.33, $p$< 0.05, ηp2=0.19. British participants were slower than Asian participants on the **switch trials** $t$ (15) =2.38, $p$< 0.05, in contrast, there was no difference between the participants on the repeat trials $t$ <2. The switch cost (RT switch minus repeat trials) for the British participants were larger than the Asian participants $t$ (15) = 4.41, $p$< 0.01 (319 *vs.* 227 ms respectively). **For experiment 2** (low saliency emotion), there was no interaction between trial and race {$F$ (1,

30)=0.95, *MSE*= 4494.36, *p*=0.33, ηp2=.03}. **For experiment 1** (high saliency emotion), there was significant interaction between task and race *F* (1, 30) =17.99, *MSE*= 6434.53, *p*< 0.01, ηp2=0.37. Asian participants responded faster to emotion than to gender *t* (15) = 5.75, *p*< 0.001, in contrast, British participants responded similarly to both emotion and gender *t* <2. **For experiment 2** (low saliency emotion), again there was significant interaction between task and race *F* (1, 30) =22.41, *MSE*= 3712.52, *p*< 0.01, ηp2=0.42, Asian participants judged emotion faster than gender *t* (15) =4.25, *p*< 0.01, while the British participants showed the opposite pattern (gender < emotion, *t* (15) =2.94, *p*<0.05. The pattern of the interaction was similar across the different levels of saliency of the emotional stimuli (experiment 1 & 2). Asian participants were faster on the emotion task than the gender task. British participants tended to show the opposite result, particularly when the emotion was less salient.

For both tasks, separate repeated measures ANOVAs with factors trial (switch vs. repeat; within subjects), race (Asian vs. British), and experiment (salient vs. non salient) as between subjects were performed. **For emotion task**, there was a significant interaction between trial and race *F* (1, 60) =8.19, *MSE*= 61556.81, *p*< 0.01, ηp2=0.12, Asians showed smaller switch cost than the British [*t* (31) =2.22, *p*< 0.05, *M*= 292 vs. 362 ms respectively]. Asians were faster on switch trials than the British participants [*t* (31) =5.0, *p*< 0.001, *M*= 947 vs. 1126 ms respectively]. Again, on the repeat trials Asians performed faster than the British participants [*t* (31) =2.88, *p*< 0.01, *M*= 672 vs. 763 ms respectively]. **For gender task**, there was a significant higher order interaction between trial, race, and experiment *F* (1, 60) =4.88, *MSE*= 36013.85, *p*< 0.05, ηp2=0.7. For experiment 1 (high saliency emotion), the interaction between race and trial was significant *F* (1, 30) =5.41, *MSE*= 44255.28, *p*< 0.05, ηp2=0.15, Asians showed smaller switch cost than the British [*t* (15) =2.20, *p*< 0.05, *M*= 190 vs. 287

ms respectively]. In contrast, for experiment 2 (low saliency emotion), the interaction between race and trial failed to reach significance level $F$ (1, 30) =0.51, $MSE$= 3365.20, $p$< 0.47, ηp2=0.1.

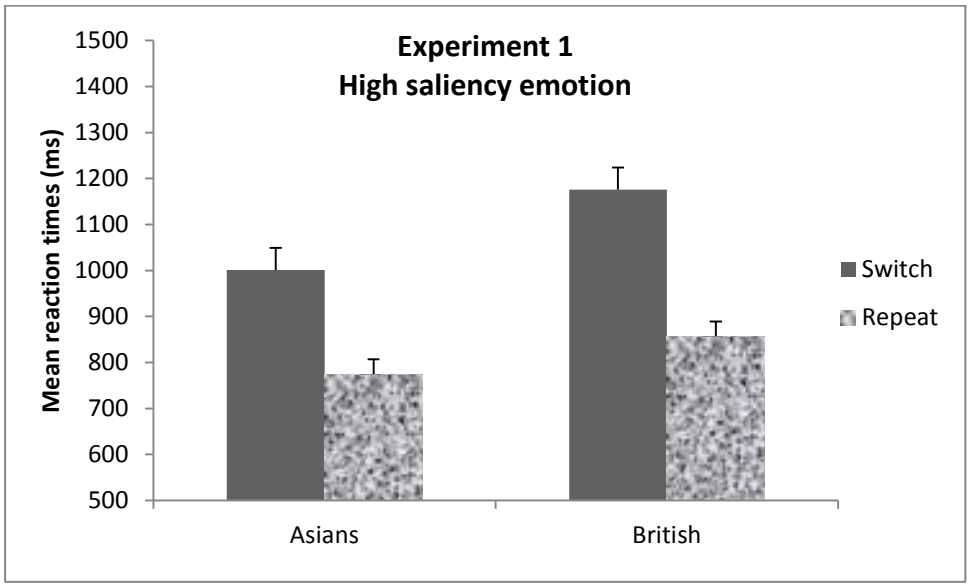


**Fig. 4.3a**. Mean reaction times of Asian and British participants on the switch and repeat trials in experiment 1 (high saliency emotion). Error bars correspond to the average standard error.

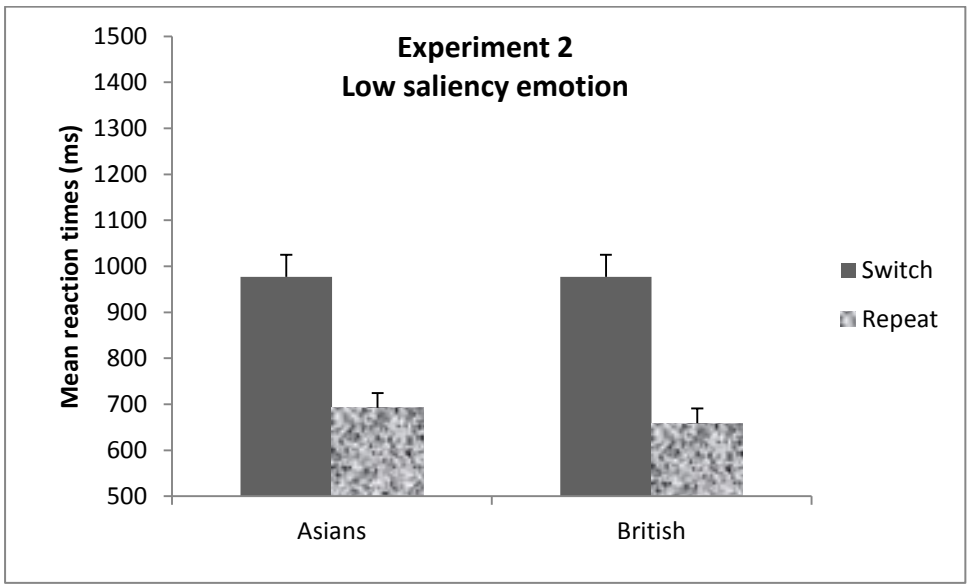


**Fig. 4.3b**. Mean reaction times of Asian and British participants on the switch and repeat trials in experiment 2 (low saliency emotion). Error bars correspond to the average standard error.

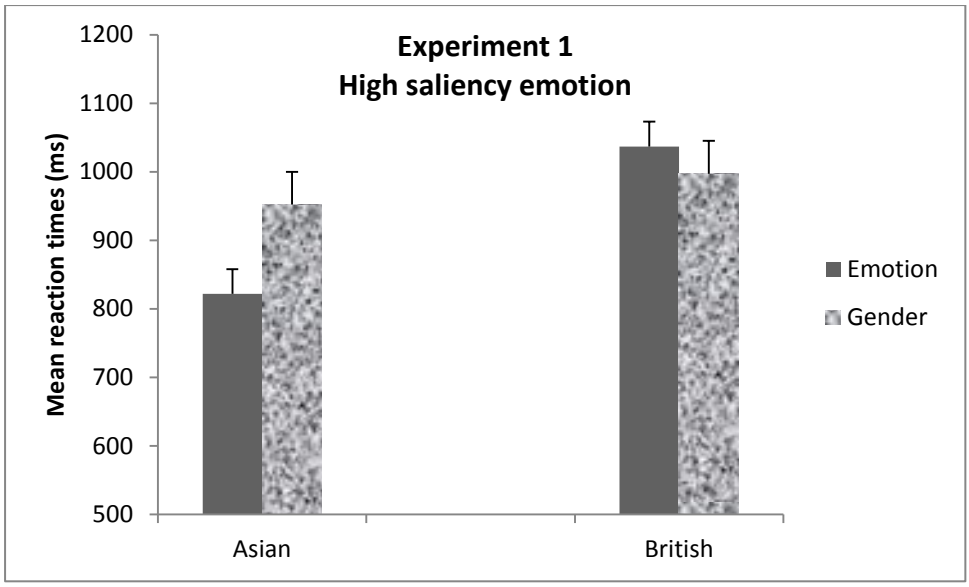


**Fig. 4.4a**. Mean reaction times of Asian and British participants in the emotion and gender task in experiment 1 (high saliency emotion). Error bars correspond to the average standard error.

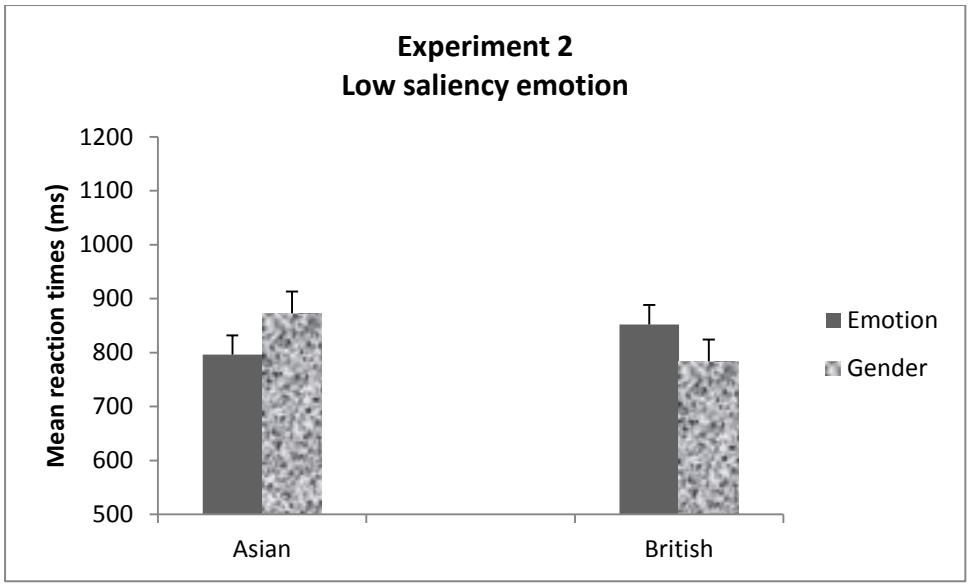


**Fig. 4.4b.**.Mean reaction times of Asian and British participants in the emotion and gender task in experiment 2 (low saliency emotion). Error bars correspond to the average standard error.

The error rate was low and there was no evidence of speed-accuracy trade-off. The results are presented in table 4.1.

**Table 4.1**

***Error rate (%) and standard deviation (SD) for the switch and repeat trials in experiment 1 (high saliency emotion) and 2 (low saliency emotion)***

| | **Emotion** | | **Gender** | |
|---|---|---|---|---|
| | Switch | Repeat | Switch | Repeat |
| Race | % (*SD*) | % (*SD*) | % (*SD*) | % (*SD*) |
| **Experiment 1** | | | | |
| Asians | 5.00 (.02) | 2.15 (.03) | 5.11 (.05) | 4.00 (.05) |
| British | 2.10 (.02) | 3.00 (.03) | 5.00 (.04) | 4.20 (.05) |
| **Experiment 2** | | | | |
| Asians | 2.12 (.02) | 4.00 (.02) | 5.12 (.05) | 4. 25(.02) |
| British | 5.00 (.05) | 3.15 (.03) | 5.00 (.05) | 5.00 (.04) |

### 4.2.3. Discussion

I have reported two experiments examining the effect of emotional salience and face classification task switching for Western and South-Asian-Pakistani participants. There were several important results – most notably there was a difference in responding on the emotion and gender decision tasks for White British and South Asian participants. White British participants showed faster RTs in the gender than the emotion task. In contrast, South Asian participants were faster to respond to emotion than to gender. These results broadly held across variations in the saliency of the emotional cue in the face, and they held across different task switching conditions.

One account of these results is that Western individuals place high attentional weight on gender, and so are faster at gender classification relative to emotion judgments. The South Asian participants were slow at gender classification. This result does not fit with the idea that South Asian participants put a high weight on facial gender, since we might then expect gender classification to be faster and difficult to disengage from a task. In contrast it appears that some Asian participants may tend to be biased against gender classification making them slow to make gender classification responses on both switch and non-switch trials. That is, the effect may best be conceptualized as the South Asian participants setting a high threshold for gender classification. One reason for this might be that Asians rely more on contextual information when making face classification responses, due to a general bias in using contextual cues (see the Introduction). This dependence on context may be particularly strong for gender classification if Muslim participants (as tested here) strongly weight external signs when making gender classifications (e.g., taking into account the style of clothing). The absence of these external cues here might disrupt the ability of such participants to make gender classification responses to faces. This should be tested in further studies when responses to individuals wearing their usual dress. Another reason is the differential proportion of male and female participants in the present sample with the data over represented male subjects (62.5%) in the Asian group in contrast with same percentage of female participants among the British group. Future research is to assess not only cultural differences in emotion and gender classification but also gender differences.

White British and South Asian/Pakistani participants also differed in that the British participants were slower on switch trials and showed larger switch cost than the Asian participants, however, there was no difference on repeat trials between these subject groups. This result suggest that none of the participant groups were more driven by bottom-up

repetition of the features of the task rather this result fits with a recent finding that bilingualism increases attentional capacity (Hernandez, Costa, & Humphreys, 2011), which may facilitate task switching. Note that the South Asian/Pakistani participants might have benefitted from being bilinguals.

Alongside the differences between the two racial/cultural groups there were overall differences between the task switching effects in the emotion and gender tasks, with the switching effect greater for emotion decisions. This was not due to a delay on switching trials, however, but rather to the speeding of emotion responses on repeat trials. I propose that this result reflects priming of an emotion response system, which leads to faster emotion responding when emotion judgments are repeated across trials. There is considerable physiological and neuropsychological evidence that facial emotion can be processed independently of other forms of information about the face (including facial identity and gender, for example, patients following brain injury can discriminate emotion but not face identity or gender; see e.g., Humphreys, Donnelly, & Riddoch, 1993; Parry, Young, Saul, & Moss, 1991; Young et al., 1993) and there is evidence for amygdala activation by emotional expressions of faces from neurophysiological and functional brain imaging studies (Vuillemier, Armony, Driver, & Dolan, 2003; George et al., 1993; Sergent, Ohta, MacDonald, & Zuck, 1994; Hasselmo, Rolls, & Baylis, 1989; see Haxby, Hoffman, & Gobbini, 2000, for a review). This suggests that emotional information may be processed through specialised sub-cortical routes through the amygdala, by-passing the cortical processes involved in identity and gender coding. It may be that this specialized neural system for processing emotions can be primed across trials. In contrast, gender decisions may require more detailed structural processing not involving a specialised ‘module’. As a consequence, it may be less easy to selectively prime gender decisions across trials.

