FAMILIARITY AND AFFECT IN ADOLESCENTS WITH AUTISM SPECTRUM DISORDER

by

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This dissertation is dedicated to Anthony and Alice,

who have brought more joy into my life than I had ever imagined it could hold.

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ABSTRACT

In typically developing (TD) individuals, simple repeated exposure to stimuli results in greater affinity toward them. The main goal of the current project was to test the hypothesis that this mere repeated exposure (MRE) effect would be atypical in individuals with autism spectrum disorder (ASD). An abnormal MRE effect in ASD was suspected for several reasons, including evidence of: 1) stronger preference for familiarity in those with ASD, 2) slowed stimulus habituation in individuals with ASD, and 3) atypicalities in the neural reward circuitry of those with ASD, relative to TD comparison participants. In the current study, we also sought to examine the influence of stimulus type (i.e., social vs. non-social) on the MRE effect, as well as the association between the MRE effect and several individual difference variables (i.e., anxiety, intolerance of uncertaintly, and restricted and repetitive behaviours). In order to answer the research questions described above, we administered several experimental tasks and characterization measures to a group of 28 adolescents with ASD and 28 matched TD comparison participants. We found that, while TD adolescents displayed a typical MRE effect, the liking ratings of participants with ASD did not increase across stimulus presentations, even at the highest exposure frequencies. We interpreted this result as an indication that the MRE is either absent or delayed in ASD. The pattern of liking ratings across exposures frequencies was similar across stimulus categories for both the TD and ASD groups, suggesting that differences in the MRE effect in ASD are domain general. Few relationships between MRE findings and individual difference variables were observed. The current study represents an important contribution to the literature for several reasons. First, it provides a valuable window into one of the processes that may contribute to familiarity preference and novelty aversion in ASD (i.e., a disrupted MRE effect). Second, through identifying a clinical population in which the MRE effect is atypical, the present study has revealed new opportunities for researchers examining theoretical accounts of this phenomenon and hypotheses regarding its neural underpinnings. Third, it has provided us with a better understanding of the MRE effect in TD youth.

LIST OF ABBREVIATIONS USED

ACC	Anterior cingulate cortex
ACG	Anterior cingulate gyrus
ADOS	Autism Diagnostic Observation Schedule
ADI-R	Autism Diagnostic Interview - Revised
ANOVA	Analysis of variance
ASD	Autism Spectrum Disorder
DLPFC	Dorsolateral prefrontal cortex
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders - Fourth Edition
DSM-5	Diagnostic and Statistical Manual of Mental Disorders - Fifth Edition
EDR	Electrodermal response
EMG	Electromyography
fMRI	Functional magnetic resonance imaging
FSIQ	Full scale intelligence quotient
HFM	Hedonic fluency model
IQ	Intelligence quotient
ISI	Interstimulus interval
LOFC	Lateral orbitofrontal cortex
MOFC	Medial orbitofrontal cortex
MRE	Mere repeated exposure
NA	Nucleus accumbens
OFC	Orbitofrontal cortex
PF/AM	Perceptual fluency/attribution model
PIQ	Performance intelligence quotient
RBS-R	Repetitive Behaviour Scale - Revised Edition
SCARED	Screen for Child Anxiety Related Emotional Disorders
SRS	Social Responsiveness Scale
TD	Typically developing
TFM	Two factor model
UND	University of Notre Dame
URM	Uncertainty reduction model
VIQ	Verbal intelligence quotient
VMPFC	Ventromedial prefrontal cortex
VS	Ventral striatum
WAIS-IV	Wechsler Adult Intelligence Scale - Fourth Edition
WASI	Wechsler Abbreviated Scale of Intelligence
WISC-IV	Wechsler Intelligence Scale for Children - Fourth Edition

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CHAPTER 1: INTRODUCTION

1.1   OVERVIEW

In typically developing (TD) individuals, increased familiarity with stimuli generally results in greater affinity toward them. This phenomenon, called the mere repeated exposure (MRE; Zajonc, 1968) effect, is robust and pervasive (Bornstein, 1989; Houston-Price et al., 2009). It has also been found to influence real-world behaviours; specifically, individuals are more likely to approach and less likely to avoid stimuli that have become familiar through MRE (Bornstein, Leone, & Galley, 1987; Burger, Soroka, Gonzago, Murphy, & Somervell, 2001; Jones, Young, & Claypool, 2011). There are many reasons to believe that an atypical MRE effect may be present in Autism Spectrum Disorder (ASD; Diagnostic and Statistical Manual of Mental Disorders - Fifth Edition; DSM-V; American Psychiatric Association, 2013) and could help to explain several associated symptoms.

First, people with ASD have frequently been described as having a preference for familiar stimuli (e.g., Croonenberghs, Bosmans, Deboutte, Kenis, & Maes, 2002; Gopnik, Capps, & Meltzoff, 2000; Gustafsson & Papliński, 2004; Pascualvaca, Fantie, Papageorgiou, & Mirsky, 1998; Pellicano & Burr, 2012). Second, research findings suggest that at least one of the two arousal processes that has been hypothesized to underlie the MRE effect (i.e., stimulus habituation; Berlyne, 1970; Bornstein, 1989; Stang, 1974) is disrupted in ASD (e.g., Guiraud et al., 2011; James & Barry, 1984; Musurlian, 1995; Perry, Minassian, Lopez, Maron, & Lincoln, 2007). Third, abnormalities in the brain's reward circuitry, upon which the MRE effect has been proposed to rely (Zebrowitz & Zhang, 2012), have been observed

in individuals with ASD (Dichter, Felder, et al., 2012; Kohls et al., 2013; Schmitz et al., 2008; Scott-Van Zeeland, Dapretto, Ghahremani, Poldrack, & Bookheimer, 2010).

Despite this, the relationship between familiarity and affect in ASD is not yet well understood. In fact, to our knowledge, only one study (i.e., South et al., 2008) has considered the performance of individuals with ASD within the context of a MRE task. In the current study, we used well-established experimental procedures to examine the familiarity-affect relationship in adolescents with ASD. The main goal of this project was to determine whether or not the MRE effect is intact in this population. Other objectives included evaluating whether stimulus type (i.e., social vs. nonsocial) affects the nature of the MRE effect in people with ASD and whether particular symptoms of this disorder (e.g., circumscribed interests) are associated with the hypothesized atypicalities in the familiarity-affect relationship.

This chapter will elaborate on the rationale provided above through a review of the relevant MRE and ASD literatures and a detailed description of the project's research questions and hypotheses.

1.2 THE MERE REPEATED EXPOSURE EFFECT

1.2.1 General Overview

Our decisions, actions, and values, as well as the attachments and alliances that we form, are influenced by how we feel about particular objects, individuals, ideas, and events (Zajonc, 2001). For example, people are motivated to approach positively evaluated stimuli (i.e.,

attempt to bring them closer in a psychological and/or physical sense) and avoid negatively evaluated stimuli (i.e., push them away, literally and/or figuratively; Chen & Bargh, 1999; Elliot, 2006, 2008). Our relative evaluations of stimuli in our environment (i.e., our patterns of preferences) are influenced by several factors (Zajonc, 2001). For example, some stimuli are innately attractive or aversive. Classical or operant conditioning can also affect our attitudes toward stimuli, as can imitation, as seen in societal adherence to trends. However, MRE (Zajonc, 1968) to stimuli is one of the simplest ways through which our preferences are shaped.

Though Fechner described the influence of familiarity on stimulus evaluation as early as 1876, it was not until the publication of a ground-breaking paper by Zajonc in 1968 that this relationship was brought to the forefront of psychological research (Bornstein, 1989). Zajonc described a phenomenon through which "mere repeated exposure of the individual to a stimulus is a sufficient condition for the enhancement of his attitude toward it" (1968, p. 1). According to Zajonc (1968), the only requirement for preferences to develop via MRE is the presentation of the stimulus; the individual does not have to perform any action, nor is any type of reinforcement provided. Studies numbering in the hundreds have demonstrated that this effect is pervasive and robust; for example, it has been elicited using multiple stimulus presentation modalities (e.g., auditory, visual, and olfactory) and stimulus types (e.g., real and nonsense words, photographs, and Chinese ideographs), across a variety of time frames, and in laboratory and real-world settings (Houston-Price et al., 2009).

A typical laboratory-based MRE study consists of two phases: an exposure phase and a rating

phase. In the exposure phase, participants are shown a series of unfamiliar neutral visual stimuli, with each stimulus presented for a set number of exposures. For instance, they might see 25 stimuli in total, with 5 stimuli in each of the 1, 2, 5, 10, and 15 exposure frequency conditions. In the rating phase, participants are asked to evaluate each of the previously presented stimuli and several novel stimuli. Most often, they provide their ratings of stimuli on a Likert scale (Likert, 1932) designed to measure stimulus liking. MRE studies typically adopt a repeated measures design, with each participant viewing and rating stimuli from each of the exposure frequencies. Experiments such as the one described above generally reveal that stimuli presented at higher exposure frequencies are assigned more positive stimulus evaluations. However, at the highest exposure frequencies (i.e., 10 exposures or more, depending on the experimental methods employed, participant characteristics, etc.), liking ratings often begin to plateau or even decline, resulting in an inverted u-shaped relationship between exposure frequency and liking ratings (Colman, Walley, & Sluckin, 1975; Lee, 2001).

1.2.2   Theoretical Accounts

While more than a dozen theoretical frameworks have been proposed to account for the MRE effect (Bornstein & Craver-Lemley, 2004), the specific mechanisms that underlie this phenomenon have yet to be conclusively established (Lee, 2001; Moreland & Topolinski, 2010; Seamon, McKenna, & Binder, 1998). Explanatory models of the MRE effect can be divided into three broad camps, each of which proposes a set of mechanisms that underlie the phenomenon: purely affective, purely cognitive, and both affective and cognitive

(Harmon-Jones & Allen, 2001). The most prominent example of each type of model will be described here, in sequence.

