Implicit and Explicit Face Recognition in Association with Autism Spectrum Disorder

Darren Hedley, BPsyc (Hons.), M.A.

School of Psychology

Faculty of Social and Behavioural Sciences

A thesis submitted to Flinders University for the degree of Doctor of Philosophy

February, 2012

TABLE OF CONTENTS

SUMMARY

Deficits in face processing have been regarded as central to the cognitive profile of individuals with an Autism Spectrum Disorder (ASD; e.g., Dawson et al., 2002; Dawson, Webb, Carver, Panagiotides, & McPartland, 2004; Schultz et al., 2000; Wilkinson, Best, Minshew, & Strauss, 2010). Given (a) face processing skills play an important role in recognising and interpreting social signals (Calder & Young, 2005; Herzmann, Danthiir, Wilhelm, Sommer, & Schacht, 2007), and (b) social disability in ASD is profound and central to the diagnostic criteria of the disorder (APA, 2000), it is not surprising that a considerable amount of research has been invested in investigating face processing in ASD (Klin et al., 1999). The present thesis examined face recognition, a central component of the face processing system which is thought to be affected in individuals ASD. More specifically, the contribution of memory associated with early implicit visual processing to the face recognition deficits that are often reported in the literature (Klin et al., 1999; Wolf et al., 2008) was assessed.

Despite the fact that face recognition skills have been widely studied in ASD, empirical evidence of a specific deficit has been mixed (Klin et al., 1999). Given these mixed results, some suggest deficits in face recognition in ASD may be the result of a general cognitive or perceptual impairment (Behrmann, Thomas, & Humphreys, 2006; Davies, Bishop, Manstead, & Tantam, 1994). Others argue that impairment in face recognition in ASD is a specific deficit resulting from atypical development of the face processing system (Dawson, Webb, & McPartland, 2005; Wolf et al., 2008).

Thus, two main theoretical perspectives on the face recognition deficit in

ASD have been proposed. The social motivation or expertise hypothesis posits that face recognition deficits arise from a failure to orient to faces during development. Consequently, the development of specialised brain regions associated with face processing is disrupted (Dawson et al., 2005). An alternative perspective suggests impairment in face recognition in ASD may result from difficulties with complex information processing (Minshew, Williams, & McFadden, 2008; D. L. Williams, Goldstein, & Minshew, 2006). To gather further evidence relevant to the evaluation of these perspectives I conducted four experiments to examine face recognition in individuals with ASD. Specifically, I examined whether there was evidence of dissociation between the early, automatic processing of face information and late, effortful face recognition. This should assist evaluation of whether the face recognition impairment in ASD is isolated to (a) late stage, complex information processing, or (b) affects multiple levels of the face processing system, including early stage processing, with the latter being more consistent with the social motivation/expertise hypothesis.

Experiment 1 confirmed previous studies reporting presence of a face recognition deficit in ASD. Participants were assessed with a standardised face recognition test, the Cambridge Face Memory Test (CFMT; Duchaine & Nakayama, 2006a). Participants with ASD performed worse than matched controls and test norms overall. Nonetheless, many individuals with ASD performed at, or even better than, the typical level for their age. Thus, it is apparent face recognition in ASD is characterised by a large degree of heterogeneity between individuals. However, given the poorer performance in ASD participants when group means were examined, the next two experiments

were designed to determine whether the deficit in face recognition in some individuals with ASD is confined to late, high-level processes associated with explicit recognition, or whether it extends to early, implicit processing of visual information. If the former position is true, then this would be more consistent with the complex information processing hypothesis. If, however, the latter position is found to be true then this would suggest that both early and late levels of processing are affected, which would be more consistent with the expertise, or social motivation hypothesis.

The next studies used eye movement fixations to assess the influence of memory on implicit processing of studied faces. Previous studies have shown that eye movement behaviour differs for viewed compared to novel faces, a difference assumed to reflect the presence of a memory trace for old, but not to new faces (Althoff & Cohen, 1999). Specifically, Experiments 2 and 3 compared (a) the influence of memory on implicit visual processing for unfamiliar faces using eye movements and reaction time (RT), and (b) explicit face memory using an old-new discrimination task. Experiment 3 differed from Experiment 2 in that the degree of similarity between study and test stimuli was manipulated: previously unseen images of target faces were presented at test, and some of the images were degraded with visual noise. Experiment 3 therefore increased the level of difficulty for the recognition task. Both experiments were supportive of a deficit in explicit face recognition in ASD, with explicit face recognition in ASD being particularly affected by task difficulty (i.e., the stimulus manipulation in Experiment 3). Eye movement-based measures, however, indicated that at least some areas of implicit visual processing associated with face recognition are

intact in ASD. Specifically, the influence of memory on visual scanning of viewed faces compared to novel faces was similar for participants with and without an ASD. Given the apparent dissociation between implicit face processing and explicit face recognition, these results are consistent with the complex information processing hypothesis.