However, in other studies I found a contrasting pattern of switching effect - either with no asymmetry of switch cost between emotion and gender (chapter 3) or larger switch cost for gender than emotion (chapter 5). One prior experiment has been conducted explicitly comparing two of the tasks used here, gender and emotion classification to faces. Reimers and Maylor (2005) found that the emotion classification was performed faster than the gender classification under baseline conditions and the switch costs were larger for emotion than the gender classification.

### 4.3. General Discussion

In this study, I examined the relative ease of switching between emotion and gender decision tasks in participants with contrasting racial/cultural groups. Three main results are apparent. First, Asian participants were faster in making decisions to emotions than the gender of face. This advantage was present regardless whether the task required decisions to salient (pronounced smile) or less salient emotions. Second, White British participants were slower than Asian participants on switch trials. Third, the switch cost for the emotion task was larger than the gender task.

#### 4.3.1. Cultural differences in face categorization

Substantial research has documented performance differences when people from contrasting cultures are asked to categorize emotions of the faces (see e.g., Matsumoto & Ekman, 1989; Matsumoto, 1992; Biehl et al., 1997) - One common notion is that cultures differ in display rules of emotions imposed by the societies (Ekman & Friesen, 1969; Mesquita & Frijda, 1992) - for example, East Asian societies are well-known for the norm to inhibit emotion expression. Alongside this, cultural groups differ in the visual cues used to categorize face gender. In Asian (and particularly Muslim culture), the norm is to conceal female face and gender is usually signaled by a dress code whereas in Western culture

female faces are categorized by different external cues (e.g., make- up). The results showed that White British participants were quicker in responding to gender than emotion, in contrast South Asian participants were faster to respond to emotion than to gender. This advantage may reflect differential attentional weight given to these face dimensions in Western and Asian cultures. Note though that the differences were found with data averaged across White and Asian faces, so the results do not reflect own-race differences in face processing rather reflect cultural differences. Face processing is known to be highly configural among Asians compared to Westerner participants (Miyamoto, Yoshikawa, & Kitayama, 2011). The absence of external cues (i.e., head scarf/ clothing style) here might have slowed the gender categorization among the Asian subjects.

Another aspect of this study was to explore switching effects in people from contrasting cultures. Given that there is differential attentional weight to contrasting dimensions of faces in different cultures, I expected performance differences between cultural groups. The results showed that White British participants were slower than Asians on switch trials, however there was no difference between the cultural groups on repeat trials. In addition, there was a larger switch cost for the British than the Asian participants. These results make clear that neither of these cultural groups is driven by bottom-up repetition of the features of the tasks rather suggest a difference in attentional control on the trials when the task changes. Note that the South Asian/Pakistani participants might have benefitted from being bilinguals. This result fits with the finding that bilingualism increases attentional capacity (Hernandez, Costa, & Humphreys, 2011), which may facilitate task switching.

### 4.3.2. Switching effects for face categorization

There is much evidence from neuropsychological studies suggest that emotion and gender categorizations rely on contrasting processes (e.g., Humphreys, Donnelly, & Riddoch, 1993; Parry, Young, Saul, & Moss, 1991). For example, emotion categorization involves the occipital to superior temporal stream with an involvement of the amygdala, while gender categorizations engage occipital to inferotemporal stream with active involvement of anterior temporal regions (Haxby, Hoffman, & Gobbini, 2000). The results here showed greater switch costs for the emotion than the gender decision task, but primarily due to faster responding when the emotion task was repeated. This result may reflect priming of an emotion response system, which leads to faster emotion responding when emotion judgments are repeated across trials. In contrast, gender responding may be less moderated by priming suggesting no hard-wired gender response system. Happy emotions are associated with human survival and well-being (e.g., Gottshalk, 1995; Fredrickson, 2000) and they can be capable of sustaining activation even without rehearsal (Anderson, 1983). Happy emotions also have an intrinsic motivation function which serves as a source of perceptual readiness (Bruner, 1957), I suggest that emotional facial attributes are more motivational and hence facilitate performance in an emotion-classification task compared with other tasks performed on faces (e.g., gender classification). Also the activation of a strong motivational goal can inhibit the accessibility of other goals, slowing switching responses (see Foster, Liberman, and Higgins, 2005).

### 4.3.3. Conclusion

I conclude that the difference in speed of emotion and gender classification between British and Asian subject groups reflect differential attentional weight placed on these face

dimensions in Western and Asian cultures. However, faster speed of switching in Asians relative to British subjects may be related to bilingualism. In addition, asymmetric switch costs between emotion and gender categorizations of faces represent priming of a response system related to emotion only.

# CHAPTER 5

# EXPLICIT AND IMPLICIT TASK SWITCHING BETWEEN FACIAL ATTRIBUTES


## Abstract

In chapter 5, I adopt a different task switching procedure to experiments 1-3, where face processing tasks are switched across consecutive pairs of trials, and, alongside this, there are changes to irrelevant aspects of the faces (e.g., whether the same emotion is maintained when gender and occupation decisions are made). The results demonstrate disruptive effects of changing the facial emotion of gender on other face decisions, but not of changing the occupation of the person. The data are consistent with the implicit processing of facial emotion and gender but not of higher-order semantic aspects of faces (the person's occupation) unless those aspects are task-relevant.

An observer perceives several attributes while looking at a face – its gender, the emotion being conveyed, perhaps the trustworthiness of the person or their identity. Some of these attributes may be extracted explicitly according to the demands of a particular task (e.g., retrieving information about the occupation of an individual), whilst others may be extracted implicitly, even when irrelevant to the task at hand. Whether our ability to compute these different attributes depends on the same or different processes is a question that has been of considerable interest for cognitive science. The present study aimed to examine this issue by assessing the ability of participants to switch from one attribute to another as they explicitly performed particular face processing tasks, and also by assessing effects of switching an irrelevant face attribute across trials as people perform tasks. Task switching may be easier to the extent that task share common processes (Schneider & Logan, 2010). There may also be some variables that exert an effect on switching even when they are irrelevant to the task, but which may or may not switch across trials. Here I examined whether changing or maintaining the emotional state of a face across trials affected the ability to switch between judgments of gender and occupation, made to faces. If emotion is extracted implicitly, then switches in emotion across trials may affect performance – for example, it may be disruptive when the primary task (e.g., gender discrimination) is maintained across trials and beneficial if the change in the emotional state of the face coincides with a change in the primary attribute driving performance (e.g., from gender to occupation).

### 5.1. Functional independence of facial attributes

Bruce and Young (1986) presented an influential cognitive model of face processing based on the assumption that face processing involved several functionally independent processing modules. The model assumed that identification of a familiar face involves the formation of

a view independent structural description, which could be compared with all known faces stored in Face Recognition Units (FRUs), followed by identification of particular person and retrieval of semantic information, after which there is activation of the phonological codes underlying the person's name.

Alongside the processes that lead to face identification and the retrieval of semantic and name information, Bruce and Young posited the operation of other processes that extract (e.g.) facial emotion. Hence the model suggests that face recognition (e.g., judged by access to semantic information about a person) is distinct from processing facial emotion. Quite how facial gender is computed is less clear – it could be retrieved by recognizing the person, or it could be computed from the structural properties of the faces.

### 5.2. Asymmetric interference between facial features

Studies have employed speeded judgments to different dimensions of faces and shown that interference can arise when there is variation in some irrelevant attributes (so-called 'Garner interference'). For example, Atkinson, Tipples, Burt and Young (2005, Experiment 1) demonstrated that gender did interfere with the emotion judgments to a face (*happy* vs. *fearful*), but the reverse pattern of interference did not occur (when the task was gender classification (*male* vs. *female*). The same results were found using morphed faces in a speeded classification task (Schweinberger, Burton, & Kelly, 1999). These asymmetries between the processing of facial attributes indicate that observers, generally, are capable of responding to some aspects of a face (such as its gender) while ignoring the emotion of that face, but emotion processing can be interfered with by variation in other facial attributes (Schweinberger & Soukup, 1998).

Another way to examine the relations between the processing of different facial attributes is to evaluate the effects of switching from one task to another – if tasks use overlapping processes, then the effects of task switching may be reduced. In addition, the implicit processing of face attributes can be assessed by measuring effects of changing this attribute on performance of the (other) explicit tasks. If the attribute is processed implicitly, then it may affect performance on the explicit tasks when the implicit attribute changes (especially if the change in the implicit attribute coincides with the main task being maintained or changing). Here I used this approach to examine the relations between processing the gender, occupation and emotion of faces. Unlike the experiments reported in chapters 2-4, the design of Rogers and Monsell (1995) was used, where tasks switched across pairs of trials rather than trial blocks. This enabled the implicit property to be changed or maintained in a dynamic fashion, coinciding with or contradicting the maintenance or change in the main, explicit task. Participants were asked to make gender and occupation decisions (experiment 1), gender and emotion decisions (experiment 2) and occupation and emotion decisions (experiment 3) to faces and the effect of switching from one explicit task to another was measured. In addition, the other attribute (emotion in experiment 1; occupation in experiment 2 and gender in experiment 3) was varied. Are there differences in task switching between different explicit tasks (across the experiments), and are there effects of switching or maintaining the implicit property? I report effects of changing facial emotion and gender as an implicit manipulation but not effects of changing occupation.

## 5.3. Experiment 1: gender and occupation decisions (implicit change in emotion)

### 5.3.1. Method

*Participants*

Sixteen postgraduate students from the University of Birmingham (9 female and 7 male, ages 21-25 years, mean 23.25 years) with normal colour vision, volunteered for the study in response to an advertisement. None had reported any injury, disease or eye surgery.

*Materials and displays*

*Gender-occupation task stimuli.* The stimuli were 16 faces in colour bitmap images (standardized to 300 × 300 pixels & matched subjectively for luminance and contrast) of 8 famous singers and actors which depicted happy and neutral facial emotional expression. Half of the images were of women. The 8 photos of singers comprised Robbie Williams, Paul McCartney, Britney Spears, Madonna, while 8 photos of actors included Daniel Radcliffe, Rowan Atkinson, Kate Winslet, and Elizabeth Taylor. These stimuli were embedded in Rogers and Monsell's (1995) alternating-run task switching paradigm. Pilot testing ensured that the famous faces were recognizable by the sample population, and efforts were made to equate the famous faces in terms of stimulus quality (e.g., resolution) as well as face angle, race (white), emotional expression (positive & neutral), and attractiveness. Half of the pictures portrayed happy expression (smiling-obvious teeth). The experiment was designed in E-prime software (Schneider, Eschman, & Zuccolotto, 2002, version 1.2). The faces were presented in the lower right/left quadrants as a cue for the occupation task while presented in upper right/left quadrants as a cue for the gender task. For half of the participants, the experiment started with the presentation of the gender task. For the other half, the occupation task was presented first. While half the faces were happy the

other half were presented with a neutral expression, so the emotion could change when the main task stayed the same or changed– creating a 2 (emotion switch or repeat) x 2 (main task switch or repeat) design. Each trial consisted of a fixation (+) displayed for 1000 ms, followed by a blank white screen, then the face appeared in upper/lower quadrants with a fixation cross (+) in the center of the screen. A manual response was made to the face. The stimuli were presented on a 14 inch laptop and remained on the screen until the response was made. Participants were presented with 241 trials experimental trials.

Procedure

The study received approval by University of Birmingham Ethic Research Committee. Upon arrival participants were given an informed consent form to review and sign. Upon consent, they were given a description of the procedure. Next, s/he was seated before the laptop at a comfortable viewing distance (approximately 60 cm). Participants were told that this was a reaction time experiment, and that they must respond by pressing the fixed keys on keyboard as quickly as possible without sacrificing accuracy. The stimuli and the tasks were then explained (gender-occupation). On each trial, participants were presented with a face and they were required to judge gender (male/female) or occupation (actor/singer) of the face in 241 experimental trials of the gender and occupation task. Following the experiment, the results were saved and participants were debriefed and thanked for their participation.

### 5.3.2. Results

RTs for the first trial were discarded because no task switch took place, then outliers were removed and response times (RTs) were excluded above 2.5 standard deviations from each participants' mean. Responses longer than 3,000 ms or shorter than 100 ms were omitted. The data are reported in two sections. First, the effect of explicit task switching was assessed

with the data for the gender and occupation tasks. Second, the effect of implicit emotion switch was examined with the data averaged across gender and the occupation tasks on the switch and repeat trials.

**(a). Explicit task switching**

Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (*switch* vs. *repeat*) x task (*gender judgment* vs. *occupation judgment*) as within subject factors. The main effect of task switch was significant $F$ (1, 15) =33.00, $p$<0.001, $MSE$=13881.18, ηp2=.68. RTs were slower on switch ($M$=961.94 ms) than repeat ($M$=792.72 ms) trials. There was a reliable main effect of task $F$ (1, 15) =92.80, $p$<0.001, $MSE$=1385.76, ηp2=.86. The RTs were faster on the gender than the occupation task ($M$=832.50 vs. 922.16 ms respectively). There was a significant interaction between task switch and task $F$ (1, 15) =10.04, $p$<0.01, $MSE$=1178.68, ηp2=.40 (fig. 5.1). Pair wise comparisons revealed a significant difference in switch costs (switch – repeat trials) between the gender and occupation tasks $t$ (15) = 3.16, $p$<0.01. The switch cost was larger for the occupation than for the gender task.

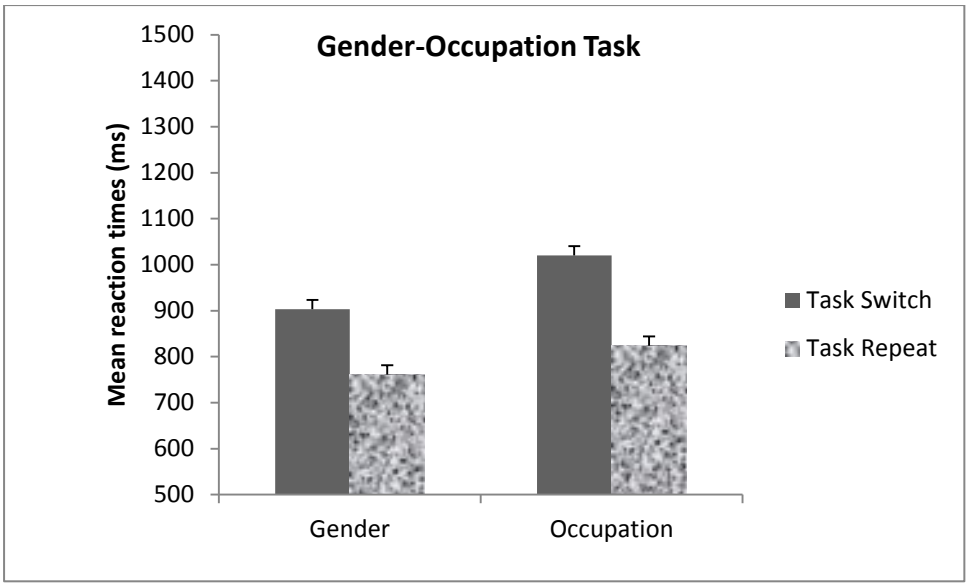


**Fig.5.1.** Mean reaction times (ms) on the switch and repeat trials for the gender and occupation task. Error bars correspond to the average standard error.