Affective: The Uncertainty Reduction Model. The uncertainty reduction model (URM) of the MRE effect is an extension of an earlier theory called the two-factor model (TFM; Lee, 2001). Through their TFM, Berlyne (1970) and Stang (1974) proposed that the combined effects of two antagonistic arousal processes, habituation and boredom, produce the MRE effect. The model suggests that when stimuli are initially introduced, they produce a high level of arousal because they are associated with uncertainty. The TFM posits that this high level of arousal is aversive and any factor that reduces it to a moderate level will be perceived as pleasant and rewarding. The model proposes that repeated exposure to a stimulus serves an arousal moderating purpose by providing the individual with the opportunity to discriminate, classify, and recognize its elements, thereby resolving any associated uncertainty. However, the TFM also suggests that if the stimulus is presented too many times, boredom can set in and a downturn in affect toward it can result.

To these basic principles of the TFM, Bornstein's (1989) URM added the stipulation that implicit, unconscious learning could contribute to the MRE effect. Previous iterations of the model had only acknowledged the contributions of conscious, deliberate learning (Lee, 2001). Bornstein (1989) explained that the addition of an implicit learning component was necessary to account for his meta-analytic findings that stimulus recognition is not necessary for MRE effects to be observed. Consistent with Zajonc's early writings on the MRE effect (1968), Bornstein (1989) also placed the phenomenon within an evolutionary context. He

suggested that it is adaptive to prefer familiar stimuli to novel ones because the unknown is inherently associated with risk. That is, novel stimuli are more likely to be dangerous than stimuli that have previously been encountered with neutral or positive outcomes. From an evolutionary perspective, therefore, individuals who experience some degree of heightened arousal and apprehensiveness when confronted with novel stimuli may survive to pass on their genetic material when their less cautious counterparts do not. Later in his career, Bornstein, who proposed the URM, put forward another model of the MRE effect, the perceptual fluency/attribution model (PF/AM). Interestingly, while Bornstein himself has moved away from the URM, this early model has continued to garner support in the research community (e.g., Lee, 2001; Zebrowitz & Zhang, 2012).

Cognitive: Perceptual Fluency/Attribution Model. In presenting the PF/AM, Bornstein and D'Agostino (1992, 1994) suggested that previously encountered stimuli are easier to perceive, encode, and process than novel stimuli (Harmon-Jones & Allen, 2001). This ease of processing is called perceptual fluency. According to the PF/AM, individuals are sometimes unaware that they are experiencing perceptual fluency as a result of previous exposure to a stimulus (e.g., in cases of very short stimulus presentations). The model suggests that, in these instances, individuals will search for a logical explanation for the experience of perceptual fluency and, in doing so, will look to the experimental context for cues. The PF/AM posits that if participants are asked to rate their positive affect toward a stimulus, they will misattribute processing ease to stimulus liking. However, the model also proposes that participants will incorrectly ascribe the experience of perceptual fluency to other factors (e.g., brightness, loudness, disliking, etc.) if these are the focus of ratings. In

cases in which participants are aware that their performance may have been affected by previous stimulus presentations (e.g., in cases of very long stimulus exposures), the PF/AM suggests that they will correct their misattribution of perceptual fluency and, instead, correctly link it to MRE. When this correction process occurs, a MRE effect is less likely to be observed. In that the PF/AM explains the increases in liking that are associated with the MRE effect as artefacts of cognitive misattributions of the experience of perceptual fluency, affect does not play a role in this model of the phenomenon (Harmon-Jones & Allen, 2001).

Cognitive/Affective: Hedonic Fluency Model. The hedonic fluency model (HFM) of the MRE effect proposed by Winkielman and Cacioppo (2001) is similar to the PF/AM in that it incorporates the concept of perceptual fluency. However, the two explanations differ in how they conceptualize the mechanisms through which perceptual fluency influences stimulus evaluations. Unlike the PF/AM, the HFM suggests that the experience of perceptual fluency elicits a genuine positive affective reaction, which leads participants to evaluate previously encountered stimuli more positively.

Winkielman and Cacioppo (2001) proposed that the experience of positive affect associated with perceptual fluency may assist in the internal monitoring of cognitive processes. For example, a person may interpret positive emotion as an indicator that they are progressing toward recognizing and interpreting a stimulus (Carver & Scheier, 1990). Further, the positive affect that accompanies perceptual fluency may motivate them to continue with the cognitive activity in which they are currently engaged (Ramachandran & Hirstein, 1999). Finally, ease of processing may serve as a cue to the person that he/she is equipped with the

knowledge structures required to complete the task at hand (Bless & Fiedler, 1995). Reber, Schwarz, and Winkielman (2004) proposed that perceptual fluency may also indicate a positive state of affairs in the broader world. Specifically, it may signal to the individual that the stimulus is familiar, and is therefore likely to be harmless.

Reconciling the Evidence. While no consensus has been reached regarding the mechanisms that underlie the MRE effect, the results of several studies cast doubt upon the ability of the PF/AM to fully account for the phenomenon (Harmon-Jones & Allen, 2001). For example, as indicated previously, one of the main assumptions of the PF/AM is that participants should misattribute perceptual fluency to factors other than liking if they are asked to rate stimuli on these characteristics. However, while Mandler, Nakamura, and Van Zandt (1987) found that perceptual fluency could be attributed to factors beyond positive affect (i.e., brightness and darkness), several subsequent studies (e.g., Reber, Winkielman, & Schwarz, 1998; Seamon et al., 1998) have failed to replicate these findings. Further, a prediction of the PF/AM is that the MRE effect should be larger for stimuli that are not recognized than for those that are. While some results support this assertion (Bornstein, 1989; Bornstein & D'Agostino, 1992), recent research indicates that this finding may not be as consistent as previously suggested (Newell & Shanks, 2007; Stafford & Grimes, 2012).

Evidence from studies employing facial electromyography (EMG), a technique used to monitor muscle activity, is also hard to reconcile within the PF/AM framework. For example, in two experiments Winkielman and Cacioppo (2001) manipulated perceptual fluency through the presentation of contour primes and variation of stimulus exposure

duration. Contour primes were created by removing the inside details of pictures and degrading remaining visual information by overlaying random patterns. In addition to collecting liking data, Winkielman and Cacioppo monitored the cheek and brow areas of participants' faces using EMG during the tasks. Increased activity in the cheek region (i.e., incipient smiles) has previously been associated with positive affect in EMG studies, whereas increased activity in the brow region (i.e., incipient frowns) has been connected to negative affect (Dimberg, 1990). For both types of perceptual fluency manipulations, Winkielman and Cacioppo (2001) found that stimuli that were easier to process were associated with more positive evaluations and higher EMG activity over the cheek region. These results indicated that perceptual fluency is not affectively neutral, as suggested within the PF/AM model.

Harmon-Jones and Allen (2001) reported findings similar to those of Winkielman and Cacioppo (2001); specifically, they observed that during a typical MRE task, participants' cheek muscles were more active while they were viewing familiar stimuli, compared to unfamiliar stimuli. They also observed that liking ratings and muscle activity in the cheek region were positively correlated. In that Harmon-Jones and Allen (2001) demonstrated increased activity in the cheek region without corresponding decreased activity in the brow region for familiar stimuli, the results of their study suggest that an increase in positive affect is associated with the MRE effect. Harmon-Jones and Allen (2001) proposed that their finding was more consistent with the HFM, which suggests that perceptual fluency results in increased positive affect, than the URM, which posits a reduction in the negative affect initially associated with novel stimuli. However, Zebrowitz and Zhang (2012) caution that

either an increase in positive affect or a decrease in negative affect could result in the production of incipient smiles.

In their own study, Zebrowitz and Zhang (2012) observed results that they suggested were more consistent with the URM than the HFM. Zebrowitz and Zhang (2012) monitored neural activation in participants' lateral and medial orbitofrontal cortices (LOFC and MOFC, respectively) using functional magnetic resonance imaging (fMRI) while they completed a standard MRE experiment. The LOFC and MOFC have been found to exhibit increased activity when negatively and positively valenced stimuli, respectively, are presented (e.g., O'Doherty et al., 2003). Zebrowitz and Zhang (2012) found less activation in the LOFC for previously presented stimuli than for novel stimuli. They suggested that this result was consistent with the URM, which predicts a decrease in negative affect with repeated stimulus presentations. Zebrowitz and Zhang (2012) interpreted their finding of no difference in MOFC activation between familiar and unfamiliar stimuli to indicate that positive affect does not increase with repeated stimulus presentations, a result that is in contrast to the predictions of the HFM.

While recent studies have not conclusively determined which existing account of the MRE effect is most plausible, their combined evidence suggests that the MRE effect cannot be entirely accounted for by purely cognitive models (e.g., the PF/AM). That is, affective processes seem to be involved in the MRE effect, though the precise nature of their contribution is yet to be determined. It should be noted that the URM and HFM accounts of the MRE effect are not mutually exclusive (Zebrowitz & Zhang, 2012). That is, it

remains possible that both an increase in positive affect associated with perceptual fluency and a decrease in negative affect resulting from habituation both contribute to the MRE effect.

1.2.3   Neural Basis

To our knowledge, four neuroimaging studies have examined the neural basis of the MRE effect. The results of these investigations have been somewhat inconsistent with respect to the brain structures that they have implicated in the phenomenon. As indicated previously, Zebrowitz and Zhang (2012) found less activation in the LOFC for previously presented stimuli than for novel ones. Zebrowitz and Zhang (2012) also noted repetition suppression (i.e., less activation for familiar than novel stimuli) in the caudate, occipital temporal cortex, inferior frontal cortex, and medial prefrontal cortex. In their study, Green, Bærensten, Stødkilde-Jørgensen, Roepstorff, and Vuust (2012) reported greater activation (i.e., repetition enhancement) of the dorsolateral prefrontal cortex (DLPFC) and inferior parietal cortex for familiar stimuli than for unfamiliar stimuli. They interpreted these findings as evidence that the MRE effect involves working memory and retrieval processes. The results of a study conducted by Elliott and Dolan (1998) were somewhat similar, in that they implicated the right lateral prefrontal cortex in the MRE effect. Elliott and Dolan (1998) suggested that this result indicated the contribution of the implicit memory system to the familiarity-affect relationship. Finally, Koutstaal, Butler, Coates, and Simons (2013) described the results of an fMRI study in which they observed greater activation in the left amygdala and uncus for stimuli familiarized through MRE, compared to novel stimuli.