Consistent with the complex information processing hypothesis, face processing in ASD may be affected by a deficit in holistic or configural processing, and a bias for part or feature based encoding. Some studies have reported an advantage for inverted face recognition in individuals with an ASD compared to non-ASD persons. More specifically, individuals with an ASD may not be affected to the same extent as non-ASD persons by face inversion, which disrupts configural processing. This is referred to as the Face Inversion Effect (FIE). If persons with ASD are reliant on feature based recognition then this will be advantageous for inverted face recognition, but disadvantageous for upright recognition. Experiment 4 examined the FIE in participants with an ASD. Again, eye movement measures were used to assess implicit visual processing of face stimuli, RTs were examined, and an old-new recognition task assessed explicit face recognition. Eye movement measures did not reliably discriminate old and new faces. It is likely that either the stimuli or the task led to a high degree of homogeneity in eye movements between all stimuli. Nonetheless, and contrary to expectation, both participants with and without an ASD showed strong RT and accuracy based FIEs. This indicates that ASD participants demonstrated configural face processing and did not show an advantage for feature based recognition as predicted. Explicit face recognition was again found to be worse in

ASD participants compared to non-ASD participants.

Given that the influence of memory on implicit processing has not been well studied in persons with ASD, and there is little or no research with this group that has specifically examined the role of memory on implicit face processing, this research adds to the knowledge base in this area. The results reported here place the origin of the deficit in resource intensive processes associated with explicit, high-order recognition decisions. In contrast, early, automatic face processing may be spared. Contrary to some studies, no difference in regions viewed (e.g., reliance on the mouth compared to the eyes) was found between ASD and non-ASD participants, and there was no evidence of an ASD advantage for feature based recognition.

DECLARATION

I certify that this thesis does not contain any material which has been accepted for the award of any other degree or diploma; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text of the thesis or notes.

Darren Hedley, BPsyc (Hons.), M.A.

22nd February, 2012

ACKNOWLEDGEMENTS

First and foremost, thank you to my supervisors. Robyn, your support, encouragement, and confidence in my work pushed me both academically and personally. Your passion for your work provides a continual reminder of why we do what we do, and is truly inspirational. Neil, I have benefited greatly from your kindness, wisdom and encouragement. Despite your commitments you have always found time for me. Keep on riding that banzai pipeline!

Thank you to Ben Maddock for providing technical expertise and support, also to Sean Fitzgibbon, Nathan Weber, Alyssa Sawyer, Pawel Skuza, Nathan Leggett, Paul Williamson and everyone from the eyewitness lab at Flinders University.

Thank you to Yessica for hanging in there and for moving so far from home to support me, to my mum Robyn for many years of unconditional encouragement and support, to my brother David who also provides me with inspiration and of whom I am so proud, to Anusha, Micah and Zachary, and to my extended family; particularly Daryl and the rest of the wanderers and adventurers from the clan who feed my spirit. To my dad for advising me to accept the offer of the PhD position. To members of the Flinders University Underwater Club (FUUC), roomies Cath, Nicole and Fei, the Crazy Farmers, and to Billy T, Aussie Bob, Jason, and the rest of the unsavoury musicians, hangers on, and unsavoury hangers on who have kept me truly amused over the last few years. Un fuerte abrazo a Jerrilou, Jane y Jason, a mis compadres de Alliant, y a todos mis amigos de Mexico.

Thank you to Brad Duchaine for supplying the Cambridge Face Memory Test (CFMT), and for valuable feedback and comments regarding Experiment 1.

Above all, thank you to all of the participants who so freely gave their time, and to Jon Martin and Autism SA for their assistance with recruitment.

This research was supported by (a) Australian Research Council (ARC) LE0882562 to Neil Brewer, Robyn Young et al., and ARC DP1093210 to Neil Brewer et al., (b) a Flinders University Research Grant to Robyn Young and Neil Brewer, and (c) a Flinders University Research Scholarship (FURS).

Portions of the research in this paper use the FERET database of facial images collected under the FERET program, sponsored by the DOD Counterdrug Technology Development Program Office (Phillips, Moon, Rizvi, & Rauss, 2000; Phillips, Wechsler, Huang, & Rauss, 1998), the Productive Aging Laboratory (PAL) Face Database (Minear & Park, 2004), and the Computer Vision Laboratory (CVL) Face Database, University of Ljubljana, Slovenia (Peer, 2011; Solina, Peer, Batagelj, Juvan, & Kovač, 2003).