### (b). Effect of implicit emotion

Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (*switch* vs. *repeat*) x emotion switch (*emotion switch* vs. *emotion repeat*) as within subject factors. The main effect of task switch was significant $F$ (1, 15) =28.34, $p$<0.001, $MSE$=13433.04, ηp2=.65. RTs were slower on switch ($M$=954.41 ms) than repeat ($M$=800.15 ms) trials. The main effect of emotion switch was significant $F$ (1, 15) =42.51, $p$<0.001, $MSE$=4506.93, ηp2=.73. RTs were slower on emotion switch ($M$=931.99 ms) than repeat ($M$=822.57 ms) trials. There was significant interaction between emotion switch and task switch $F$ (1, 15) =13.84, $p$<0.001, $MSE$=1006.10, ηp2=.48 (fig.5.2). This was decomposed by analyzing the data separated for emotion switch and emotion repeat trials, for the task switch and task repeat conditions. For the **task switch condition,** there was a significant effect of emotion switch $F$ (1, 15) =46.73, $p$<0.001, $MSE$=3304.14, ηp2=.75. RTs on emotion switch trials were slower than emotion repeat trials $t$ (15) = 6.83, $p$<0.001. For

the **task repeat condition,** there was also significant effect of emotion $F$ (1, 15) =23.13, $p$<0.001, $MSE$=2208.89, ηp2=.60. RTs on emotion switch trials were slower than emotion repeat trials $t$ (15) = 4.81, $p$<0.001. The interaction arose because the effect of switching the emotion of the face was larger on trials where there was a switch in the explicit task than on trials here the explicit task remained the same (see fig. 5.2).

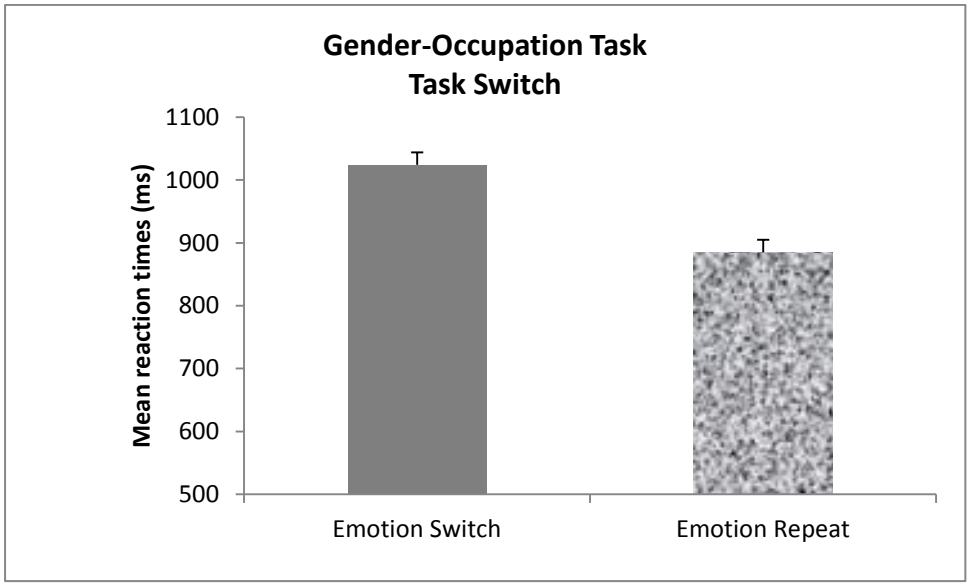


**Fig.5.2a**. Mean reaction times (ms) for the emotion switch and emotion repeat trials in the task switch condition. Error bars correspond to the average standard error.

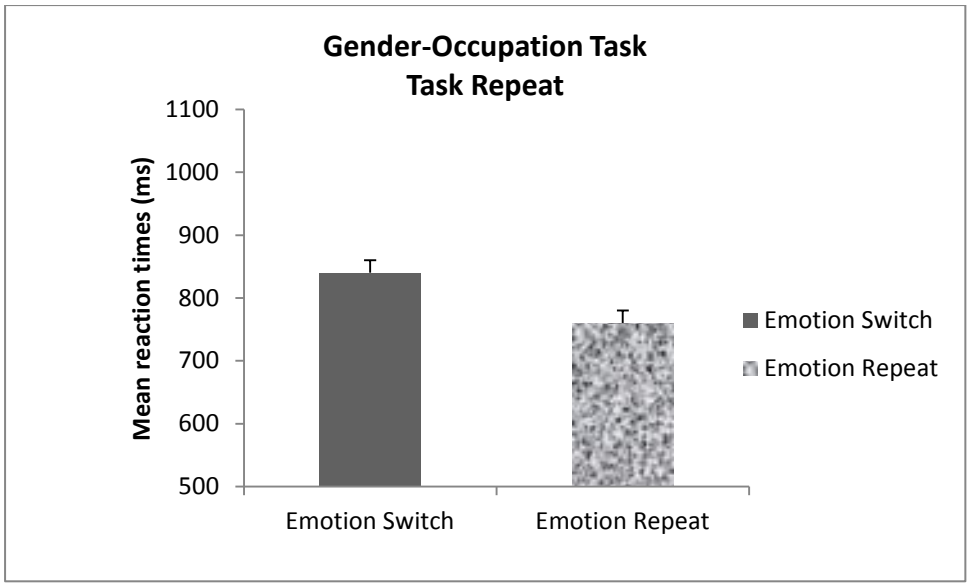


**Fig.5.2b**. Mean reaction times (ms) for the emotion switch and emotion repeat trials in the task repeat condition. Error bars correspond to the average standard error.

The error rate was low and there was no evidence of speed-accuracy trade-off. The results are presented in table 5.1.

**Table 5.1a**

*Mean error rate (standard deviation) for the explicit task switch in the gender and occupation task*

| **Gender** | | **Occupation** | |
|---|---|---|---|
| **Switch** | **Repeat** | **Switch** | **Repeat** |
| *M (*SD) | *M (*SD) | *M (*SD) | *M (*SD) |
| 2 (.02) | 1 (.02) | 2 (.02) | 2 (.01) |

**Table 5.1b**

*Mean error rate (standard deviation) for the effect of implicit emotion switch in the gender and occupation task*

| **Emotion Switch** | **Emotion Repeat** |
|---|---|
| *M (*SD) | *M (*SD) |
| 2 (.02) | 1.5 (.01) |

### 5.3.3. Discussion

The study showed that the occupation decision task showed larger effects of task switching than the gender decision task. The same result was found in an earlier study with occupation and gender blocked presentation (chapter 3 - experiment 3). This asymmetrical task switching effect cannot be attributed to selective inhibition of the easier task here, to enable switching to take place (see Allport & Wylie, 1999, for experiments on task switching with Stroop stimuli). An alternative account is that it was less easy for participants to disengage attention from the gender than the occupation task, and this slowed switches to occupation decisions.

In addition to this, the experiment showed clear effects of repeating or switching the emotional state of the faces. RTs were faster if facial emotion stayed the same than if it changed. Interestingly, this effect of changing the emotional state was larger on switch than repeat trials in the explicit task. It may be that, when the explicit task switches, participants are distracted from the explicit switch by the change in the (implicit) emotional state of the face, and this slows performance on the explicit switch trial. Whatever the case, the data indicate that facial emotion was processed, even though it was irrelevant to the main tasks.

## 5.4. Experiment 2: gender and emotion decisions (implicit change in occupation)

### 5.4.1. Method

*Participants*

Sixteen postgraduate students from University of Birmingham (10 female and 6 male, ages 20-25 years, mean 22.81 years) with normal colour vision, volunteered for the study in response to the advertisement. None had reported any injury, disease or eye surgery.

*Materials and displays*

*Emotion-gender task stimuli.* The stimuli and displays were same as in experiment 1 except that the faces were presented in the lower right/left quadrants as a cue for the emotion task while they were presented in the upper right/left quadrants as a cue for the gender task. For half of the participants, the experiment started with the presentation of emotion task. This was counterbalanced across participants. The occupation of the individuals could be repeated or switched across trials, and this created a 2 x 2 design where the explicit tasks either repeated or switched while there was either a repeat or switch of the implicit task (occupation).

Procedure

The procedure was the same as in experiment 1 except that the stimuli and the tasks were explained as emotion-gender. On each trial, participants were presented with a face and they were required to judge the emotion (happy/neutral) or gender (male/female) of the face in 241 experimental trials of the emotion and gender task. Following the experiment, the results were saved and participants were debriefed and thanked for their participation.

### 5.4.2. Results

As for the experiment 1, the data are reported in two sections. First, the effect of explicit task switching was assessed with the data for the emotion and gender tasks (relevant features) on the switch and repeat trials separately. Second, the effect of implicit occupation switches on the task switch and task repeat conditions was examined with the data averaged across the emotion and the gender tasks.

RTs for the first trial were discarded because no task switch took place for the first trial, then outliers were removed and response times (RTs) were excluded above 2.5 standard deviations from each participants' mean. Responses longer than 3,000 ms or shorter than 100 ms were omitted.

#### (a). Explicit task switching

Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (*switch* vs. *repeat*) x task (*emotion judgment* vs. *gender judgment*) as within subject factors. The main effect of task switch was significant $F$ (1, 15) =153.05, $p$<0.001, $MSE$=17105.91, ηp2=.91. RTs were slower on switch ($M$=1179.12 ms) than repeat ($M$=774.60 ms) trials. There was a reliable main effect of the task $F$ (1, 15) =73.11, $p$<0.001, $MSE$=3868.73, ηp2=.83. RTs were faster on the emotion than the gender task ($M$=910.37 vs. 1043.34 ms respectively). There was a significant interaction between task switch and task $F$ (1, 15) =49.81, $p$<0.001, $MSE$=2967.78, ηp2=.76. Pair wise comparison on the switch cost (switch minus repeat trials) between the emotion and the gender task was significant $t$ (15) =7.05, $p$<.001. The switch cost for the gender task was larger than for the emotion task (fig.5.3).

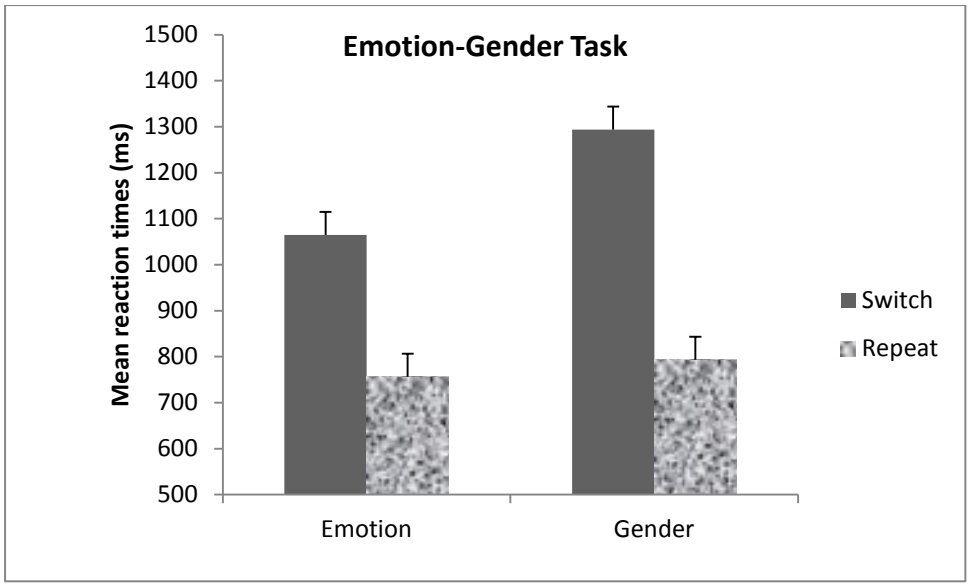


**Fig. 5.3.** Mean reaction times (ms) on Switch and repeat trials for the emotion and gender task. Error bars correspond to the average standard error.

### (b). Effect of implicit occupation switch

Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (*switch* vs. *repeat*) x occupation switch (*occupation switch* vs. *occupation repeat*) as within subject factors. The main effect of task switch was significant $F$ (1, 15) =140.59, $p$<0.001, $MSE$=17980.83, ηp2=.90. RTs were slower on switch ($M$=1179.12 ms) than repeat ($M$=774.60 ms) trials. There was no effect of occupation switch $F$ <1. The interaction between task switch and occupation switch was significant $F$ (1, 15) =4.71, $p$<0.05, $MSE$=629.31, ηp2=.23 (fig.5.4). There was a small cross over result in which responses on explicit task switch trials were slower when the occupation of the faces changed than when they stayed the same, while when the explicit task repeated, RTs tended to be faster when the occupations of the faces switched (see fig. 5.4). However the effects of switching the occupations of the faces were not reliable, either for trials where the explicit task stayed the same and when it switched ($t$ <2).

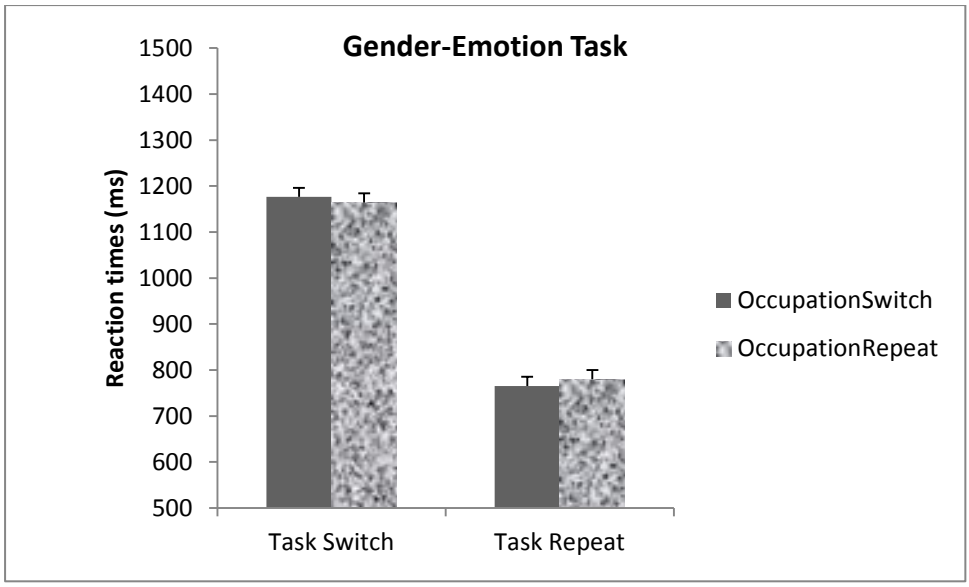


**Fig. 5.4**. Mean reaction times (ms) on the task switch and task repeat trials for the occupation switch and occupation repeat trials. Error bars correspond to the average standard error.