Koutstaal et al. (2013) interpreted their findings as evidence that brain regions involved in the processing of affect are recruited in the MRE effect.

Two examinations of the MRE effect in clinical populations also contribute to our understanding of the neural underpinnings of this phenomenon. Barker, Andrade, Romanowski, Morton, and Wasti (2006) administered an auditory MRE task to a group of individuals with head injuries and associated executive function deficits. The lesions of participants with brain injuries were mainly centred in the frontal lobe and particularly in the ventromedial prefrontal cortex (VMPFC) and DLPFC. Barker et al. (2006) observed no MRE effect in their sample of participants with VMPFC and DLPFC damage. Similarly, Chiba, Kesnter, Matsuo, Heilbrun, and Madden (2013) found that the MRE effect was absent in patients with selective amygdala damage.

Overall, the neuroimaging and neuropsychological data reviewed above are somewhat inconsistent and, because of this, we do not yet have a clear picture of the neural underpinnings of the MRE effect. However, Zebrowitz and Zhang (2012) have hypothesized that the brain's reward circuitry is likely to be involved in the phenomenon and some of the results reviewed above do support this theory. For example, the orbitofrontal cortex (OFC) is thought to be involved in the detection, perception, and expectation of rewards (W. Schultz, 2000) and the LOFC, specifically, has been found to be particularly responsive to negatively valenced stimuli (O'Doherty, Kringelbach, Rolls, Hornak, & Andrews, 2001). Also, the VMPFC is thought to code for rewarding and punishing stimuli and process information related to reward probability (Delgado, Locke, Stenger, & Fiez, 2003), while the DLPFC has

been hypothesized to employ reward-related information to prepare and initiate behaviour intended to acquire rewards (W. Schultz, 2000). Further, the amygdala plays a critical role in fear conditioning and is also thought to be an important contributor to reward learning (Dichter, Richey, Rittenberg, Sabatino, & Bodfish, 2012; Shabel & Janak, 2009).

1.2.4 Behavioural Implications

Most previous studies have focused on the attitudinal changes that result from MRE rather than associated behavioural outcomes (Jones et al., 2011). However, the few studies that have examined observable behaviour following MRE are valuable to consider because, while evaluations of stimuli are frequently consistent with actions toward them, this is not always the case (Elliot & Covington, 2001). Further, the practical importance of the MRE effect depends largely on its ability to transcend the realm of attitudes and influence how individuals interact with their surroundings. Hypotheses regarding the behavioural implications of MRE have generally focused on approach and avoidance responses. Specifically, it has been theorized that, as stimuli are familiarized through MRE, approach behaviours toward them should increase and avoidance behaviours should decrease (e.g., Zajonc, 2001).

In one experiment examining this hypothesis, Jones et al. (2011) showed participants novel stimuli and stimuli familiarized through MRE. They directed participants to make either approach (i.e., pushing a joystick toward a computer screen) or avoidance (i.e., pulling a joystick away from a computer screen) movements in response to these stimuli. They recorded the time it took participants to perform these actions and found that they were

significantly faster at making approach movements for familiar stimuli than for novel stimuli. Similarly, participants were slower at making avoidance movements for familiar stimuli than for novel stimuli. In a second similar experiment, Jones et al. (2011) presented novel and familiar stimuli and asked participants to move a joystick either toward or away from the computer screen, depending on their "gut reactions" (p. 388). They found that participants made approach movements more often when presented with familiar stimuli than when presented with novel stimuli. Further, Jones et al. (2011) asked participants to provide liking ratings for stimuli and found that participants evaluated familiar stimuli significantly more positively than novel stimuli. They also observed that the more participants liked familiar stimuli, the more often they demonstrated approach movements toward them.

Bornstein et al. (1987) also examined the effects of MRE on observable behaviour. They found that prior subliminal exposure to a photograph of one of two confederates made participants more likely to agree with the familiar confederate than the unfamiliar confederate in a later discussion regarding poetry. Similarly, Burger et al. (2001) found that participants who had previously completed a task in the same room as a confederate were more likely to comply with a later request from him/her than those who had not encountered the confederate previously.

Overall, the results of the studies reviewed above suggest that, consistent with predictions (e.g., Zajonc, 2001), MRE is associated with increases in approach and decreases in avoidance responses. As indicated previously, these findings are noteworthy because they

confirm the theoretical assumption that MRE influences real-world behaviour, which establishes the practical importance of the phenomenon.

1.2.5 Development

The majority of the MRE literature has focused on examining the familiarity-affect relationship in adult samples. Those studies that have included child and/or adolescent participants have yielded relatively inconsistent results, with some researchers finding MRE effects (e.g., Busse & Seraydarian, 1978; G. N. Cantor, 1972; Heingartner & Hall, 1974; Houston-Price et al., 2009) and others not (e.g., G. N. Cantor, 1968; G. N. Cantor & Kubose, 1969; J. H. Cantor & Cantor, 1964). It is likely that variable findings in the youth MRE literature are at least partly attributable to methodological inconsistencies. Many of the laboratory-based MRE studies that included child or adolescent samples were conducted in the 1960s and 1970s, before the publication of methodological papers (e.g., Bornstein, 1989) that considerably influenced the design of subsequent MRE experiments. Issues such as the use of lengthy stimulus presentations (G. N. Cantor, 1968, 1972; G. N. Cantor & Kubose, 1969), relatively simple or already familiar stimuli (G. N. Cantor, 1968; G. N. Cantor & Kubose, 1969; J. H. Cantor & Cantor, 1964), and non-traditional measures of affect (J. H. Cantor & Cantor, 1964, 1966) cloud the interpretability of results from these early MRE studies in youth.

More recent MRE investigations in child and adolescent samples have tended to weight ecological validity more heavily than experimental control and, therefore, their methods have not closely paralleled those employed in the adult MRE literature. For example, Houston-

Price et al. (2009) found a MRE effect in children using picture books, read at home by parents, to familiarize children with stimuli. Although their results are noteworthy, the picture book paradigm is not purely one of MRE (i.e., parents presumably interacted with children as they read the book) and it is difficult to determine the degree to which parents adhered to exposure schedules. Similarly, Auty and Lewis (2004) and Morgenstern, Isensee, and Hanewinkel (2012) found typical MRE effects in children, but employed stimuli from movies and advertising campaigns that participants were likely to have encountered previously. This is in contrast to traditional MRE tasks, which use unfamiliar stimuli. Beyond the studies described above, much of the remaining modern MRE research with child samples has been published in the food preference literature (e.g., de Wild, de Graaf, & Jager, 2013; Hausner, Olsen, & Møller, 2012). While the results of these examinations do indicate the presence of MRE effects in youth, Bornstein (1989, p. 267) suggests that studies of MRE to gustatory stimuli "present a different set of methodological issues that are only tangentially related to findings obtained using better-controlled visual and auditory stimuli."

In a recent study, we sought to add to the existing literature on the MRE effect in youth. Specifically, we examined the phenomenon in a sample of TD children and adolescents aged 8 to 18 (Kerr, Filliter, & Johnson, 2013) using a highly controlled experimental paradigm. Overall, we found a significant positive correlation between participant age and the strength of the MRE effect. That is, the older children in our sample demonstrated larger MRE effects than the younger children, suggesting that the MRE effect becomes more robust across development. Our findings fit well with previous attempts by MRE researchers to explain findings of novelty preference in infants (for a review, please see Pascalis & de Haan,

2003) and familiarity preference in adults. For example, Bornstein (1989) proposed that, as children become more autonomous, responsibility for assessing possible dangers transfers to them from their parents and a familiarity preference develops. It is also likely that differences in the MRE effect across childhood and adolescence are at least partly reflective of the considerable transformation that takes place in the brain's reward system during the same period (Galvan, 2010).

1.3   AUTISM SPECTRUM DISORDER

1.3.1   General Overview

ASD is a complex neurodevelopmental disorder that affects approximately 1% of the population (Davidovitch, Hemo, Manning-Courtney, & Fombonne, 2013). Diagnostic criteria for ASD outlined in the DSM-5 (American Psychiatric Association, 2013) divide characteristics of the disorder into two broad categories. "Social communication and social interaction" symptoms include difficulties engaging in social-emotional reciprocity, using nonverbal communicative behaviours, and fostering and understanding social relationships (American Psychiatric Association, 2013, p. 50). The other subset of symptoms, "restricted, repetitive patterns of behavior, interests, or activities" include stereotyped or repetitive movements, object use, or speech, interests that are atypical with respect to their intensity or focus, and differences in reactivity to, or interest in, sensory stimuli (American Psychiatric Association, 2013, p. 50). Also included within this second symptom category, and of particular relevance to the present study, are symptoms that seem to indicate a general preference for the familiar and aversion to novelty in ASD. For example, the DSM-5

describes "[i]nsistence on sameness" and "inflexible adherence to routines" and gives examples of "extreme distress at small changes" and the "need to take [the] same route or eat [the] same food every day" (American Psychiatric Association, 2013, p. 50).

1.3.2   Patterns of Preferences

The notion that ASD is associated with familiarity preference has been articulated by many researchers (e.g., Croonenberghs et al., 2002; Gopnik et al., 2000; Gustafsson & Papliński, 2004; Pascualvaca et al., 1998; Pellicano & Burr, 2012). For example, in the first description of ASD, Kanner (1943) suggested that the behaviour of the children that he had studied was "[g]overned by an *anxiously obsessive desire for the maintenance of sameness…*" (p. 245). Kootz, Marinelli, and Cohen (1982) depicted children with ASD similarly when they said that "[r]ather than responding to novelty with orientation, observation, and exploration, the autistic child often responds with avoidance, thus preventing the development of new schemas and subsequent familiarization." Similarly, Dawson and Lewy (1989) described the "autistic child's tendency to respond to novel stimuli of normal intensity with aversive reactions" and Happé and Frith (2009, p. 1349) suggested that "sameness is what people with ASD would prefer, even over decades."