The error rate was low and there was no evidence of speed-accuracy trade-off. The results are presented in table 5.2.

**Table 5.2a**

*Mean error rate (standard deviation) for the explicit task switch in the emotion and gender task*

| **Emotion** | | **Gender** | |
|---|---|---|---|
| **Switch** | **Repeat** | **Switch** | **Repeat** |
| *M (*SD) | *M (*SD) | *M (*SD) | *M (*SD) |
| 3 (.02) | 2 (.02) | 2 (.02) | 3 (.01) |

**Table 5.2b**

*Mean error rate (standard deviation) for the effect of implicit occupation switch in the emotion and gender task*

| **Occupation Switch** | **Occupation Repeat** |
|---|---|
| *M (*SD) | *M (*SD) |
| 2.5 (.02) | 2.5 (.01) |

**5.4.3. Discussion**

As in experiment 1, there were again asymmetrical effects of task switching in the primary (explicit tasks), with task switch effects now being larger on the gender than the emotion decision tasks. Indeed the effects of task switching on the gender task were reliably greater here than in experiment 1 ($t$ (30) =6.90, $p$<.001). Again this result does not reflect inhibition of the easier task, since the emotion decisions were faster than the gender decisions on repeat trials. Rather the results can be attributed to the difficulty in switching attention from face emotion to compute gender, slowing gender decisions on switch trials.

In contrast to experiment 1, there were very weak effects of switching another aspect of the faces – the occupations performed by the actors. There was no main effect of implicit task switch, and though there was a borderline interaction between implicit and explicit task switching, the differences between repeat and switch occupation trials were not reliable for either the repeat or the switch trials in the explicit task. The data suggest only weak computation of an individual's occupation when this is not the explicit task that must be performed.

## 5.5. Experiment 3: occupation and emotion decisions (implicit change in gender)

### 5.5.1. Method

*Participants*

Sixteen postgraduate students from University of Birmingham (6 female and 10 male, ages 21-25 years, mean 22.62 years) with normal colour vision, volunteered for the study in response to the advertisement. None had reported any injury, disease or eye surgery.

*Materials and displays*

*Emotion-Occupation Task stimuli.* The stimuli and displays were same as in experiment 1, except that the faces were presented in lower right/left quadrants as a cue for the emotion task while presented in upper right/left quadrants as a cue for the occupation task. For half of the participants, experiment started with the presentation of the emotion task. This was counterbalanced across participants, as the other half of participants performed occupation task first.

Procedure

The procedure was the same as in experiment 1, except that the stimuli and the tasks were explained as emotion and occupation decisions. On each trial, participants were presented with a face and they were required to judge the emotion (happy/neutral) or occupation (singer/actor) of the face in 241 experimental trials of the emotion and occupation task. Following the experiment, the results were saved and participants were debriefed and thanked for their participation.

### 5.5.2. Results

As for experiment 1, the data are reported in three sections. First, the effect of explicit task switching was assessed with the data for the emotion and occupation tasks (relevant features of the task) on switch and repeat trials separately. Second, the effect of an implicit gender switch was examined with the data averaged across the emotion and occupation task on switch and repeat trials. RTs for the first trial were discarded because no task switch took place for the first trial, then outliers were removed and response times (RTs) were excluded above 2.5 standard deviations from each participant's mean. Responses longer than 3,000 ms or shorter than 100 ms were omitted.

#### (a). Explicit task switching

Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (*switch* vs. *repeat*) x task (*emotion judgment* vs. *occupation judgment*) as within subject factors. The main effect of task switch was significant $F$ (1, 15) =204.06, $p$<0.001, $MSE$=6515.87, ηp2=.93. RTs were slower on switch ($M$=1275.37 ms) than repeat ($M$=967.42 ms) trials. There was a reliable main effect of task $F$ (1, 15) =151.29, $p$<0.001, $MSE$=4439.44, ηp2=.91. RTs for the emotion task were faster than for the occupation task (1008.80 vs. 1205.69 ms, respectively). There was a significant interaction between task switch and task (1, 15) =37.85, $p$<0.001, $MSE$=4381.40, ηp2=.71 (fig.5.5). The task switch cost (switch minus repeat) was larger for the occupation than the emotion task $t$ (15) =6.15, $p$<0.001.

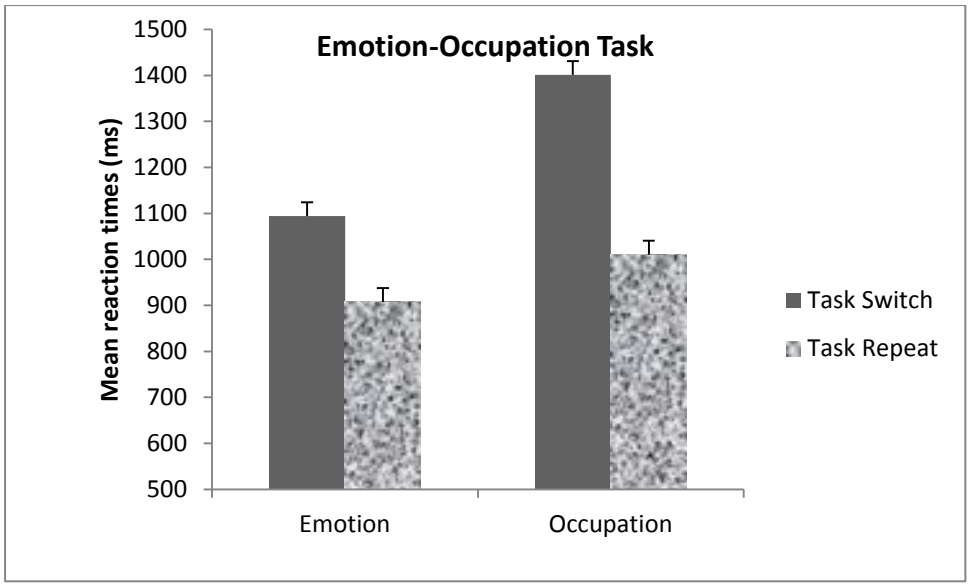


**Fig. 5.5**. Mean reaction times (ms) on the task switch and task repeat trials for the emotion and occupation task. Error bars correspond to the average standard error.

### (b). Effect of implicit gender

Mean RTs were submitted to a repeated measures analysis of variance (ANOVA) with task switch (*switch* vs. *repeat*) x gender switch (*gender switch* vs. *gender repeat*) as within subject factors. The main effect of task switch was significant $F$ (1, 15) =419.31, $p$<0.001, $MSE$=3618.39, ηp2=.96. RTs were slower on switch ($M$=1275.37 ms) than repeat ($M$=967.42 ms) trials. There was significant main effect of gender switch $F$ (1, 15) =64.04, $p$<0.001, $MSE$=4143.26, ηp2=.81. RTs on gender switch trials were slower compared to gender repeat trials (1185.79 vs. 1057.01 ms, respectively). There was no interaction between task switch and gender switch $F$<3 (fig. 5.6).

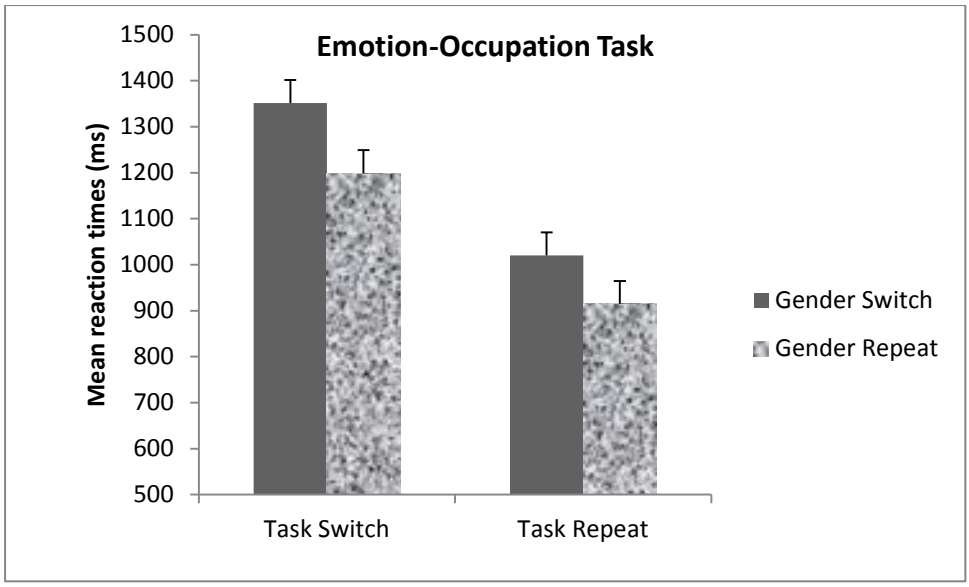


**Fig.5.6**. Mean reaction times (ms) on the task switch and task repeat trials for the gender switch and gender repeat trials. Error bars correspond to the average standard error.

The error rate was low and there was no evidence of speed-accuracy trade-off. The results are presented in table 5.3.

**Table 5.3a**

*Mean error rate (standard deviation) for the explicit task switch in the emotion and occupation task*

| **Emotion** | | **Occupation** | |
|---|---|---|---|
| **Switch** | **Repeat** | **Switch** | **Repeat** |
| *M (*SD) | *M (*SD) | *M (*SD) | *M (*SD) |
| 2 (.02) | 1 (.02) | 2 (.02) | 3 (.01) |

**Table 5.3b**

*Mean error rate (standard deviation) for the effect of implicit gender switch in the emotion and occupation task*

| **Gender Switch** | **Gender Repeat** |
|---|---|
| *M (*SD) | *M (*SD) |
| 2 (.02) | 2 (.01) |

### 5.5.3. Discussion

The effects of switching explicit tasks mirrored those found in experiment 2. There was an asymmetry in switch costs with the effects on occupation decisions being larger than those on emotion decisions. As emotion decisions were also faster than occupation decisions on repeat trials, the data cannot be attributed to inhibition of the easier task when switch costs would be larger on emotion decisions). However the results fit with the argument that facial emotion is difficult to disengage from, and hence switch costs are increased to the non-emotion task. Indeed, as for the effects of switching to the ender task in experiment 2, there were increased effects of task switching on occupation decisions ($t$ (30) =5.30, $p$<0.001) here relative to experiment 1 (when occupation decisions were paired with gender decisions). It should be noted here that switch costs changed as a function of the other explicit task it was paired with (i.e., larger when paired with gender decisions ($t$ (30) =2.93, $p$<0.01) than when the emotion decisions were paired with occupation decisions.

Unlike the changes in the occupations of the faces, which had minimal effect when occupation decision was not the main task, changing the gender of the faces did affect performance here. RTs were slowed when faces changed gender than when the gender

stayed the same, even though the gender of the individuals was irrelevant to the task. The data indicate that there is implicit processing of the gender of the faces. It is interesting that this evidence for implicit processing of facial gender occurred here even though famous faces were used. Quinn, Mason, and Macrae (2009) reported that the gender of famous individuals was not automatically coded. These data contradict this assertion and suggest that implicit task switching effects may provide a particularly sensitive way to measure whether facial attributes are processed.

### 5.6. General discussion

This study provides clues from task switching for an asymmetric relationship between the processes underlying judgments of facial attributes. In experiment 1, gender was faster than the occupation task but the occupation task yielded larger switch costs. In experiment 2 emotion decisions were faster than gender decisions, but the gender task produced larger switch cost than the emotion task. In experiment 3, the emotion task, again was faster than the occupation task but the occupation task showed larger switch costs. These results counter the argument that asymmetric switch costs necessarily emerge because participants must inhibit the easier of two tasks to enable the harder task to be conducted. It is interesting that this result occurred here despite that fact that the stimuli (faces) were the same in all the tasks, and so the same stimulus could have cued the more automatic process, and this might need to be inhibited to enable performance to be effected. The failure to find larger switch costs on the easier tasks (gender in experiment 1 and emotion in experiments 2 and 3) suggests instead that the asymmetric switch costs may reflect the ease of disengaging attention from a more salient property of the stimulus (facial emotion or gender) compared

with a less salient property (occupation). If participants maintained attention on the more salient property, then large switch costs would emerge on the other task.

The switch effects in earlier chapters with blocked presentations are not same as those reported here in terms of the relative magnitudes of the effects across tasks. Has this something to do with blocked switch tasks (chapters 2-4) being sensitive to other factors? For example, in chapter 4, emotion decisions showed larger switch costs than gender decisions, but this was due to fast responding to emotion on repeat trials – suggesting that there was priming of emotion responding and this may be especially influential when I had blocked presentations and priming builds up across trials. Maybe priming plays a reduced role when there are more rapid switches across trials, when the ease of disengaging attention from one attribute becomes important – in which case emotion decisions show a smaller switch cost, as I found here.

As well as requiring participants to make explicit switches from one task to another, I also examined the effects of making an implicit switch, when an irrelevant attribute of the stimulus changed across trials (emotion, occupation and gender, in experiments 1-3 respectively). When emotion and gender changed, performance on the other tasks was affected. In experiment 1, changes in emotion affected both repeat and switch trials in the main tasks, with the effects on switching being stronger. To account for this, I suggest that participants found it difficult to select the appropriate aspects of the face to respond to – when both the emotional state of the face and the task changed. In experiment 3, effects of changing gender were also pronounced, but in this instance it affected performance equally in the repeat and switch trials of the main tasks. One reason why effects were less pronounced on switch trials in this case is that the switches involved facial emotion, which

might be a relatively strong cue either to switch tasks or to repeat the task, so that equal effects of changing facial gender occurred in both instances. In contrast to these effects, switching the occupation associated with the face had minimal effect of gender and emotion decisions.

These results fit with the idea that facial emotion and gender are computed in a relatively automatic way, even when they are irrelevant to the main task. Hence changing the facial emotion or gender slowed performance, perhaps by distracting attention from the main task(s). In contrast to this, there was little evidence that the occupations of people are computed in other face processing tasks.

Within accounts such as that of Bruce and Young (1986) these results can be accommodated if emotion and gender are computed by slave systems, separate from the face recognition system, with the slave systems operating automatically. In contrast, access to semantic information from faces (related to peoples' occupations), depends on attention to the relevant aspects of the face. The data indicate that there is implicit processing of the gender of the faces. It is interesting that this evidence for implicit processing of facial gender occurred here even though famous faces were used. Quinn, Mason and Macrae (2009) reported that famous faces were not classified automatically for gender. The data here contradict this assertion and suggest that implicit task switching effects may provide a particularly sensitive way to measure whether facial attributes are processed.

### 5.6.1. Conclusion

I have provided evidence from a task switching paradigm that:

(i) there are asymmetrical effects of switching between different judgments with face stimuli, and in particular it was difficult to switch from emotion judgments to make gender and occupation judgments. This is consistent with facial emotion being difficult to disengage from.