Parents' descriptions of their children further reinforce the notion that familiarity preference is a characteristic of many individuals with ASD. For example, in a book about his son with ASD, British Broadcasting Corporation journalist Michael Blastland (2006) suggested that youth with the disorder "have the appearance of fending off what they don't know by hanging on to the skirts of what they do, normal enough among all children, but here carried

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to an obsessive excess." Individuals with ASD have also recognized familiarity preference within themselves. For example, Soderstrom, Rastam, and Gillberg (2002) and Anckarsäter et al. (2006) found that adults with ASD endorsed fewer characteristics of "novelty seeking" than age- and sex-matched normative groups on the Temperament and Character Inventory (Cloninger, Svrakic, & Przybeck, 1993).

In addition to being linked to ASD in both the scientific and mainstream literatures, familiarity preferences have also been incorporated within various models attempting to explain the disorder. For example, Dawson and colleagues (Dawson & Lewy, 1989; Dawson, Meltzoff, Osterling, Rinaldi, & Brown, 1998) hypothesized that ASD may be characterised by an aversion to novelty that is particularly salient for social stimuli, which are dynamic and unpredictable. They suggested that this novelty aversion has far-reaching downstream consequences for information processing in ASD. Further, an artificial neural network designed by Gustafsson and Papliński (2004) to model learning in ASD incorporated a strong familiarity preference. Interestingly, this neural network produced a pattern of learning similar to what is observed in ASD (i.e., highly detailed knowledge in a narrow field).

Findings of decreased exploratory behaviour in children with ASD also hint at a preference for the familiar in this population. For example, Pierce and Courchesne (2001) found that when children with ASD were presented with an unstructured novel environment they spent 46% less time engaging in active exploratory behaviour than their TD peers. Similarly, Pisula (2003) found that children with ASD were less likely to approach a toy shelf in an unfamiliar

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room, compared to children with typical development and those with Down syndrome. In a subsequent study, Kawa and Pisula (2013) observed similar results; children with ASD demonstrated less exploratory behaviour in a novel environment than their TD peers.

Despite relatively widespread recognition that familiarity preference is a characteristic shared by many individuals with ASD and findings of decreased exploration of novel environments in this population, the relationship between familiarity and affect has not yet been rigorously evaluated in the ASD literature. In fact, to our knowledge, the MRE effect has been examined in ASD in only one previous study (South et al., 2008). Certainly, the descriptions of ASD reviewed above provide some indication of an abnormal relationship between stimulus exposure and affect in ASD. Findings of atypicalities in the brain's reward circuitry in ASD lend further credence to the notion that the familiarity-affect relationship may be disrupted in this disorder.

1.3.3   Neural Reward Circuitry

As indicated previously, although the neural substrates of the MRE effect have not yet been conclusively established, Zebrowitz and Zhang (2012) have proposed that the brain's reward circuitry is likely to play a central role in the familiarity-affect relationship. The neural reward system is thought to be composed of a network of structures (e.g., the medial temporal cortex, prefrontal cortex, OFC, striatum, thalamus, and amygdala) that are, together, responsible for the detection and prediction of rewards and the integration of reward information into the planning and execution of goal-directed behaviour (W. Schultz, 2000). As indicated previously, studies implicating the LOFC, VMPFC, DLPFC, and

amygdala in the MRE effect provide initial support for this hypothesis. Interestingly, with respect to the current study, there is mounting evidence of a dysfunctional neural reward system in ASD (Dichter, Damiano, & Allen, 2012). For example, Schmitz et al. (2008) observed greater activity in the left anterior cingulate gyrus (ACG) in a group of adults with ASD, compared to a group of typical participants, during a continuous performance task that incorporated monetary incentives. This region of the ACG is thought to play a role in the monitoring of performance based on reward-related feedback. Schmitz et al. (2008) also found a positive correlation between left ACG activity and social interaction difficulties, as assessed using the Autism Diagnostic Interview - Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994), in participants with ASD.

Scott-Van Zeeland et al. (2010) had children with ASD and TD comparison participants complete an implicit learning task that incorporated monetary incentives and social rewards (i.e., photographs of smiling faces). They observed less activation in the ventral striatum (VS) for both monetary and social rewards in the ASD group, as compared to the TD group. This difference was larger for the social reward condition. The VS is thought to be involved in temporal aspects of reward processing (Gregorios-Pippas, Tobler, & Schultz, 2009). Scott-Van Zeeland et al. (2010) also found significantly less activation of frontostriatal networks for the ASD group than the TD group during social, but not monetary, reward learning.

In another study of reward system function, Dichter, Felder, et al. (2012) monitored neural responses both during the anticipation and the receipt of rewards, which were either monetary prizes or images of objects often preferred by those with ASD. Dichter, Felder, et

al. (2012) found less activation of the nucleus accumbens (NA) in the ASD group, compared to the TD group, during the anticipation and receipt of monetary rewards. The NA is thought to be involved in the anticipation of rewards. For images of objects, however, the ASD group was characterized by less activation of the dorsal anterior cingulate cortex (ACC) and greater activation of the VMPFC during reward anticipation. The ACC is thought to be involved in cognitive control (Dichter, Felder, et al., 2012), while, as indicated previously, the VMPFC is hypothesized to code for rewarding and punishing stimuli and process information related to reward probability (Delgado et al., 2003).

Most recently, Kohls et al. (2013) asked a group of boys with ASD and a group of TD comparison participants to complete a go/no go task with social reward (i.e., photographs of smiling faces) and monetary reward conditions. They found diminished activation of the brain's reward circuitry in response to both social and monetary rewards in participants with ASD, compared to their TD peers. Specifically, the ACC and amygdala were noted to be hyporesponsive in the ASD group for both social and monetary rewards. The NA was also found to be less responsive to monetary rewards in the ASD group than in the TD group.

Taken together, the results of these studies indicate the presence of reward system dysfunction in ASD. Further, findings of atypical brain responses within both social and non-social reward conditions suggest that differences in the neural reward circuitry in ASD may be more generalized than initially suspected (Dawson, Webb, & McPartland, 2005; Dichter, Felder, et al., 2012; Kohls et al., 2013; R. T. Schultz, 2005). Certainly these results, in combination with theoretical and empirical work linking the MRE effect to the brain's

reward system (Chiba et al., 2013; Elliott & Dolan, 1998; Green et al., 2012; Koutstaal et al., 2013; Zebrowitz & Zhang, 2012), provide additional support for the notion that the familiarity-affect relationship may be atypical in individuals with ASD. As suggested by Happé and Frith (2009, p. 1349), it may be that ASD is characterised by "a different balance of rewards from novelty and familiarity."

1.3.4 Habituation

The literature reviewed thus far provides a strong foundation for hypothesizing an atypical MRE effect in ASD. To develop specific hypotheses about the nature of this atypicality, however, it is important to consider the cognitive and affective mechanisms that have been proposed to underlie the familiarity-affect relationship. As indicated previously, one of the main theories of the MRE effect, the URM, suggests that evaluations of stimuli become more positive across exposures as a consequence of stimulus habituation. Specifically, the URM proposes that the uncertainty associated with a novel stimulus decrease as the individual acquires more information about it over time.

Interestingly, a number of studies have produced results suggesting atypical stimulus habituation in ASD. For example, James and Barry (1980) found that TD children and those with intellectual disability demonstrated respiratory pause habituation across repeated presentations of simple visual stimuli, but participants with ASD did not. Respiratory pause is the increase in the length of the respiratory cycle that typically occurs when a novel stimulus is presented (Barry & James, 1988). In a subsequent study, James and Barry (1984) observed respiratory pause and electrodermal response (EDR; galvanic skin response)

habituation to simple auditory and visual stimuli in children with typical development and in those with intellectual disability, but not in participants with ASD. EDR is a method of measuring the skin's electrical resistance, which typically decreases within the few seconds following stimulus presentation (Barry & James, 1988). Similarly, Barry and James (1988) found that children with ASD showed almost no evidence of respiratory pause or EDR habituation to simple visual and auditory stimuli. In contrast, participants with typical development and those with intellectual disability demonstrated habituation on both dependent variables within five trials.

Musurlian (1995) also found that adults with ASD were less likely than comparison participants to demonstrate EDR habituation to auditory stimuli. In another EDR study, Stevens and Gruzelier (1984) found "marginal" (p. 257) evidence of slowed habituation to auditory stimuli in children with ASD, relative to comparison groups matched on age and intellectual ability. Using a prepulse inhibition task, Perry et al. (2007) observed that both adults with ASD and typical comparison participants exhibited decreasing startle responses, as measured by EMG, across repeated presentations of auditory pulses. However, individuals with ASD took approximately 30 more trials to maximally habituate to stimuli than did TD comparison participants.

The Kawa and Pisula (2013) study described previously also provided evidence of slowed habituation in ASD. Recall that, in this study, Kawa and Pisula (2013) found that children with ASD displayed less exploratory behaviour than their TD peers in a novel environment. With regard to habituation, Kawa and Pisula (2013) observed that the decline in exploratory

behaviour that took place across repeated exposures to the novel environment in TD participants was somewhat delayed and more gradual in children with ASD. In fact, when only the zone of the experimental environment that contained the most interesting toys was considered, the ASD group demonstrated no decline in exploratory behaviours across trials. In contrast, habituation was observed in all zones for the TD group.

While the results reviewed above suggest that ASD may be characterized by slow or absent habituation to stimuli, as Rogers and Ozonoff (2005) point out, there have also been studies (e.g., Bernal & Miller, 1970; Van Engeland, 1984) that have failed to demonstrate slowed stimulus habituation in participants with ASD. Rogers and Ozonoff (2005) suggest that some of the inconsistency in results in this area may relate to variation in the methods (e.g., diagnostic criteria, comparison groups, dependent variables, and sample sizes) that have been employed across studies. This is certainly likely, especially given the fact that the studies reviewed here span more than four decades. Despite the conflicting results described by Rogers and Ozonoff (2005), the majority of findings in this area generally suggest that individuals with ASD take longer to habituate to novel stimuli than comparison participants. If this is the case and, per the URM, stimulus habituation is a core process underlying the MRE effect, it would be expected that the familiarity-affect relationship would be atypical in individuals with ASD. Specifically, evaluations of stimuli would be predicted to increase more gradually across exposures in participants with ASD than in their TD peers.