(ii) judgment of facial attributes can be significantly influenced by changes in the emotion and gender of faces even when emotion and gender are irrelevant to the task at hand. These data indicate that emotion and gender are processed automatically.

# CHAPTER 6

## GENERAL DISCUSSION

This chapter provides an integrative overview of the five main factors related to task switching which have been the focus of this thesis: (i) learning and switching, (ii) individual differences in switching, (iii) switch cost asymmetries, (iv) cultural factors and (ii) implicit processing of stimuli under conditions of task switching. The work provides answers to the following research questions: How does practice affect performance? What is the nature of individual differences and asymmetries in face categorization? Is it easier to switch attention to one facial feature rather than others? Does the ease of categorizing certain facial features vary across cultures? How is switching may be modulated by implicit coding of stimuli?

### 6.1. Learning and switching

The data reported in chapter 2 indicate that practice generally reduced switch costs. This replicates prior findings (e.g., Sohn & Anderson, 2001; Cepeda, Kramer, & Gonzalez de Sather, 2001), however, I did not find any evidence of larger switch costs for word reading than for colour naming. This does not match with previous findings by Allport, Styles, & Hsieh (1994). However, the experiments in chapter 2 used manual responses rather than a naming task. Standard asymmetrical Stroop interference effects are typically reduced under manual response conditions (e.g., Keele, 1972; Pritchatt, 1968), presumably because, unlike verbal responding, manual responding to words is not over learned when compared to manual responses to colours.

Most interestingly, Stroop congruency effects increased across trials under conditions where a small constant-set of incongruent colour-words were used. The effects emerged through increasing benefits to colour identification on congruent trials, while RTs on incongruent trials showed dual patterns: either they tended to increase or they remained constant. To account for these results, I suggest that there were two effects of practice on constant, incongruent colour words which traded-off against each other to reduce any overall changes on performance: there were overall beneficial effects of practice, pitted against increased interference as integrated colour-word representations developed (with a small set of words with constant colour-word relations). On the congruent trials, the word and colour carry no competition, therefore the congruence of stimulus properties makes a perceptual unit which is easy to retrieve from its' stored presentation in the visual system-facilitating the responses even more with the practice. The increased congruency effects were most apparent on colour identification trials, consistent with it being more difficult to focus attention on colour and to ignore word identity when the colour and the word are strongly integrated. This pattern of results was not found when specific pairings of colours and words were not used and words and colours were randomly re-paired across trials, indicating that the effects reflecting the learning of specific word-colour bindings.

The results in chapter 2 are consistent with prior evidence that Stroop interference is stronger for stimuli that form integrated representations, probably because integrated representations of stimuli makes it difficult to attend to the colour dimension relative to the word. Previously word-colour integration has been manipulated by varying the perceptual relations between the colour and the whole word (e.g., Besner, Stolz, & Boutilier, 1997). The current results add to this by showing that learning a specific word colour relation is also critical. This matches with prior findings that learning can modulate the binding between

stimulus attributes (e.g., Humphreys, Riddoch, & Fortt, 2006). The learning leads to facilitated responses to colours on congruent trials. On incongruent trials, I suggest that the potentially negative consequences of attending to a word strongly integrated with the colour was balanced by the benefits of overall practice. This meant that performance on incongruent trials did not vary across the blocks. It is also of interest that the results were strongest on colour identification relative to word identification, despite the fact that overall RT differences between the tasks were minimized by the use of manual responding. This indicates that there can remain a residual difference in the ease of attending to colour and to word identity, which is highlighted when the word and colour are strongly integrated. Attention to colour remains vulnerable to the effects of word identity even under manual response conditions.

### 6.2. Individual differences in task switching

Previous work (Salthouse et al., 1998) demonstrated that there are individual differences in the ability to switch between different tasks. In particular, the ease of switching from one task to another is modulated by intelligence (IQ) - faster 'switchers' have higher intelligence.

In chapter 3, I examined individual differences in switching between facial features and the relations not only between task switching and IQ but also the relations between switching and EI. EI and IQ are not synonymous. Though EI is related to crystallized IQ (see e.g., Farrelly & Austin, 2007; MacCann et al., 2004; Zeidner et al., 2005) it is more specifically related to skills in emotion perception – so that people high in EI tend to be better at perceiving emotional expressions from faces than those low in EI

In chapters 3, participants performed emotion, gender and occupation judgments and in chapter 4 participants performed emotion and gender judgments with a common set of

faces, with different pairings of tasks brought together in different experiments and participants required to switch between tasks after each block of 16 trials. Emotion classification responses were overall easier than the other tasks but there was no asymmetric switch costs when emotion was paired with the gender or occupation tasks in chapter 3, though the emotion task showed larger switch costs in chapter 4. Switching between tasks of unequal difficulty is often not symmetric and significant asymmetries have been observed in various tasks (e.g., Allport, Styles, Hsieh, 1994; Wang et al., 2007; Koch, Prinz, & Allport, 2005). Reimers & Maylor (2005) also reported asymmetries between emotion and gender classification tasks (i.e., larger switch costs for the emotion than the gender categorization task). The data reported by Reimers and Maylor are similar to those found in chapter 4 here. Reimers and Maylor did not separate out switch and repeat trials. In the present case, the larger switch costs for the emotion task arose because repeat trials became faster for the emotion task. It may be that emotion decisions can be primed across trials, enabling RTs to speed on repeat trials. It should be noted too that, in chapter 5, when switches took place after fewer sets of trials, switch costs were lower on emotion decisions than on gender and occupation classifications. In the latter case there would be less opportunity for emotion-priming to build up, reducing the advantage for repeat emotion decisions, and performance may then be more sensitive to the ease of disengaging attention from the switching tasks – with emotion decisions being harder to disengage attention from.

Over and above this, I found differential effects of EI and IQ on task switching performance. EI had a reliable inverse correlation with the switch costs when emotion classification was included, but not when switches were made between gender and occupation. This suggests that EI is not related to all aspects of task switching, but rather is more linked with emotion judgments. This finding fits with the idea that EI is positively

associated with skill at identifying emotional expressions among faces (Ciarrochi, Chan, & Bajgar, 2001) and it enables emotion judgments both to be engaged in more quickly and more rapidly disengaged from – thereby reducing switch costs. In addition, while all EI factors predicted task switching performance when emotion classification was involved, this effect was strongest for intrapersonal EQ, perhaps because emotion judgments particularly relate to this factor (Mayer & Geher, 2002). It is also interesting to note here the null effect of EI in predicting switch costs when emotion was an implicit feature of the task but gender and occupation judgments were made (note that, in this case, the emotions of the faces could vary across trials; see chapter 5 where this was examined more thoroughly). This suggests that EI is not related to the implicit recognition of emotion.

In contrast to the null effect of EI when gender and occupation decisions were made, there was a reliable effect of IQ - participants with higher IQ were better able to switch between tasks than those with a lower IQ. This result is consistent with previous findings that people with higher IQ are faster 'switchers' (Salthouse et al., 1998) and that the measures of IQ inversely correlate with mixing costs when two different tasks are presented in a block of trials (Yehene & Meiran, 2007).

**6.3. Switch cost asymmetries**

Previous work suggests that emotion is classified automatically (e.g., Driver & Vuilleumier, 2001) while face gender is not, at least for famous faces (Quinn, Mason, & Macrae, 2009). The results here showed that overall, emotion decisions were easier than gender and occupation decisions (chapters 3-5), though the switch costs varied. Switch costs were either equal across the tasks (chapter 3), larger for emotion (chapter 4) or smaller for emotion (chapter 5). The results generally do not agree with the argument that there are necessarily asymmetries in switch costs when tasks of unequal difficulty are paired together switch (see

Allport, Styles, Hsieh, 1994; Wang et al., 2007; Koch, Prinz, & Allport, 2005) rather suggest that different factors may affect switch costs according to whether tasks are presented in relatively long or short trial blocks. Notably, under long trial blocks it is possible for factors such as priming to build up, so that (e.g.,) repeat emotion decisions speed up. The net outcome might then be a large switch costs due to the relative speeding of repeat trials. With short trial blocks performance may be less affected by this and more by (e.g.,) the ease of disengaging attention from one task and applying it to the stimulus properties appropriate for the new task. Here it seems that emotion decisions are difficult to switch from, generating costs on switch trials for other tasks performed on the same faces (gender and occupation decisions here). Another account relates to the motivation-related constructs. For example, goals and other motivation functions could serve as a source of perceptual readiness (Bruner, 1957) and are capable of sustaining activation even without rehearsal (Anderson, 1983). These factors in turn direct informational processing accordingly (Wyer & Srull, 1986, 1989) - for example, Goschke and Kuhl (1993) asked their participants to rehearse a series of actions followed by either the performance of the actions (goal condition) or observation of the actions performed by another person (no-goal condition). Using a recognition test, participants responded faster and more accurate to the actions in the goal condition compared to the no-goal condition, when actually they did not rehearse the actions in the intervening time suggesting the persisting activation due to the formation of an intention. Foster, Liberman, and Higgins (2005) suggested that fulfillment of a goal inhibits the accessibility of goal-related constructs and is proportional to the strength of the motivation. I suggest that some of the facial attributes are rather more motivational which inhibits the accessibility of the other goal-related constructs, rather remain active in order to prepare the individual for transforming the intentional status into action. Emotion is encoded as a

commitment marker which is tagged to the representation of the activity and in turn serves as an internal context cue that biases the cognitive system (attentional/retrieval process) and build-up of performance than the other facial attributes (say gender/occupation).

### 6.4. Cultural effects in categorization

In chapter 4, I investigated the effects of race/culture on face classification and task switching. Asian participants showed overall smaller switch costs than British/white participants. This may be attributed to various factors. British participants may be more driven by bottom-up repetition of stimulus features, which might delay task switching; Asian participants may be more top-down driven and better able to implement executive control over the tasks. This argument fits with an earlier finding suggesting that bilinguals are better at top-down management of competing task sets (Soveri, Rodriguez-Fornells, & Laine, 2011; Anat & Brian, 2010).

In addition, the Asian participants were bilingual while the British participants were not. Prior studies indicate that bilingual individuals can enjoy better executive control in processing, perhaps due to the demands of processing multiple languages and the need to engage language-specific inhibition processes when switching from one language to another (Rodriguez-Fornells, De Diego, & Muente, 2006). This may help Asian participants switch between tasks. In addition to this, there was a cross-over interaction across the tasks; Asian participants were faster to make emotion decisions than gender decisions while the British/White participants showed the opposite result. This interesting result may reflect cultural differences in dealing with the gender issues. In western societies, gender is signalled by external cues on faces - makeup, hairstyles and differences in facial structure that distinguish men and women, while in Asian cultures, particularly in Muslim societies,

gender is signaled by the dress code. This finding is consistent with the differential face processing between the contrasting cultures- Easterners rely on contextual cues while Westerners tend to use feature based processing of faces (Miyamoto, Yoshikawa, & Kitayama, 2011). This might be particularly the case in Muslim cultures where men and women wear different external 'gender markers'. Hence, Asian participants may place less weight on facial features when making gender classifications. This may in turn slow gender decisions when these participants are presented only with faces (as here).

### 6.5. Implicit processing of emotion

The experiments in chapter 5 differed from the earlier ones in two ways. First, a different task-switching procedure was used, with tasks switched across short trial blocks (see Rogers & Monsell, 1995). I have already discussed the potential implications of this change for the effects of task switching. In addition, I varied whether there was a change or repeat of an irrelevant factor as different explicit tasks were performed (e.g., the emotion expression of the faces could vary as participants performed gender and occupation decisions). Here I found that variation in facial emotion affected gender and occupation decisions, and variation in gender affected emotion and occupation decisions. In contrast, varying the occupations of faces made minimal difference to emotion and gender classifications. This last set of results is consistent with emotion and gender being processed implicitly, while occupation information is not necessarily retrieved when faces are classified on other bases.

There is prior evidence for implicit processing of facial emotion. Evidence comes from fMRI data showing greater activity in temporal lobe cortex when subjects attended to, and judged facial expression explicitly while implicit processing of expressions (when subjects attended to and judged gender among faces depicting happy and angry expression)

evoked greater activity in amygdala region (Critchley et al, 2000). In addition PET data, when subjects performed gender discrimination task among static grey-scale images of faces expressing sad and angry expressions, show an enhanced activity in the left amygdala and right temporal pole (Blair et al., 1999). Behavioural data support fMRI and PET data in suggesting implicit processing of identity and gender using Garner-type speeded classification task- for example, identity interferes with emotion classification when subjects classified morphed faces along the dimension of emotion-happy/angry, with identity being irrelevant dimension- person A/B (Schweinberger, Burton, & Kelly, 1999) and gender interfered with the emotion classification when subjects classified faces along a emotion-happy/fearful dimension with gender-male/female being irrelevant face dimension; Atkinson et al., 2005). Schweinberger and Soukup (1998) found same effects in Garner paradigm when subjects performed emotion categorization (happy/sad) among personally familiar faces, RTs were affected by identity (person A/B-task irrelevant dimension).

I found evidence for implicit processing of gender as well as emotion. This result is counter to the argument that face gender is not classified automatically, at least for famous faces (Quinn, Mason, & Macrae, 2009) suggesting that implicit task switching effects may provide a particularly sensitive way to measure whether facial attributes are processed. These findings are consistent with the earlier report (Zhao et al., 2011, experiment 1) of facial emotion interfering with the task switching performance. In this study, face images posing fearful/neutral expression were presented as cues, with the gender of the faces indicating which task to do (classification of digit as either odd/even or high/low -more/less than 5), with the finding that the switch costs were larger in the trials containing fearful cues than in the trials containing neutral cues. For switch trials, when fearful faces were presented, RTs were longer than when neutral faces were presented while this effect did not

emerge on repeat trials. Note that here the digit has to be attended while the strength of my study is that a face has to be attended with the focus on gender and occupation classifications. These differential effects on switch trials may occur if participants then find it difficult to select the appropriate attribute of the face they are supposed to respond to, when the emotion change coincides with the task change. This was not found for changing the gender of the face here, though changing the gender did have an overall effect on emotion and occupation classifications (chapter 5), perhaps because the emotion change is more attentionally distracting.

### 6.6. Implications

The present work could have implications for understanding task switching in other contexts. A first application concerns the understanding of psychopathological behaviour, as for example, task switching can be difficult in patients with poor executive control (e.g., following frontal lobe damage) (Stablum et al., 2000). The present work demonstrated that executive control in task switching can improve after some blocks of practice. This has implications for training more generally and specifically for individuals with executive dysfunctions. The second application concerns the relations between switching ability and individual difference measures. The present results indicate that IQ is a core cognitive factor contributing to the ease of switching while EI is more involved with explicit emotion judgments. On the other hand, EI was not related to implicit variations in emotion. It may be that studies need to use implicit manipulations of emotion in order to lessen effects of EI on performance. On the other hand, if the interest is with whether individuals have EI, then explicit emotion decisions can tap into this.