1.3.5   Perceptual Fluency

Recall that another main theory of the MRE effect, the HFM, suggests that the phenomenon occurs because perceptual fluency, which is affectively positive, increases with repeated exposures. There is evidence in the ASD literature indicating that individuals with this disorder have intact or superior perceptual processing abilities compared to their TD counterparts across a range of tasks (e.g., visual search, pitch perception, and pattern discrimination; please see Dakin & Frith, 2004; Happé & Frith, 2006; and Mottron, Dawson, Souliéres, Hubert, & Burack, 2006 for further discussion). However, most of these findings relate to the processing of novel stimuli. We know relatively less about how prior exposures to stimuli influence the ease with which they are subsequently perceived in ASD. Fortunately, a few repetition priming studies provide some information about how stimulus repetition might affect perceptual fluency in individuals with ASD. Repetition priming tasks evaluate the influence of previous stimulus presentation on performance (Butler & Berry, 2004). Perceptual repetition priming tasks include those involving word and picture naming, word fragment or word stem completion, anagram solution, and lexical decision (Fleischman & Gabrieli, 1998).

In the first experiment examining repetition priming in ASD, Bowler, Matthews, and Gardiner (1997) had adults with the disorder and a group of typical comparison participants complete a word-stem completion task. They found that individuals in both groups completed word stems (i.e., the first three letters of words) with the remaining letters of words familiarized in a pre-exposure phase with approximately the same frequency. Renner, Klinger, and Klinger (2000) also reported typical repetition priming when they administered

a perceptual identification task to a group of children with ASD and TD comparison participants. That is, participants with ASD and those with typical development identified a higher percentage of familiar pictures than novel pictures when asked to name images presented very briefly (i.e., for 33 or 50 ms). Gardiner, Bowler, and Grice (2003) added further support to the notion that perceptual repetition priming is preserved in ASD by replicating the results of Bowler et al. (1997). That is, Gardiner et al. (2003) found that adults with ASD and typical comparison participants completed word stems with the remaining letters of pre-exposed words with approximately the same frequency. Both groups completed word stems to form familiarized words more often than unfamiliarized words, indicating the presence of repetition priming.

Overall, the results of these three repetition priming studies suggest that the perceptual fluency associated with repeated stimulus presentation is intact in ASD (Renner et al., 2000). However, to our knowledge, no studies have examined whether individuals with ASD experience perceptual fluency as affectively positive. At present, our understanding of the subjective experience of emotion in people with ASD is quite limited. Further, it is unclear whether differences that have been reported in this area (e.g., Hill, Berthoz, & Frith, 2004; Losh & Capps, 2006) reflect an underlying atypicality in the experience of emotion or a difficulty identifying and reflecting on feelings (Gaigg, 2012). Without any indication of how people with ASD affectively experience perceptual fluency, it is difficult to generate clear hypotheses regarding the nature of the MRE effect in ASD from a HFM perspective. If perceptual fluency and positive affect were not linked in those with ASD, no MRE effect would be expected.

1.3.6   Anxiety and Intolerance of Uncertainty

Also relevant to how the familiarity-affect relationship might be affected in ASD is research examining the influence of individual difference variables on the MRE effect. While hundreds of studies have considered the MRE effect, fewer than ten have sought to evaluate the influence of individual difference variables on this phenomenon (Harmon-Jones & Allen, 2001). Two participant characteristics that have been examined in this relatively small body of research, anxiety and intolerance of uncertainty, are relevant to the consideration of the familiarity-affect relationship in ASD.

Anxiety. Schick, McGlynn, and Woolam (1972) selected, from amongst a large group of university students, individuals with high and low scores on the Taylor Manifest Anxiety Scale (Taylor, 1953). Then, they administered a MRE task, employing cartoon strips as stimuli. Following the exposure phase of their experiment, Schick et al. (1972) asked participants to rate how funny they found each cartoon on a four-point scale. Schick et al. (1972) observed that participants with low anxiety and those with high anxiety both found familiar stimuli to be funnier than unfamiliar stimuli. However, participants with high anxiety assigned higher ratings to familiar cartoons than did participants with low anxiety. The high anxiety group also gave lower ratings to unfamiliar stimuli than did the low anxiety group. This finding of a linkage between anxiety and the MRE effect is interesting with respect to the present study because anxiety symptoms are very common in ASD. In fact, van Steensel, Bögels, and Perrin (2011) found that approximately 39.6% of the children and adolescents with ASD in their sample also met criteria for at least one Anxiety Disorder, as

described in the Diagnostic and Statistical Manual of Mental Disorders - Fourth Edition (DSM-IV; American Psychiatric Association, 2000).

Intolerance of Uncertainty. Crandall (1968) asked participants with high and low intolerance of uncertainty, as measured by Budner's Scale of Tolerance-Intolerance of Ambiguity (1962), to complete a MRE task. Participants in both groups were repeatedly exposed to non-word letter strings and asked to rate them on a "good-bad" scale (Crandall, 1968, p. 74). Crandall (1968) found that participants who were intolerant of uncertainty rated previously exposed stimuli more positively than did participants who were tolerant of uncertainty.

It is not surprising that Crandall's (1968) results were similar to those of Schick et al. (1972) because intolerance of uncertainty and anxiety are related constructs. Specifically, intolerance of uncertainty, which is "a dispositional characteristic that reflects a set of negative beliefs about uncertainty and its implications" (Koerner & Dugas, 2006, p. 620), is a vulnerability factor for clinically significant worry, which is associated with generalized anxiety (Dugas & Ladouceur, 2000). Intolerance of uncertainty is also of interest in the current study because of its relationship to ASD. Specifically, many individuals with ASD insist on sameness in their environments and inflexibly adhere to routines (American Psychiatric Association, 2013). Further, recent research suggests that individuals with ASD have difficulty recovering following the occurrence of ambiguous events (South, White, Chamberlain, Freeston, & Rodgers, 2013).

1.3.7 Existing Mere Repeated Exposure Research

To date, there has only been one published report of MRE performance in individuals with ASD. South et al. (2008) administered a MRE task to a group of high-functioning individuals with ASD. Their stimuli consisted of unfamiliar real words and abstract brushstroke drawings. South et al. (2008) found that participants with ASD preferred familiar stimuli over novel stimuli to a similar degree as TD comparison participants. While these results are interesting, several distinctive methodological characteristics complicate their interpretability.

South et al. (2008) acknowledged the use of a broad participant age range (i.e., 11 to 38 years) as a limitation of their study. However, it should also be noted that their MRE task was quite distinct from traditional MRE protocols. Stimuli were presented only once during the exposure phase, whereas a typical MRE task includes a range of stimulus exposure frequencies (Bornstein, 1989). The rating phase of the study was also distinctive in that participants were not asked to provide liking ratings on a Likert scale, as is most often the case in MRE research (Bornstein, 1989; Bornstein & Craver-Lemley, 2004). Instead, they were required to choose their preferred stimulus from a pair of stimuli, one familiar and one unfamiliar. Participants were asked to make this forced-choice judgement as quickly as possible. The forced-choice nature of participants' responses in the South et al. (2008) study is important to consider in light of concerns raised by Butler and Berry (2004). Specifically, Butler and Berry (2004) suggested that forced-choice and Likert scale ratings may measure different constructs within MRE tasks. They pointed out that forced-choice responses necessarily include a comparative judgement, whereas Likert ratings do not. Further, Butler

and Berry (2004) described Likert scales as providing the opportunity for relatively unrestricted response formation and forced-choice methods as imposing considerably more constraints. To provide support for their hypothesis that forced-choice and Likert scale ratings may measure fundamentally different constructs, Butler and Berry (2004) pointed to the Alzheimer's disease literature, where the results of MRE studies that have used forced-choice responses (Willems, Adam, & Van der Linden, 2002; Winograd, Goldstein, Monarch, Peluso, & Goldman, 1999) differ from those of investigations that have employed Likert-scale ratings (Halpern & O'Connor, 2000). As the only MRE study conducted to date with an ASD sample employed relatively atypical MRE methods, a considerable void remains in the literature.

1.4   RESEARCH QUESTIONS AND HYPOTHESES

Following from the literature reviewed above, the primary research questions that were examined in this study, and their respective hypotheses, were as follows:

1.   Is the MRE effect intact in adolescents with ASD?

We chose to examine the MRE effect in adolescents because the results of a previous study in our laboratory (Kerr et al., 2013) suggested that we could detect a robust MRE effect in TD participants in this age group, whereas the effect was less clear in younger children. We predicted that participants with ASD would demonstrate a MRE effect, but would require more stimulus presentations than their TD peers before they began displaying increasingly positive stimulus evaluations. Furthermore,

we expected that the MRE effect would be more persistent in the ASD group relative to the comparison group. That is, we expected that, while TD participants would demonstrate a decline in liking ratings at high exposure frequencies (i.e., a boredom effect), adolescents with ASD would not. These hypotheses were based on several pieces of evidence unearthed in the MRE and ASD literatures, including: 1) observations that individuals with ASD exhibit strong familiarity preferences (Happé & Frith, 2009; Kanner, 1943; Kootz et al., 1982) and less exploratory behavior in novel situations (e.g., Kawa & Pisula, 2013; Pierce & Courchesne, 2001; Pisula, 2003), 2) findings that generally associate ASD with abnormality of the brain's reward system (Dichter, Felder, et al., 2012; Schmitz et al., 2008; Scott-Van Zeeland et al., 2010), which has been hypothesized to underlie the MRE effect (Zebrowitz & Zhang, 2012), and 3) evidence suggesting that stimulus habituation, one of the two processes that has been proposed to underlie the MRE effect (Berlyne, 1970; Bornstein, 1989; Stang, 1974) may be slowed in ASD (e.g., Guiraud et al., 2011; James & Barry, 1984; Musurlian, 1995; Perry et al., 2007).

2. Is the nature of the MRE effect consistent across stimulus categories (i.e., social and non-social) in individuals with ASD?

We expected that the MRE effect would be similarly affected across stimulus categories in ASD. This prediction was also based on several lines of reasoning, including: 1) indication that familiarity preferences and decreased exploratory behavior in individuals with ASD are not restricted to social stimuli (e.g., Kawa &

Pisula, 2013; Pierce & Courchesne, 2001; Pisula, 2003), 2) neuroimaging results suggesting that differences in neural reward circuitry associated with ASD are more generalized than initially suspected (Dawson et al., 2005; Dichter, Felder, et al., 2012; Kohls et al., 2013; R. T. Schultz, 2005), and 3) findings of slowed habituation to both social and non-social stimuli in participants with symptoms of ASD (James & Barry, 1984; Musurlian, 1995).

3.   Is there a relationship between the MRE effect and clinical features of ASD?

We expected that participants with more severe manifestations of ASD, and especially those with higher levels of restricted and repetitive interests, would demonstrate a more delayed MRE effect (i.e., more stimulus exposures would be required before increases in liking were noted). We also predicted that ASD participants with higher levels of anxiety and greater intolerance of uncertainty would demonstrate a more delayed MRE effect. Such a result would be in contrast to findings of a positive association between anxiety and intolerance of uncertainty levels and size of the MRE effect in TD participants (Crandall, 1968; Schick et al., 1972).

These hypotheses were based on Zajonc's (2001) suggestion that, through MRE, avoidant responses recede over time and individuals develop a level of comfort with, and positive affect toward, stimuli. Based on this reasoning, TD individuals are continuously expanding the range of stimuli with which they are comfortable. If this process is affected in ASD in the manner proposed, we would expect that it would

take longer for people with ASD to become comfortable with new stimuli and, consequently, that they would demonstrate a preference for the familiar and a restricted pattern of preferences. Further, we would anticipate that those with more prominent ASD symptoms, restricted and repetitive behaviours, intolerance of uncertainty, and anxiety would exhibit a more atypical (i.e., delayed) MRE effect.

CHAPTER 2: EXPERIMENTAL TASK DEVELOPMENT

Recall that the typical paradigm designed to elicit the MRE effect involves the repeated presentation of neutral visual stimuli (e.g., photographs, line drawings, nonsense words, etc.), at varying numbers of exposures, followed by the collection of a measure of affect (e.g., liking, pleasantness, etc.; Bornstein, 1989). Within this standard experimental method, there are a number of parameters (e.g., stimulus type, affect measure, exposure frequency, exposure duration, and exposure sequence) that vary across experiments. As indicated previously, one of the main goals of the current study was to determine whether the relationship between familiarity and affect is intact in adolescents with ASD. Therefore, it was important to establish experimental parameters that maximized the likelihood that a MRE effect, if present, would be observed. In order to accomplish this, a preliminary MRE task was developed based upon a review of the scientific literature and the collection of original data. Pilot testing was then conducted with a group of university students to ensure that the task was functioning as expected in TD participants. This process, its findings, and the decisions that it informed, are detailed in this chapter. The development of two associated experimental tasks is also described.

2.1   TASK PARAMETERS

2.1.1   Stimuli

Stimuli were drawn from three categories: polygons, photographs of faces, and line drawings. These stimulus types were chosen for several reasons. First, polygons, faces, and line drawings

had been previously demonstrated to elicit a strong MRE effect in a well-designed experiment conducted by Bornstein and D'Agostino (1992). Second, in his thorough review and meta-analysis of the MRE literature, Bornstein (1989) found that polygons and photographs elicited amongst the most robust MRE effects of all of the stimulus categories considered. Third, this combination of stimulus types, which included both "abstract, non-representational" stimuli (i.e., polygons and non-representational line drawings) and "meaningful social" stimuli (i.e., faces; Bornstein & D'Agostino, 1992, p. 546), would later allow us to investigate potential differences in the MRE effect elicited by social and non-social stimuli in the main study's ASD group.

Polygons. Polygon stimuli were created in accordance with the following procedure proposed by Attneave (1957, p. 221):

> First, peripheral points were connected into a convex polygon, which enclosed all the points not included in its contour (as if a pin were stuck into each point and a rubber band snapped around the whole cluster). Second, the unconnected points were given a random order and each in turn was "taken into" a randomly chosen segment of the surrounding polygon (as if by hooking that segment of the rubber band over the interior pin). Since lines connecting the points were not permitted to cross, the number of alternative segments into which a given point might be taken could either

increase or decrease as the process continued; hence the assignment

of a random sequence to the unconnected points.

As nine-sided polygons, similar to those employed by Bornstein and D'Agostino (1992), were desired, a Python script was used to generate ten random dots on a grid. These dots were joined together, according to the procedure described above, using black 10-point line segments on a white background in Adobe Illustrator CS5. Examples of the polygon stimuli used in the current experiment are presented in Figure 1, along with sample face and line drawing stimuli. Seventy-two polygon stimuli were required for the experimental tasks employed in this study.

Faces. Face stimuli were acquired from the stimulus set developed by the Computer Vision Research Laboratory at the University of Notre Dame (UND; Flynn & Bowyer, 2003). High-quality images of similarly aged males and females displaying neutral facial expressions were desired for the purposes of the current study. A review of numerous databases of face stimuli (e.g., those described by Gross, 2005) indicated that the UND stimuli were particularly well suited to the current study, given these requirements. From their original format, the UND face stimuli were converted to grayscale. The photographs were then cropped at the hair and jawlines to remove any potentially distracting features (e.g., unique hairstyles or jewellery). This was particularly important in the current study in light of findings suggesting that both children (Chawarska & Shic, 2009) and adults (Pelphrey et al., 2002) with ASD may be more likely to attend to external face features than comparison participants. The edges of the face stimuli were then blurred slightly so that they appeared

somewhat more natural. Adobe Photoshop CS5 was used to perform all editing of face stimuli.

A set of 100 face stimuli was initially created according to the method described above. However, only 72 stimuli were required for the experimental tasks that were to be employed. More stimuli were produced than were needed so that the stimulus set could be systematically refined to include faces that were of similar attractiveness, consistent with Bornstein and D'Agostino (1992), and that were perceived to convey neutral expressions. Nine male and 27 female undergraduate students, whose mean age was 25.75 (SD = 6.87) provided ratings of all 100 face stimuli on two dimensions: attractiveness and emotional valence. Participants viewed the entire set of stimuli twice, rating each stimulus on one dimension during the first viewing and on the other dimension during the second viewing. The dimension upon which participants rated stimulus sets first was determined randomly, as was the order in which the stimuli were presented.

For the attractiveness ratings, participants were asked to respond to the question "How attractive is this face?" and for the emotional valence ratings they were asked to respond to the question "What is the emotional valence of this face?" The term emotional valence was explained during the instructions. For both rating dimensions, participants were asked to assign each face stimulus a value on a seven-point Likert scale. The scale for attractiveness ratings included two anchors: a rating of 1 was paired with the label "very unattractive" and a rating of 7 was paired with the label "very attractive". The scale for emotional valence ratings included three anchors: a rating of 1 was paired with the label "very negative," a rating of 4

was paired with the label "neutral," and a rating of 7 was paired with the label "very positive." For both types of rating trials, a visual scale with the numbers 1 to 7 and the associated anchors was presented below each to-be-rated stimulus. Please see Figures 2 and 3 to review instructions and sample items for the attractiveness and emotional valence ratings, respectively. Based on the ratings that were provided, items with the most extreme (i.e., high or low) emotional valence and attractiveness ratings were removed. This procedure was carried out separately for male and female faces so that the final stimulus set would have an equal number of stimuli from each sex. It is important to note that the ratings provided by male and female participants did not differ significantly. The set of 72 line drawings that was used in the current study had a mean attractiveness rating of 3.34 (SD = .59) and a mean emotional valence rating of 3.77 (SD = .59).

Line Drawings. The line drawings used by Bornstein and D'Agostino (1992) were taken from the Welsh Figure Preference Test (Welsh, 1949). One hundred line drawings (i.e., Welsh figures) similar to those employed by Bornstein and D'Agostino (1992; i.e., relatively complex, non-representational images) were scanned in order to create image files. As for face stimuli, this initial grouping of 100 line drawings was refined to create a final set of 72 stimuli. For line drawings, the primary concern was that stimuli were similar with respect to degree of visual complexity, as this characteristic has been noted within several literature syntheses (Bornstein, 1989; Harrison, 1977; Stang, 1974) to influence the magnitude of the MRE effect. Specifically, more complex visual stimuli have been associated with a more robust MRE effect.

In their study, Bornstein and D'Agostino (1992) indicated that they employed images similar to those used in Bornstein, Kale, and Cornell (1990; i.e., Welsh figures 8, 10, 20, 33, 42, 55, and 66). To facilitate the winnowing of the stimulus set, seven female and three male volunteers, whose mean age was 25.29 (SD = 3.06), were recruited to evaluate the stimuli. These volunteers were provided with examples of the seven stimuli employed by Bornstein et al. (1990) and Bornstein and D'Agostino (1992). They were also given a stack of 100 cards upon which the preselected Welsh figures were printed. Participants were asked to identify, from the stack of 100 cards, which 65 line drawings were most similar to those depicted on the instruction sheet with respect to visual complexity. Consistent with Snodgrass and Vanderwart (1980), visual complexity was defined as "the amount of detail or intricacy of line in the picture" (p. 184). The seven images originally employed by Bornstein et al. (1990) and Bornstein and D'Agostino (1992) and the 65 images most often selected by rating study participants were then used as the final 72-item line-drawing stimulus set. Each of the images included in the final study was chosen by at least six rating study participants.

The final set of 72 stimuli was saved at a resolution of 43 pixels per cm. The size of each image was vertically constrained to approximately 4.92 degrees of visual angle at a viewing distance of approximately 100 cm. Although stimuli varied with respect to their horizontal dimensions, the widest stimulus subtended approximately 6.37 degrees of visual angle.

2.1.2   Apparatus

Participants completed all experimental tasks on a 15-inch MacBook Pro laptop running OS X Leopard (Version 10.5.8). PsyScope X Build 57 (J. D. Cohen, MacWhinney, Flatt, &

Provost, 1993) software was used to present visual and auditory information to participants and to collect responses, when necessary. All statistical analyses were carried out using IBM SPSS Statistics (Version 20.0.0).

2.1.3   Procedure

Mere Repeated Exposure Task. The MRE task was divided into two main parts: an exposure phase and a rating phase. The two task phases were always completed in the same order, with the exposure phase being presented first, followed by the rating phase.