Another implication is that the studies can help us understand asymmetries in face categorization tasks. Asymmetries arise because one task is relatively difficult to switch

attention from (for example, facial expression for emotion judgments) than others (e.g., using information relevant to gender/occupation), and because some tasks are more sensitive to the build-up of performance when the task stays constant (e.g., emotion judgments). The factors that sustain such priming effects are currently little understood and this is a clear area for future research.

There are also implications from the effects of culture in face categorization. There are differences between cultures particularly in dealing with gender and emotion. The factors behind this remain to be specified. For example, is the relative slow response of Asian participants to gender something that is specific to faces or might it be more general, affecting other aspects of gender classification (e.g., to clothes, to verbal descriptions)? Does this vary across different ages of participant?

Finally, the results on the effects of implicit stimulus changes on task switching are of interest. It is noteworthy that changing the gender of faces affected performance here, whereas this has not always been found to be the case with famous individuals (Quinn, Mason, & Macrae, 2009). It may be that implicit processing may be revealed under conditions of task switching due (in part at least) to the executive demands placed on the participant. This could decrease executive control over stimulus processing, allowing effects of implicit processing of different facial attributes to emerge. For example, implicit social processing emerge when executive processes are loaded such as the effects of stereotype emerge more strongly when people have a task load (Macrae, Hewstone, & Griffiths, 2006). This can be studied in future by more systematically varying the task load.

### 6.7. Limitations

There are several limitations concerning the present studies.

1. The present work is focused on categorization of happy expressions of emotions. This limits the generalizability of the results concerning to emotion categorization. The experiments should be extended to examine other emotions.
2. Throughout the thesis RTs were relatively long. This is likely due to the administration of self-paced tasks, which may have left participants to adopting a relatively slow mode of responding. However, given that the thesis examined primarily the relative magnitudes of different variables, then variations in overall RTs may not be critical.
3. The switching effects were examined under conditions of relatively long cue-response/stimulus-response intervals. This can allow at least some 'set-up' to take place of the task set prior to the new stimulus appearing in the new task. For the generality of the results it will be important to examine the switching effects across a greater range of intervals.
4. The experiments on individual differences in IQ and EI used relatively small numbers of participants, compared to large-scale analyses of individual differences. Though the numbers we reported were sufficient to generate effects, it will be important to conduct more extensive analyses in the future, to ensure that the interesting patterns of results remain the same.

# APPENDICES

## APPENDIX A

**Table 1**

*Pearson Correlations between mean Switch cost (emotion and gender task), NART VIQ, Bar On EQ-i and BarOn EQ-i Composite Scales Scores*

| | SC | NA | EQ-i | RAeq | EReq | SMeq | GMeq | ADeq |
|---|---|---|---|---|---|---|---|---|
| SC | - | -.87** | -.88** | -.83** | -.83** | -.75** | -.63** | -.76* |
| NA | -.87** | - | .71** | .67** | .41 | .51* | .73** | .68** |
| EQ-i | -.88** | .71** | - | .96** | .96** | .68** | .76** | .93** |
| RAeq | -.86** | .63** | .96** | - | .91** | .71** | .61* | .85** | |
| EReq | -.83** | .67** | .96** | .91** | - | .56* | .71** | .89** |
| SMeq | -.75** | .51* | .68** | .56* | .56** | - | .34 | .44 |
| GMeq | -.63** | .72** | .76** | .71* | .71** | .34 | - | .83** |
| ADeq | -.76** | .68** | .93** | .89** | .89** | .44 | .83** | - |

*Note.* Read SC=switch cost, NA= NART VIQ, EQ-i= Total EI, RAeq= Intrapersonal EI, EReq= Interpersonal EI, SMeq= Stress management EI, GMeq= General mood EI, ADeq= adaptability EI. **$p$<.01. *$p$ <.05.

**Table 1b**

*Partial correlations (controlled for NART VIQ scores) between the Switch cost (emotion and gender task) and the BarOn EQ-i Composite Scales*

| RAeq | EReq | SMeq | GMeq | ADeq |
|---|---|---|---|---|
| -.84** | -.68* | -.74** | -.01 | -.48 |

*Note.* Read RAeq= Intrapersonal EI, EReq= Interpersonal EI, SMeq= Stress management EI, GMeq= General mood EI, ADeq= Adaptability EI. **$p$<.001. *$p$ <.01.

**Table 1c**

*Mean (standard deviation) scores on BarOn EQ-i Composite Scales*

| RAeq | EReq | SMeq | GMeq | ADeq |
|---|---|---|---|---|
| 95.00 (10.30) | 94.62 (9.52) | 91.43 (5.63) | 87.93 (3.06) | 94.12 (10.56) |

*Note.* Read RAeq= Intrapersonal EI, EReq= Interpersonal EI, SMeq= Stress management EI, GMeq= General mood EI, ADeq= Adaptability EI.

# APPENDIX B

**Table 1**

*Pearson Correlations between mean Switch cost (emotion and occupation task), NART VIQ, BarOn EQ-i and EQ-i Composite Scales*

| | SC | NA | EQ-i | RAeq | EReq | SMeq | GMeq | ADeq |
|---|---|---|---|---|---|---|---|---|
| SC | - | -.80** | -.80** | -.81** | -.54* | -.78** | -.62** | -.70** |
| NA | -.80** | - | .65** | .61* | .41 | .62* | .63** | .60* |
| EQ-i | -.80** | .65** | - | .93** | .76** | .83** | .62** | .92** |
| RAeq | -.81** | .61* | .93** | - | .58* | .87** | .53* | .86** |
| EReq | -.54* | .41 | .76** | .58 | - | .35 | .25 | .52* |
| SMeq | -.78** | .62* | .83** | .87** | .35 | - | .80** | .83* |
| GMeq | -.62** | .63** | .62** | .53* | .25 | .80** | - | .64** |
| ADeq | -.70** | .60* | .92** | .86** | .52* | .83** | .64** | - |

*Note.* Read SC= Total switch cost, NA=NART VIQ, EQ-i= Total EI, RAeq= Intrapersonal EI, EReq= Interpersonal EI, SMeq= Stress management EI, GMeq= General mood EI, ADeq= Adaptability EI. ***p*<.01. **p* <.05.

**Table 1b**

*Partial correlations (controlled for NART VIQ scores) between the Switch cost (emotion and occupation task) and the BarOn EQ-i Composite Scales*

| RAeq | EReq | SMeq | GMeq | ADeq |
|---|---|---|---|---|
| -.69* | -.38 | -.60* | -.23 | -.46 |

*Note.* Read RAeq= Intrapersonal EI, EReq= Interpersonal EI, SMeq= Stress management EI, GMeq= General mood EI, ADeq= Adaptability EI. **p* <.01.

**Table 1c**

*Mean (Standard Deviation) scores on EQ-i Composite Scales*

| RAeq | EReq | SMeq | GMeq | ADeq |
|---|---|---|---|---|
| 99.50 (10.16) | 96.56 (10.75) | 87.43 (2.18) | 90.18 (4.16) | 103.87 (11.98) |

*Note.*RAeq= Intrapersonal EI, EReq= Interpersonal EI, SMeq= Stress management EI, GMeq= General mood EI, ADeq= Adaptability EI.

# APPENDIX C

**Table 1**

*Pearson Correlations between mean Switch cost (occupation and gender task), NART VIQ, BarOn EQ-i and EQ-i Composite Scales*

| | SC | NA | EQ-i | RAeq | EReq | SMeq | GMeq | ADeq |
|---|---|---|---|---|---|---|---|---|
| SC | - | -.79** | -.30 | -.25** | -.08** | -.31* | -.41 | -.42 |
| NA | -.79** | - | .30 | .28 | .10 | .29 | .31 | .40 |
| EQ-i | -.30 | .30 | - | .95** | .89** | .85** | .69** | .89** |
| RAeq | -.25 | .28 | .95** | - | .84** | .71** | .63** | .82** |
| EReq | -.08 | .10 | .89** | .84** | - | .77** | .53* | .64** |
| SMeq | -.31 | .29 | .85** | .71** | .77** | - | .74** | .77** |
| GMeq | -.41 | .31 | .69** | .63** | .53* | .74**. | - | .58** |
| ADeq | -.42 | .40 | .89** | .82** | .64** | 77** | .58* | - |

*Note.* Read SC=switch cost, NA=NART VIQ, EQ-i= Total EI, RAeq= Intrapersonal EI, EReq= Interpersonal EI, SMeq= Stress management EI, GMeq= General mood EI, ADeq= adaptability EI.**$p$<.01. * $p$<.05.

**Table 1b**

*Partial correlations (controlled for NART VIQ scores) between the Switch cost (occupation and gender task) and the BarOn EQ-i Composite Scales*

| RAeq | EReq | SMeq | GMeq | ADeq |
|---|---|---|---|---|
| -.04 | -.00 | -.14 | -.27 | -.19 |

*Note.* Read RAeq= Intrapersonal EI, EReq= Interpersonal EI, SMeq= Stress management EI, GMeq= General mood EI, ADeq= Adaptability EI.

**Table 1c**

*Mean (standard deviation) Scores on EQ-i Composite Scales*

| RAeq | EReq | SMeq | GMeq | ADeq |
|---|---|---|---|---|
| 102.05 (7.76) | 99.31 (6.81) | 87.37 (1.96) | 87.62 (1.58) | 101.25 (7.13) |

*Note.* Read RAeq= Intrapersonal EI, EReq= Interpersonal EI, SMeq= Stress management EI, GMeq= General mood EI, ADeq= Adaptability EI.

# APPENDIX D












## REFERENCES

Ackerman, J. M., Shapiro, J. R., Neuberg, S. L., Kenrick, D. T., Becker, D. V., Griskevicius, V., Maner, J. K., & Schaller, M. (2006). They all look the same to me (unless they're angry): From outgroup homogeneity to outgroup heterogeneity. *Psychological Science*, *17*, 836–840. doi:10.1111/j.1467-9280.2006.01790.x

Ach, N. (1935). Analyse des willens. In E. Abderhalden (Ed.), *Handbuch der biologischen Arbeitmethoden. Bd. VI. Berlin:* Urban & Schwarzenberg.

Allport, A., & Wylie, G. (1999). Task switching: Positive and negative priming of task-set. In G. W. Humphreys, J. Duncan, & A. M. Treisman (Eds.), *Attention, space and action: Studies in cognitive neuroscience* (pp. 273–296). Oxford, England: Oxford University Press.

Allport, D.A., Styles, E.A., & Hsieh, S. (1994). Shifting intentional set: Exploring the dynamic control of task. In C.Umilta & M. Moscovitch (Eds.), *Attention and Performance XV: Conscious and nonconscious information processing* (pp.421-452). Cambridge, MA: MIT Press.

Aron, A. R., Monsell, S., Sahakian, B. J., & Robbins, T. W. (2004). A componential analysis of task-switching deficits associated with lesions of left and right frontal cortex. *Brain, 127*, 1561-1573.

Anat, P., & Brian, M. (2010). A Bilingual advantage in Task switching. *Bilingualism: Language and Cognition,13*, 253-262. doi.10.1017/S1366728909990526.

Anderson, J. R. (1983). *The architecture of cognition*. Cambridge, MA: Harvard University Press.

Atkinson, A. P., Tipples, J., & Burt, D. M. (2005). Asymmetric interference between sex and emotion in face perception. *Perception & Psychophysics*, *67 (7*), 1199-1213.

Barchard, K. A. & Hakstian, A. R. (2004). The nature and measurement of emotional intelligence abilities: Basic dimensions and their relationships with other cognitive-ability and personality variables. *Educational and Psychological Measurement*, *64*, 437-462. doi: 10.1177/0013164403261762.

BarOn, R. (1997). *BarOn Emotional Quotient Inventory: Technical manual.* Toronto, Ontario, Canada: Multi-Health Systems.

Baudouin, J. Y., & Humphreys, G. W. (2006). Configural information in gender categorisation. *Perception*, *35 (4)*, 531-540. doi: 10.1068/p3403

Bennett, M., & Sani, F. (2003). The role of target gender and race in children's encoding of category-neutral person information. *British Journal of Developmental Psychology*, *21*, 99-112. doi: 10.1348/026151003321164645

Bernstein, M. J., Young, S. G., & Hugenberg, K. (2007). The cross-category effect: Mere social categorization is sufficient to elicit an own-group bias in face recognition. *Psychological Science*, *18*, 706–712. doi:10.1111/j.1467-9280.2007.01964.x

Besner, D., Stolz, J. A., & Boutlilier, C. (1997). The Stroop effect and the myth of automaticity. *Psychonomic Bulletin & Review*, *4 (2)*, 221-225. doi: 10.3758/BF03209396

Biederman, I., & Kalocsai, P. (1997). Neurocomputational bases of object and face recognition. *Philosophical Transactions of the Royal Society London: Biological Sciences, 352,* 1203-1219.

Biehl, M., Matsumoto, D., Ekman, P., Hearn, V., Heider, K., Kudoh, T., & Ton, V., (1997). Matsumoto and Ekman's Japanese and Caucasian facial expressions of emotions (JACFEE): Relability data and Cross-national differences, *Journal of Nonverbal Behavior*, *21 (1)*, 3-21. doi: 10.1023/A:1024902500935

Bigler, R. S., & Liben, L. S. (1993). A cognitive-developmental approach to racial stereotyping and reconstructive memory in Euro-American children. *Child Development, 64*, 1507-1518.doi: 10.2307/1131549

Blair, J. R., & Spreen, O. (1989). Predicting premorbid IQ: A revision of the national adult reading test. *The clinical Neuropsychologist, 3*, 129-136.
doi: 10.1080/13854048908403285.

Blair, R. J., Morris, J. S., Frith, C. D., Perrett, D. I., & Dolan, R. J. (1999). Dissociable neural responses to facial expressions of sadness and anger. *Brain*, *122* (5), 883–893. doi: 10.1093/brain/122.5.883

Blais, C., Jack, R. E., Scheepers, C., Fiset, D., & Caldara, R. (2008). Culture shapes how we look at faces. *PLoS one*, 3 (8), e3022

Brass, M., & von Cramon, D. Y. (2002). Fractionating the neural substrate of cognitive control processes. *Proceedings of the National Academy of Sciences*, *U.S.A*, *99*, 14595-14600.

Brewer, M. B., & Gardner, W. (1996). Who is this "we"? Levels of collective identity and self-representations. *Journal of Personality and Social Psychology*, *71*, 83-93. doi: 10.1037//0022-3514.71.1.83

Brigham, J. C., & Malpass, R. S. (1985). The role of experience and contact in the recognition of faces of own- and other-race persons. *Journal of Social Issues*, *41*, 139–155. doi: 10.1111/j.1540-4560.1985.tb01133.x

Brown, C., George-Curran, R., & Smith, M. L. (2003). The role of emotional intelligence in the career commitment and decision making process. *Journal of Career Assessment*, *11*, 379–392. doi: 10.1177/1069072703255834.