Exposure Phase. Three blocks comprised the exposure phase, one for each stimulus type (i.e., polygons, faces, and line drawings). For each participant, the order of block presentation was determined randomly. The number of times that each stimulus appeared during the exposure phase (i.e., exposure frequency) was systematically manipulated in order to permit examination of the relationship between exposure frequency and liking ratings. Within each exposure block, eight stimuli were presented at each of the following exposure frequencies: 3, 6, 9, and 15. These exposure frequencies were selected for several reasons. First, in his review and meta-analysis of the MRE literature, Bornstein (1989) found that experiments employing between one and nine stimulus exposures generated the most robust MRE effects. Second, a previous study in our laboratory (Quinlan, Filliter, & Johnson, 2013) included a MRE task with three, six, and nine stimulus exposures and elicited a clear MRE effect. Third, participants with ASD were expected to require a greater number of stimulus exposures to demonstrate an increase in liking (i.e., a MRE effect), and thus, a higher

exposure frequency condition (i.e., 15 stimulus presentations) was included. Recall that liking ratings have been demonstrated to decline after approximately 10 exposures in typical adult samples and that this has been interpreted as a boredom effect.

In that eight stimuli were presented at each of the four exposure frequencies (3, 6, 9, and 15 stimulus presentations), 32 stimuli were viewed across 264 trials within each block. Individual trials, described in detail below, were 2100 ms in length. Therefore, the duration of each exposure block was 9.2 minutes. Within blocks (i.e., stimulus types), stimuli were randomly assigned to each exposure level and trials were presented in a random, heterogeneous sequence. This is consistent with Bornstein's (1989, p. 278) finding that while homogeneous exposure sequences generally produce no MRE effect at all, heterogeneous stimulus presentations elicit "moderate" MRE effects. A similar conclusion, that heterogeneous exposure sequences elicit stronger MRE effects than homogeneous exposure sequences, was also reached by Harrison (1977) in his review of the MRE literature.

Each trial began with the presentation of a central fixation cross for 500 ms. The appearance of this fixation cross was accompanied by an auditory "system beep" in order to ensure that the participant was optimally alert for the stimulus presentation (consistent with Posner & Boies, 1971). Upon the removal of the fixation cross, a single stimulus (i.e., a polygon, face, or line drawing, depending on the block being presented) was presented for 100 ms at the centre of the computer screen. This stimulus presentation was followed by the appearance of a blank screen that remained for 1500 ms. This somewhat lengthy inter-stimulus interval (ISI) was selected because pilot testing revealed that 100 ms stimulus presentations were

aversive with shorter ISIs. Then, the next trial began with another fixation cross and a system beep. This structure was adopted for exposure trials for two reasons. First, Bornstein (1989, p. 273) found that exposure durations of less than one second elicit "strong" MRE effects, whereas exposure durations of greater than one second produce "small" MRE effects. Second, several studies have demonstrated MRE effects using stimuli presented for 100 ms (e.g., Förster, 2009; Newell & Bright, 2003). Third, a similar trial structure had generated a robust MRE effect in a previous study in our laboratory (Quinlan et al., 2013). For a schematic depiction of trials within the exposure phase of the MRE task, please consult Figure 4.

Rating Phase. Similar to the exposure phase, the rating phase was divided into three blocks, one for each stimulus type. The order of block presentation for each participant was the same in the rating phase as in the exposure phase. In the rating phase, participants were presented with one stimulus at a time and asked to respond to the question "How much do you like this [polygon/face/line drawing]?" by providing a liking rating on a seven-point Likert scale. This approach to obtaining ratings of positive affect was selected for several reasons. First, Bornstein (1989, p. 275) demonstrated that liking ratings generally produce "moderate" MRE effects, while other types of ratings (e.g., goodness, pleasantness, etc.) elicit "slightly smaller" MRE effects. Second, Bornstein and D'Agostino (1992, p. 547) used a "like-dislike" scale in their MRE study, which employed similar stimuli. Third, a comparable scale was successfully used in a previous investigation in our laboratory (Quinlan et al., 2013).

A visual liking scale with the numbers 1 to 7 was presented below each to-be-rated stimulus and participants simply pressed the MacBook Pro number key associated with their desired rating for the item. Two anchors were included on this scale: a rating of 1 was paired with the label "dislike very much" and a rating of 7 was paired with the label "like very much". Participants' ratings were not recorded until they had pressed the "enter/return" key and, therefore, they were able to edit their responses as desired. Within each block of the rating phase, participants rated the 32 stimuli that they had seen during the exposure phase, as well as 24 novel stimuli drawn from the same category (i.e., polygons, faces, or line drawings). More ratings were obtained for the 0 exposure frequency (i.e., novel stimuli) than for any other exposure frequency (i.e., 3, 6, 9, and 15) in case it was necessary to collapse across previously exposed stimuli to detect a MRE effect. As in the exposure phase, to-be-rated stimuli were presented in a random order. Please see Figure 5 to review instructions and a sample item from the rating phase.

Recognition Task. As indicated previously, the literature contains contradictory findings with respect to the influence of stimulus recognition on the MRE effect (e.g., Bornstein, 1989; Bornstein & D'Agostino, 1992; Newell & Shanks, 2007; Stafford & Grimes, 2012). To permit the investigation of this facet of the MRE effect within the current study, a recognition task was included. Similar to the exposure and rating phases of the MRE task, the recognition task was divided into three blocks based on stimulus type (i.e., polygons, faces, and line drawings). The order of blocks for this task was the same as for both phases of the MRE task. During each block of the recognition task, participants were presented with 32 stimuli one at a time in a random order. Participants had seen 16 of these 32 stimuli

during the exposure phase of the MRE task. They had not seen the other 16 stimuli previously. Of the 16 previously seen stimuli, four were drawn from each exposure frequency (i.e., 3, 6, 9, and 15). The previously unseen, or "foil," stimuli were randomly selected from amongst stimuli that had not been employed in either phase of the MRE task. Participants were asked to indicate whether they had seen each stimulus previously; they did so by pressing either the left or right arrow key on the MacBook Pro keyboard. Please see Figure 6 to review instructions and a sample item from the recognition task.

Discrimination Task. A discrimination task was included in order to confirm that all participants were able to differentiate among the stimuli employed in this experiment on a perceptual basis. Like all of the other experimental tasks, the discrimination task had three blocks, divided by stimulus category, that were presented in the same order as for all other experimental tasks. Each participant was simultaneously presented with a target stimulus and a search group of four stimuli drawn from the same category (i.e., polygons, faces, or line drawings), one of which was identical to the target stimulus. The participant's task was simply to indicate which stimulus within the search group was the same as the target stimulus. Four discrimination trials were presented for each stimulus type for a total of 12 trials. Please see Figure 7 to review instructions and a sample item from the discrimination task.

2.2   PILOT TESTING

Once the experimental tasks described above had been developed, pilot testing was conducted with a group of university students. As indicated previously, this exercise was

important in order to ensure that the MRE task, in particular, was functioning properly and eliciting the desired effects. The pilot testing process, its results, and the decisions that it informed are described within this section.

2.2.1   Method

The MRE, recognition, and discrimination tasks described above were completed by thirty-two undergraduate students. This sample of pilot participants was made up of twenty-nine females and three males, whose mean age was 20.52 (*SD* = 1.55). All pilot participants were enrolled in the Dalhousie University Department of Psychology and Neuroscience Subject Pool and received course credit for their time.

2.2.2   Results

Please note that the results reported in this section, and in the rest of this document, are presented according to the conventions described in *Appendix A: Presentation of Statistical Results*.

Mere Repeated Exposure Task. A 3 (Stimulus Category: polygons, faces, and line drawings) x 5 (Exposure Frequency: 0, 3, 6, 9, and 15) repeated measures analysis of variance (ANOVA) was carried out. The liking ratings that participants assigned in the rating phase of the MRE task were employed as the dependent variable in this analysis. The ANOVA revealed significant main effects of both Stimulus Category [$F(2, 62) = 6.14$, $p = .004$; $\eta_p^2 = .17$] and Exposure Frequency [$F(4, 28) = 4.93$, $p = .004$; $\eta_p^2 = .41$]. However, a Stimulus Category x Exposure Frequency interaction was not observed [$F(8, 248) = .62$, $p = .76$; $\eta_p^2 = $

.02]. Table 1 contains descriptive statistics for liking ratings by Stimulus Category and Exposure Frequency. Graphical depictions of the Stimulus Category and Exposure Frequency main effects can be found in Figures 8 and 9, respectively. Figure 10 shows liking ratings presented by stimulus category and exposure frequency.

Paired samples t-tests were carried out to further investigate the main effects that were observed. For the Stimulus Category main effect, t-tests revealed significant differences in liking ratings between the line drawing stimuli and both the polygon [$t(31)$ = -3.10, p = .004; d = .55] and face [$t(31)$ = -3.08, p = .004, d = .55] stimuli. The polygon and face stimuli did not differ from one another with respect to liking ratings [$t(31)$ = .41, p = .68; d = .07]. Mean liking ratings for the face, polygon, and line drawing stimulus categories were 3.68 (SD = .55), 3.72 (SD = .52), and 4.02 (SD = .43), respectively.

For the Exposure Frequency main effect, t-tests revealed significant differences between the 0 and 3 [$t(31)$ = -3.44, p = .002; d = .61], 0 and 6 [$t(31)$ = -3.06, p = .004; d = .54], 0 and 9 [$t(31)$ = -3.32, p = .002; d = .59], and 0 and 15 [$t(31)$ = -3.91, p < .001; d = .69] exposure levels. All other comparisons generated nonsignificant findings (i.e., p ≥ .05). Mean liking ratings for the 0, 3, 6, 9, and 15 exposure levels were 3.58 (SD = .46), 3.85 (SD = .48), 3.80 (SD = .44), 3.87 (SD = .45), and 3.93 (SD = .47), respectively.

Recognition Task. A corrected hit rate was used as a measure of stimulus recognition in order to protect against any participant bias toward "yes" or "no" responses in the recognition task. The corrected hit rate value was calculated by subtracting the false alarm rate (i.e., the proportion of trials upon which participants incorrectly indicated that they had previously

seen a novel stimulus) from the hit rate (i.e., the proportion of trials upon which participants correctly indicated that they had previously seen a familiar stimulus).