Bruce, V., & Young, A. (1986). Understanding Face recognition. *Br J Psychol*, *77 (3)*, 305-27. doi: 10.1111/j.2044-8295.1986.tb02199.x

Bruce, V., Burton, A. M., Hanna, E., Healey, P., Mason, O., Coombes, A., Fright, R., & Linney, A. (1993). Sex discrimination: How do we tell the difference between male and female faces? *Perception*, 22, 131-152. doi: 10.1068/p220131

Bruner, J. S. (1957). Going beyond the information given. In H. E. Gruber, K. H. Hammond, & R. Jessor (Eds.), *Contemporary approaches to cognition* (pp.41-69). Cambridge, MA: Harvard University Press.

Calder, A.J., Young, A. W., Keane, J., & Dean, M, (2000). ``Configural information in facial expression perception". *Journal of Experimental Psychology: Human Perception and Performance*, *26*, 527 -551.

Campbell, J. I. D. (2005). Asymmetrical language switching costs in Chinese–English bilinguals' number naming and simple arithmetic. *Bilingualism:Language and Cognition*, *8*, 85–91.

Campbell, R., Landis, T., & Regard, M. (1986). Face recognition and lip-reading: A neuropsychological dissociation, *Brain*, *109*, 509-521. doi: 10.1093/brain/109.3.509

Carey, S., & Diamond, R. (1994). Are faces perceived as configurations more by adults than by children? *Visual Cognition*, *1*, 253–274.

Cattell, R. B. (1971). *Abilities: Their structure, growth, and action*. New York: Houghton Mifflin. ISBN 0395042755.

Cepeda, J. N., & Kramer, F. A., Gonalez de Sather, M. C. J. (2001). Changes in Executive control across the Life span: Examination of Task-Switching Performance. *Developmental Psychology, 37 (5)*, 715-730.

Chronicle, E.P., Chan, M.Y., Hawkings, C., Mason, K., Smethurst. K., Stallybrass, K., Westrope, K. & Wright, K. (1995). You can tell by the nose--judging sex from an isolated facial feature. *Perception*, *24 (8)*, 969-73. doi: 10.1068/p240969

Ciarrochi, J., Chan, A. Y. C., & Bajgar, J. (2001). Measuring emotional intelligence in adolescents. *Personality and Individual Differences*, *31*, 1105-1119. doi: 10.1016/S0191-8869(00)00207-5.

Clarke, S., Lindermann, A., Maeder, P., Borruat, Francois-Xavier., & Assal, G. (1997). Face recognition and postero-inferior hemispheric lesions. *Neuropsychologia*, *35 (12*), 1555-1563. doi: 10.1016/S0028-3932(97)00083-3

Correll, J., Lemoine, C., Ma, D. S. (2011). Hemispheric asymmetry in cross-race face recognition. *Journal of Experimental Social Psychology*, *47(*6), 1162-1166. doi:10.106/j.jesp.2011.04.001

Costarelli, V., Demerzi, M., & Stamou, D. (2009). Disordered eating attitudes in relation to Body Image and Emotional Intelligence in young women. *Journal of Human Nutrition and Dietetics*, 22 (3), 239-245. doi: 10.1111/j.1365-277X.2009.00949.x

Critchley, H., Daly, E., Phillips, M., Brammer, M., Bullmore, E., Williams, S., Van Amelsvoort, T., Robertson, D., David, A., & Murphy, D. (2000). Explicit and implicit neural mechanisms for processing of social information from facial expressions: a functional magnetic resonance imaging study. *Human Brain Mapping*, *9*, 93-105.

Cherkasova, M. V., Manoach, D. S., Intriligator, J. M., & Barton, J. J. S. (2002). Antisaccades and task switching: Interactions in controlled processing. *Experimental Brain Research*, *144*, 528–537.

Chua, H. F., Boland, J. E., & Nisbett, R. E. (2005). Cultural variation in eye movements during scene perception. *Proceedings of the National Academy of Sciences*, *USA, 102, 12629-12633.*

Driver, J., & Vuillemeumier, P. (2001). Perceptual awareness and its loss in unilateral neglect and extinction. *Cognition, 79*, 39-88. doi: 10.1016/S0010-0277(00)00124-4

Dumotheil, I., Thompson, R., Duncan, J. (2011). *Assembly and use of new task rules in the frontoparietal cortex*. *Journal of Cognitive Neuroscience*, *23(1)*, 168-182. doi:10.1162/jocn.2010.21439.

Dunbar,K. N., & MacLeod, C. M. (1984). A horse race of a different colour: Stroop interference patterns with transformed words. *Journal of Experimental Psychology: Human Perception and Performance, 10*, 622-639.

Duncan, J., & Burgess, P., & Emslie, H. (1995). Fluid Intelligence after frontal lobe lesions. *Neuropsychologia, 33 (3)*, 261-268.

Ekman, P., & Friesen, W. (1978). *Facial action coding system: A technique for the measurement of facial movement.* Palo Alto, CA: Consulting Psychologists Press.

Ekman, P., & Friesen, W. V. (1969). The repertoire of nonverbal behavior: Categories, origins, usage, and coding. *Semiotica*, *1*, 49-98.

Ellis, N. R., & Dunaley, C. L. (1991). Further evidence for cognitive inertia of persons with mental retardation. *Am J Ment Retard*, *95 (6)*, 613-21.

Ellis, N. R., Woodley-Zanthos, P., Dunaley, c. L., Palmer, R. L. (1989). Automatic effortful processing and cognitive inertia in persons with mental retardation. *American Journal on Mental Retardation, 93 (4)*, 412-423.

Farrelly, D., & Austin, E. J. (2011). Ability EI as an intelligence? Associations of the MSCEIT with performance on emotion processing and social tasks and with cognitive ability. *Cognition and Emotion*, *21 (5)*, 1043-1063. doi: 10.1080/02699930601069404

Fiske, S. T. (1993). Social cognition and social Perceptions. Annual Review of Psychology (Annual Reviews), *44 (1)*, 155-194.
doi: 10.1146/annurev.ps.44.020193.001103

Flowers, J. H., & Stoup, C. M. (1977). Selective attention between words, shapes and colours in speeded classification and vocalization tasks. *Memory and Cognition*, *5*, 299-307.

Flude, B. M., Ellis, A. W., & Kay, J. (1989). Face Processing and Name Retrieval in an Anomic aphasic: Names Are Stored Separately from Semantic Information about Familiar People. *Brain and Cognition*, *11*, 60-72. doi: 10.1016/0278-2626(89)90005-5

Fredrickson, B. L. (2000). Cultivating positive emotion to optimize health and well-being. *Prevention & Treatment, 1 (3),* 00. doi: 10.1037/1522-3736.3.1.31a

Freeman, B. J., Ambady, N., & Rule, O. N. (2008). Will a Category cue attract you? Motor Output reveals Dynamic Competition across Person construal. *Journal of Experimental Psychology: General, 137 (4)*, 673-690. doi: 10.1037/a0013875

Foster, J. , Liberman, N., & Higgins, E. T. (2005). Accessibility from active and fulfilled goals. *Journal of Experimental social Psychology, 41,* 220-239.
doi: 10.1016/j.jesp.2004.06.009

Ge, L., Zhang, H., Wang, Z., Quinn, P. C., Pascalis, O., Kelly, d., Slater, A., Tian, J., Lee, K. (2009). Two faces of the other-race effect: recognition and categorization of Caucasian and Chinese faces. *Perception*, *38 (8)*, 1199-210. doi:10.1068/p6136

George, M. S., Ketter, T. A., Gill, D. S., Haxby, J. V., Ungerleider, L. G., Herscovitch, P., & Post, R. M. (1993). Brain regions involved in recognizing facial emotion or identity: An oxygen-15 PET study. *Journal of Neuropsychiatry*, *5 (4)*, 384–394.

Goldstein, A. G., & Chance, J. E. (1985). Effects of training on Japanese face recognition: Reduction of the other-race effect. *Bulletin of the Psychonomic Society*, *23*, 211–214.

Goleman, D. (1995). *Emotional intelligence.* New York: Bantam.

Goschke, T., & Kuhl, J. (1993). Representation of intentions: Persisting activation in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 19,* 1211-1226.

Gottfredson, S. L. (1994, December.13). Mainstream Science on Intelligence. *Wall street Journal.* p.81A.

Gottshalk, l. a. (1985). Hope and other deterrents of illness. *American Journal of Psychotherapy, 39*, 515-524.

Gur, R. C., Skolnick, B. E., & Gur, R. E. (1994). Discrimination tasks on cerebral blood flow: regional activation and its relation to performa. *Brain and cognition, 25 (2),* 271-286.

Hasselmo, M. E., Rolls, E. T., & Baylis, G. C. (1989). The role of expression and identity in the face-selective responses of neurons in the temporal visual cortex of the monkey. *Behavioral Brain Research*, *32*, 203-218.doi: 10.1016/S0166-4328(89)80054-3.

Haxby, J. V., Hoffman, E. A., & Gobbini, M. I. (2000). The distributed human neural system for face perception. *Trends in Cognitive Sciences*, *4*, 223-233. doi:10.1038/71152

Hernandez, M., Costa, A., Humphreys, G. W. (2011). Escaping capture: Bilingualism modulates distraction from working memory. *Cognition*, *122(1)*, 37-50. doi: 10.1016/j.cognition.2011.08.002

Higgins, E. T., & King, G. A. (1981). Accessibility of social constructs: Information-processing consequences of individual and contextual variability. In N. Cantor & J. Kihlstrom (Eds.), *Personality, cognition and social interaction* (pp.69-122), Hillsdale, NJ: Erlbaum.

Hugenberg, K. (2005). Social categorization and the perception of facial affect: Target race moderates the response latency advantage for happy faces. *Emotion*, *5*, 267–276. doi:10.1037/1528-3542.5.3.267

Hugenberg, K., & Sacco, D. F. (2008). Social categorization and stereotyping: How social categorization biases person perception and face memory. *Social and Personality Psychology Compass*, *2*, 1052–1072. doi:10.1111/j.1751-9004.2008.00090.x

Hugenberg, K., Young, S. G., Bernstein, M. J., & Sacco, D. F. (2010). The categorization individuation model: An integrative account of the other-race recognition deficit. *Psychological Review*, *117*, 1168–1187. doi:10.1037/a0020463

Humphreys, G. W., Donnelly, N., & Riddoch, M. J. (1993). Expression is computed separately from facial identity, and it is computed separately from for moving and static faces: Neuropsychological evidence. *Neuropsychologia*, *31*, 173-181. doi: 10.1016/0028-3932(93)90045-2

Humphreys, G. W., Riddoch, M. J., & Fortt, H. (2006). Action relations, semantic relations, and familiarity of spatial position in Balint's syndrome: Crossover effects on perceptual report and on localization. *Cognitive, Affective, & Behavioural Neuroscience*, *6 (3)*, 236-245. doi: 10.3758/CABN.6.3.236

Izard, C. E. (1994). Innate and universal facial expressions: Evidence from developmental and cross-cultural research. *Psychological Bulletin, 115,* 288–299.

Jersild, A. T. (1927). Mental set and shift. *Archives of Psychology,* whole No. 89.

Hugenberg, K., & Bodenhausen, G. V. (2003). Facing prejudice: Implicit prejudice and the perception of facial threat. *Psychological Science*, *14*, 640–643. doi:10.1046/j.0956-7976.2003.psci_1478.x

Hugenberg, K., & Bodenhausen, G. V. (2004). Ambiguity in social categorization. *Psychological Science*, *15*, 342–345. doi:10.1111/j.0956-7976.2004.00680.x

Katz, P. A., & Kofkin, J. A. (1997). Race, gender, and young children. In S. S. Luthar, J. A. Burack, D. Cicchetti, & J. R. Weisz (Eds.), *Developmental psychopathology: Perspectives on adjustment, risk, and disorder* (pp. 51–74). New York: Cambridge University Press.

Kaur, I., Schutte, N.S., & Thorsteinsson, E.B. (2006). Gambling control self-efficacy as a mediator of the effects of low emotional intelligence on problem gambling. *Journal of Gambling Studies, 22*, 405-411. doi: 10.1007/s10899-006-9029-1

Keele, S. (1972). Attention demands of memory retrieval. *Journal of Experimental Psychology*, *93*, 245-2458. doi: 10.1037/h0032460

Kelly, D. J., Quinn, P. C., Slater, A. M., Lee, K., Ge, L., & Pascalis, O. (2007). The Other-Race Effect Develops During Infancy, Evidence of Perceptual Narrowing. *Psychol Sci*, *18 (12)*, 1084-1089. doi: 10.1111/j.1467-9280.2007.02029.x

Kim, S.H., Sherman, K. D., Mojaverian, T., Sasaki, Y. J., Park, J., Suh, M. E., & Taylor, E. S. (2011). Gender-culture interaction: Oxytocin receptor polymorphism (OXTR) and emotion regulation. *Social Psychological and Personality Science*, 000(00), 1-8.

Kitayama, S., Duffy, S., Kawamura, T., & Larsen, J. (2003). Perceiving an object and its context in different cultures: A cultural look at New Look. *Psychological Science*, *14*, 201-206.

Koch, I., Prinz, W., & Allport, A. (2005). Involuntary retrieval in alphabet-arithmetic tasks: Task-mixing and task-switching costs. *Psychological Research, 69,* 252-261. doi: 10.1007/s00426-004-0180-y

Kramer, F. A., Hahn, S., & Gropher, D. (1991). Task coordination and aging: explorations of executive control processes in the task switching paradigm. *Acta Psychologica, 101 (2-3)*, 339-378.

Lam L.T., Kirby S.L. (2002). Is Emotional Intelligence an Advantage? An exploration of the impact of emotional intelligence on individual performance. *The Journal of Social Psychology, 142(1)*, 133-143.

Leible , T. L. , & Snell , W. E. (2004). Borderline personality disorder and multiple aspects of emotional intelligence. *Personality and Individual Differences*, *37*, 393–404. doi:10.1016/j.paid.2003.09.011.

Levin, D. T. (1996). Classifying faces by race: The structure of face categories. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *22*, 1364–1382. doi:10.1037/0278- 7393.22.6.1364

Levin, D. T. (2000). Race as a visual feature: Using visual search and perceptual discrimination tasks to understand face categories and the cross-race recognition deficit. *Journal of Experimental Psychology: General*, *129*, 559–574. doi:10.1037/0096-3445.129.4.559

Lopes, P. N., Salovey, P., & Straus, R. (2003). Emotional Intelligence, Personality, and the perceived quality of social relationships. *Personality and Individual Differences*, *35*, 641-658.doi: 10.1016/S0191-8869(02)00242-8.

MacCann, C., Roberts, R. D., Matthews, G., & Zeidner, M. (2004). Consensus scoring and empirical option weighting of performance-based emotional intelligence (EI) tests. *Personality and Individual Differences*, *36*, 645-662. doi: 10.1016/S0191-8869(03)00123-5

MacLeod, M. (1998). Training on integrated versus separated Stroop tasks: The progression of interference and facilitation. *Memory and Cognition, 26 (2)*, 201-211.

MacLeod, M. C. (1991). Half a Century of Research on the Stroop effect: An Integrative Review. *Psychological Bulletin, 109 (2),* 163-203.

Macrae, C. N., Hewstone, M., & Griffith, R. J. (1993). Processing load and memory for stereotype-based information. *European Journal of Social Psychology*, *23 (1)*, 77-87. doi: 10.1002/ejsp.2420230107

Mandal, M. K., Harizuka, S., Bhushan, B., & Mishra, R. C. (2010). Cultural variation in hemifacial asymmetry of emotion expressions. *British Journal of social Psychology*, *40 (3*), 385-398. doi: 10.1348/014466601164885

Martin, C.L., & Ruble, D.N. (2004). Children's search for gender cues: Cognitive perspectives on gender development. *Current directions in psychological science, 13*, 67-70. doi: 10.1111/j.0963-7214.2004.00276.x

Masuda, T., & Nisbett, R. (2001). Attending holistically versus analytically: comparing the context sensitivity of Japanese and Americans. *Journal of Personality and Social Psychology*, *81*, 922-934.

Masuda, T., & Nisbett, R. (2006). Culture and change blindness. *Cognitive Science: a Multidisciplinary Journal*, *30*, 381-399.

Masuda, T., Ellsworth, P., Mesquita, B., Leu, J., Tanida, S., & Van de Veerdonk, E. (2008). Placing the face in context: Cultural differences in the perception of facial emotion. *Journal of Personality and Social Psychology*, *94*, 365-381.

Matsumoto, D. (1992). American-Japanese cultural differences in the recognition of universal facial expressions. *J. Cross-Cultural Psychol. 23*, 72–84.
doi: 10.1177/0022022192231005

Matsumoto, D., & Ekman, P. (1989). American-Japanese cultural differences in judgments of facial expressions of emotion. *Motivation Emotion, 13*, 143–157.

Mayer, J. D., Caruso, D., & Salovey, P. (1999). Emotional intelligence meets traditional standards for an intelligence. *Intelligence*, *27*, 267-298.

Mayer, J.D. & Geher, G. (1996). Emotional intelligence and the identification of emotion. *Intelligence, 22*, 89-113.

Mayr, U., Diedrichsen, J., Ivry, R., & Keele, S. T. (2006). Dissociation task-set selection from task-set inhibition in the prefrontal cortex. *Journal of Cognitive Neuroscience*, *18*, 14-21.

Mayr, U., & Keele, S. (2000). Task-set switching and long-term memory retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*, 1124-1140.

McClain, L. (1983a). Colour priming effects Stroop interference. *Perceptual and Motor Skills, 56*, 643-651.

McClain, L. (1983b).Effects of response type and set size on Stroop colour-word performance. *Perceptual and Motor Skills, 56*, 735-743.

Meiran, N. (2000). Reconfiguration of stimulus task-sets and response task-sets during task-switching. In S. Monsell & J. Driver (Eds.), *Control of cognitive processes: Attention and Performance XVIII* (pp.377-399). Cambridge: MIT Press.

Meissner, C. A., & Brigham, J. C. (2001). Thirty years of investigating the own-race bias in memory for faces: A meta-analytic review. *Psychology, Public Policy, and Law*, *7*, 3–35.

Meissner, C. A., Brigham, J. C., & Butz, D. A. (2005). Memory for own- and other-race faces: A dual-process approach. *Applied Cognitive Psychology*, *19*, 545-567.doi: 10.1002/acp.1097

Mesquita, B., & Frijda, N.H. (1992). Cultural variations in emotion: A review. *Psychological Bulletin*, *112*, 197-204.

Meuter, R. F. I., & Allport, A. (1999). Bilingual language switching in naming: Asymmetrical costs of language selection. *Journal of Memory and Language*, *40*, 25–40. doi: 10.1006/jmla.1998.2602

Miyamoto, Y., Nisbett, R. E., & Masuda, T. (2006). Culture and the physical environment: Holistic versus analytical perceptual affordances. *Psychological Science*, *17*, 113-119.

Miyamoto, Y., Yoshikawa, S., & Kitayama, S. (2011). Feature and configuration in face processing: Japanese are more configural than Americans. Cognitive Science, 1-12. doi: 10.1111/j.1551-6709.2010.01163.x

Nisbett, R. E., & Masuda, T. (2003). *Proc Natl. Acad. Sci. USA, 100*, 11163-11170

O'toole, A. J., Peterson, J., & Deffenbacher, K. A. (1996). An "other-race effect" for categorizing faces by sex. *Perception*, *25 (6)*, 669-76. 10.1068/p250669

Parry, F. M., Young, A. W., Saul, J. S., & Moss, A. (1991). Dissociable face processing impairments after brain injury. *Journal of Clinical & Experimental Neuropsychology*, *13*, 545-558. doi: 10.1080/01688639108401070

Parry, F. M., Young, A. W., Saul, J. S., & Moss, A. (1991). Dissociable face processing impairments after brain injury. *Journal of Clinical & Experimental Neuropsychology*, *13*, 545-558. doi: 10.1080/01688639108401070

Pinkham, A. E., Sasson, N. J., Calkins, M. E., Richard, J., Hughett, P., Gur, R. E., & Gur, R. C. (2008). The Other-Race Effect in Face Processing Among African American and Caucasian Individuals With Schizophrenia, *Am J Psychiatry, 165, 639-645.* doi: 10.1176/appi.ajp.2007.07101604

Pritchatt, D. 1968. An investigation into some of the underlying associative verbal processes of the Stroop colour effect. *Quarterly Journal of Experimental Psychology, 20***,** 351–359.

Quinn, K. A., Mason, M. F., & Macrae, C. N. (2009). Familiarity and person construal: Individuating knowledge moderates the automaticity of category activation. *European Journal of Social Psychology*, *39*, 852–861. doi:10.1002/ejsp.596

Regan, J. E. (1981). Automaticity and Learning: Effects of familiarity on naming letters. *Journal of Experimental Psychology: Human Perception and Performance*, *7*, 180-195.

Reimers, S., & Maylor, E. A. (2005). Task switching Across the Life span. Effects of Age on General and Specific Switch Costs. *Developmental Psychology*, *41 (4)*, 661-671. doi: 10.1037/0012-1649.41.4.661

Risko, F. E., Stolz, A. J., & Besner, D. (2005). Basic processes in reading: Is visual word recognition obligatory? *Psychonomic Bulletin & Review*, *12 (1)*, 119-124.

Roberts, T., & Bruce, V. (1988). "Feature saliency in judging the sex and familiarity of faces". *Perception*, *17(4),* 475 – 481.

Rodriguez-Fornells A., De Diego Balaguer R., & Muente, T. F. (2006). Executive control in bilingual language processing. *Language Learning*, *56 (1)*, 133-190, doi::10.1111/j.1467-9922.2006.00359.x

Rogers, R. D., & Monsell, S. (1995). Costs of a predictable switch between simple cognitive tasks. *Journal of Experimental Psychology: General, 124(2),* 207-231.

Rogers, R. D., Sahakian, B. J., Hodges, J. R., Polkey, C. E., Kennard, C., & Robbins, T. W. (1998). Dissociating executive mechanisms of task control following frontal damage and Parkinsons' disease. *Brain, 121*, 815-842.

Salovey, P., & Mayer, J. D. (1990). Emotional intelligence. *Imagination, Cognition, and Personality, 9,* 185–211.

Salthouse, T. A., Fristoe, N., McGuthry, K. E., & Hambrick, D. Z. (1998). Relation of Task to speed, age, and fluid Intelligence. *Psychology and Aging*, *13 (3)*, 445-461. doi: 10.1037//0882-7974.13.3.445

Schneider, D. W., & Logan, G. D. (2010). The Target of Switching. *Canadian Journal of Experimental Psychology*, *64 (2)*, 129-133. doi: 10.1037/a0019598

Schneider, W. D., & Anderson, R. J. (2010). Asymmetric switch costs as a sequential difficulty effects. *The Quarterly Journal of Experimental Psychology, 63 (10),* 1873-1894. doi: 10.1080/17470211003624010

Schneider, W., Eschman, A., & Zuccolotto, A. (2002). Prime user's guide. Pittsburgh, PA: Psychology Software Tools, Inc.

Schutte, N. S., Schuettpelz, E., Malouff, J. M. (2001). Emotional Intelligence and Task Performance. *Imagination, Cognition, and Personality*. *20 (4)*, 347-354.

Schweinberger, S. R., & Soukup, G. R. (1998). Asymmetric relationships among perceptions of facial identity, emotion, and facial speech. *Journal of Experimental Psychology: Human Perception & Performance*, *24*, 1748-1765.

Schweinberger, S. R., Burton, A. M., & Kelly, S. W. (1999). Asymmetric dependencies in perceiving identity and emotion: Experiments with morphed faces. *Perception & Psychophysics*, *61*,1102-1115.

Sergent, J., & Villemure, Jean-Guy. (1989). Prosopagnosia in a Right Hemispherectomized Patients. *Brain*, *112 (4)*, 975-995.
doi: 10.1093/brain/112.4.975.

Sergent, J., Ohta, S., MacDonald, B. (1992). Functional neuroanatomy of face and object processing. A positron emission tomography study. *Brain*, *115*, 15-36. doi: 10.1093/brain/115.1.15

Sergent, J., Ohta, S., MacDonald, B., & Zuck, E. (1994). Segregated processing of identity and emotion in the human brain: A PET study. *Visual Cognition*, *1*, 349–369.doi: 10.1080/13506289408402305

Shioiri, T., Someya, T., Helmeste, D., & Tang, S.W. (1999a). Misinterpretation of facial expression: A cross-cultural study. *Psychiatry Clin. Neurosci. 53*, 45–50.

Shioiri, T., Someya, T., Helmeste, D., & Tang, S.W. (1999b). Cultural difference in recognition of facial emotional expression: contrast between Japanese and American raters. *Psychiatry and Clinical Neurosciences*, *53*, 629–633.

Shriver, E. R., Young, S. G., Hugenberg, K., Bernstein, M. J., & Lantner, J. R. (2008). Class, race, and the face: Social context modulates the cross-race effect in face recognition. *Personality and Social Psychology Bulletin*, *34*, 260–274. doi:10.1177/0146167207310455

Sichel, J. R. & Chandler, K. A. (1969). The colour-word interference test: The effects of varied colour-word combinations upon verbal response latency. *Journal of Psychology, 72*, 219-231.

Sohn, Myeong-Ho., Anderson, R. J. (2001). Task Preparation and Task Repetition: Two components model of Task Switching. *Journal of Experimental Psychology: General, 130 (4)*, 764-778.

Soveri, A., Rodriguez-Fornells, A., & Laine, M. (2011). Is There a Relationship between Language Switching and Executive Functions in Bilingualism? Introducing a within group Analysis Approach. *Front Psychol*, *2*, 183. doi: 10.3389/fpsyg.2011.00183

Spearman, C. (1904). General intelligence, objectively determined and measured. *American Journal of Psychology, 15,* 201–293.

Spector, A., & Biederman, I. (1976). Mental set and shift revisited. *American Journal of Psychology*, *89*, 669–679.

Spence, G., Oades, L. G., & Caputi, P. (2004). Trait emotional intelligence and goal self-integration: Important predictors of emotional well-being? *Personality and Individual Differences*, *37*, 449–461. doi:10.1016/j.paid.2003.09.001.

Stablum, F., Umilta`, C.,Mogentale, C., Carlan, M., & Guerrini, C. (2000). Rehabilitation of executive deficits in closed head injury and anterior communicating artery aneurysm patients. *Psychological Research*, *63*, 265–278.

Stankov, L. (1997). Gf-Gc Quickie test battery. Sydney, Australia: School of Psychology. Trinidad, D. R., Unger, J. B., Chou, C. P., & Johnson, C. A. (2004). The protective association of emotional intelligence with psychosocial smoking risk factors for adolescents. *Personality and Individual Differences*, *36*, 945-954.

Stephen, I. D., & McKeegan, A. M. (2010). Lip colour affects perceived sex typicality and attractiveness of human faces. *Perception, 39(8),*1104-10.

Strobach, T., Liepelt, R., Schubert, T., Kiesel, A. (2012). Task Switching: effects of Practice on Switch and Mixing costs. *Psychological Research*. *76 (1)*, 74-83.doi: 10.1007/s00426-011-0323-x.

Stroop, J. R. (1935). Studies of Interference in Serial verbal reactions. *Journal of Experimental Psychology, 18*, 643-662.

Tranel, D., Damasio, A. R., & Damasio, H. (1988). Intact recognition of facial expressions, gender, and age in patients with impaired recognition of face identity. *Neurology*, *38 (5),* 690-696.

Unsworth, N. & Engle, W. R. (2008). Speed and accuracy of accessing information in working memory: An individual differences investigation of focus switching. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *34(3)*, 616-630.

Vuillemier, P., Armony, J. L., Driver, J., & Dolan, R. J. (2003). Distinct spatial frequency sensitivities for processing faces and emotional expressions. *Nature Neurosciences*, *6*, 624–631.

Wang, Y.P., Xue, G., Cheng, C.S., Xue, F., Dong, Q., (2007). Neural bases of asymmetric language switching in second-language learners: an ER–fMRI study. *NeuroImage*, 35, 862–870. doi:10.1016/j.neuroimage.2006.09.054

White, B. W. (1969). Interference in Identifying attributes and attribute names. *Perception and Psychophysics, 6*, 166-168.

Wylie, G., & Allport, A. (2000). Task switching and the measurement of “Switch costs”. *Psychological Research*, *63*, 212-233.

Wyer, R. S., & Srull, T. K. (1989). *Memory and cognition in its social context*. Hillsdale, NJ: Erlbaum.

Wyer, R. S., & Srull, T. K. (1986). Human cognition in its social context. *Psychological Review, 93,* 322-359.

Yehene, E. & Meiran, N. (2007). Is there a general task switching ability? *Acta Psychologica*, *120*, 169-195. doi:10.1016/j.actpsy.2006.11.007.

Young, A. W., Newcombe, F., de Haan, E. H. F., Small, M., & Hay, D. C. (1993). Face perception after brain injury: Selective impairments affecting identity and expression. *Brain*, *116*, 941–959. doi: 10.1093/brain/116.4.941

Young, S. G., Hugenberg, K., Bernstein, M. J., & Sacco, D. F. (2009). Interracial contexts debilitate same-race face recognition. *Journal of Experimental Social Psychology*, *45*, 1123–1126.doi:10.1016/j.jesp.2009.05.009

Young, A .W., Hellawell, D., & Hay, D. C. (1987). "Configurational information in face perception". *Perception, 16(6)*, 747.

Zeidner, M., Shani-Zinovich, I., Matthews, G., & Roberts, R. D. (2005). Assessing emotional intelligence in gifted and non-gifted high school students: Outcomes depend on the measure. *Intelligence*, *33*, 369-391. doi:10.1016/j.intell.2005.03.001

Zhou, J., Gao, T., Zhang, Y., Liang, J., Shui, R., Shen, M. (2011). Losing control in front of a fearful face: The effect of emotional information on cognitive control. *The Quarterly Journal of Experimental Psychology*, *64 (6)*, 1187–1199.