A 3 (Stimulus Category: polygons, faces, and line drawings) by 4 (Exposure Frequency: 3, 6, 9, and 15) repeated measures ANOVA was used to analyze corrected hit rate data. This ANOVA revealed a significant main effect of Stimulus Category [$F(2, 60) = 85.37$, $p < .001$; $\eta_p^2 = .74$]. No significant main effect of Exposure Frequency was observed [$F(3, 90) = .89$, $p = .45$; $\eta_p^2 = .03$], nor was a Stimulus Category x Exposure Frequency interaction observed [$F(6, 180) = 1.15$, $p = .34$; $\eta_p^2 = .04$]. Follow-up paired samples t-tests revealed significant differences in corrected hit rates between the line drawing stimuli and both the polygon [$t(31) = -14.00$, $p < .001$; $d = 2.90$] and face [$t(31) = -11.07$, $p < .001$; $d = 2.38$] stimuli. The polygon and face stimuli did not differ from one another with respect to corrected hit rates [$t(31) = -.73$, $p = .47$; $d = .13$]. Mean corrected hit rates for the polygon, face, and line drawing stimulus categories were .30 ($SD = .24$), .35 ($SD = .28$), and .90 ($SD = .08$), respectively. Descriptive statistics for corrected hit rate further divided by exposure frequency can be found in Table 2. Pearson's correlations revealed no significant correlation between corrected hit rates and liking ratings [$r(32) = -.006$, $p = .97$].

Discrimination Task. A one-way ANOVA examining the stimulus category variable was used to analyze discrimination data, which were represented as the proportion of correct answers. As in previous analyses, all three stimulus categories (polygons, faces, and line drawings) were considered. No significant main effect of Stimulus Category was observed [$F(2, 22) = 1.00$, $p = .38$; $\eta_p^2 = .08$]. Mean proportion correct for the polygon, face, and line

drawing stimulus categories were .99 (SD = .03), 1.00 (SD = .00), and 1.00 (SD = .00), respectively.

2.2.3   Conclusions

The results of the pilot study confirmed that the preliminary MRE task was capable of eliciting a MRE effect in a sample of university students. That is, a large Exposure Frequency main effect (η_p^2 = .41) was observed and liking ratings at the 3, 6, 9, and 15 exposure frequencies were significantly higher than at the 0 exposure frequency. Further, no Stimulus Category x Exposure Frequency interaction was observed, indicating a MRE effect of similar magnitude for all three stimulus types. Given these robust MRE effects, it was determined that the same MRE task would be used to examine the MRE effect in adolescents with ASD in the main study.

Other results that were less relevant to the main purpose of the pilot study, but still of interest, included differences in initial liking ratings across stimulus types. Specifically, participants generally assigned higher liking ratings to line drawing stimuli than they did to polygon and face stimuli. Bornstein and D'Agostino (1992), who employed similar stimuli, also found that stimulus categories differed with respect to their overall liking ratings. Specifically, Bornstein and D'Agostino (1992) reported that face stimuli were marginally (p = .06) preferred to polygon stimuli. As indicated previously, the stimuli employed in the current study were modelled closely after those used by Bornstein and D'Agostino (1992). However, it is possible that subtle variances between the stimulus sets (e.g., the removal of

potentially distracting elements from the face stimuli used in the current study) contributed to differences in the relative overall liking of stimulus categories across the two studies.

The results of the recognition task were also noteworthy. In that there was a particularly high degree of within-category distinctiveness for line drawing stimuli, it was not surprising that corrected hit rate values were higher for line drawings than for polygons or faces. Further, the lack of association between liking ratings and stimulus recognition is consistent with recent findings indicating that poorer recognition may not always be associated with greater liking (Newell & Shanks, 2007; Stafford & Grimes, 2012), as was suggested previously (e.g., Bornstein, 1989; Bornstein & D'Agostino, 1992). However, this result should be interpreted with caution in that it represents a null effect. Finally, the results of the discrimination task demonstrated that pilot participants were able to perceptually discriminate between stimuli with near perfect accuracy for all three stimulus categories.

Table 1 Mean liking ratings (and SDs) presented by stimulus category and exposure frequency for pilot study

	Exposure Frequency				
	0	3	6	9	15
Polygons	3.53 (.60)	3.80 (.74)	3.67 (.62)	3.80 (.75)	3.81 (.60)
Faces	3.55 (.61)	3.68 (.71)	3.66 (.75)	3.72 (.69)	3.78 (.67)
Line Drawings	3.67 (.60)	4.06 (.77)	4.07 (.68)	4.09 (.59)	4.19 (.74)

Table 2   Mean corrected hit rates (and SDs) for recognition task presented by stimulus
            category and exposure frequency for pilot study

	Exposure Frequency			
	3	6	9	15
Polygons	.27 (.35)	.29 (.27)	.34 (.26)	.30 (.30)
Faces	.35 (.33)	.30 (.36)	.32 (.32)	.41 (.31)
Line Drawings	.90 (.13)	.90 (.15)	.92 (.11)	.90 (.14)

Polygons	Faces	Line Drawings
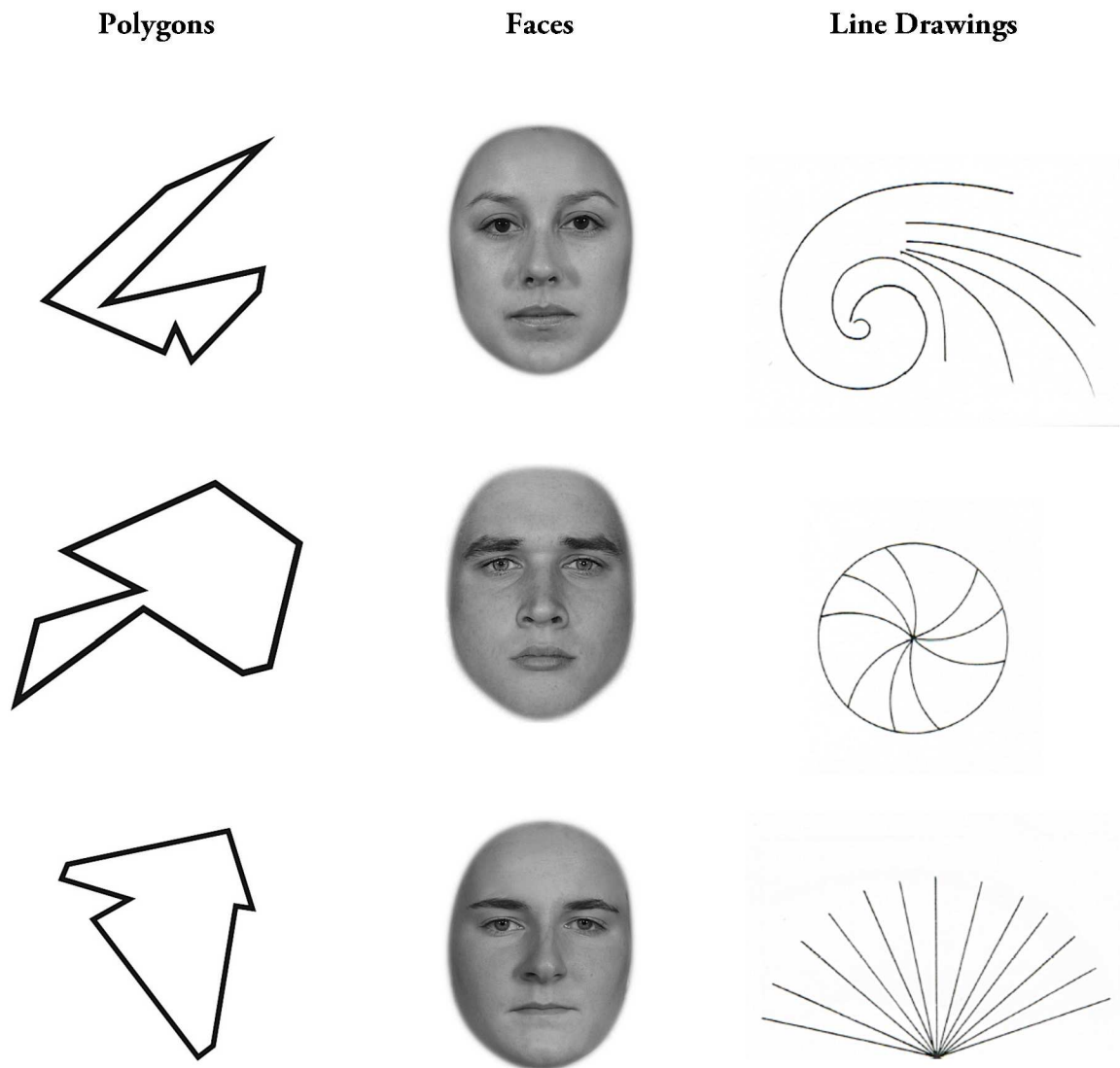
Figure 1   Examples of the stimuli employed in the mere repeated exposure task

You will be asked to provide a rating of the **attractiveness** of a series of faces using the 7-point scale that is pictured below. That is, please rate each face based on the degree to which it is visually pleasing or appealing. Press the number key (1-7) that matches your rating of the face to assign a rating.

The **less attractive** a face is, the further to the **left** you should rate it on the scale. For example, a rating of "1" would be applied to a face that is "very unattractive."

The **more attractive** a face is, the further to the **right** you should rate it on the scale. For example, a rating of "7" would be applied to a face that is "very attractive."

Press the space bar when you are ready to begin.

Very
Unattractive

Very
Attractive

How attractive is this face?

Very
Unattractive
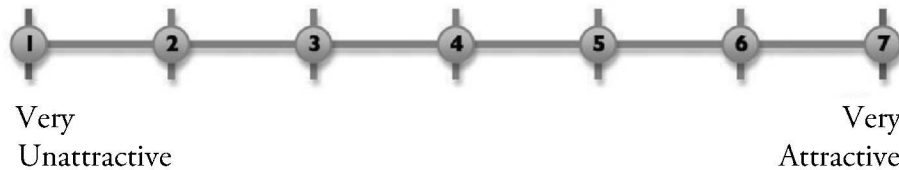
Very
Attractive
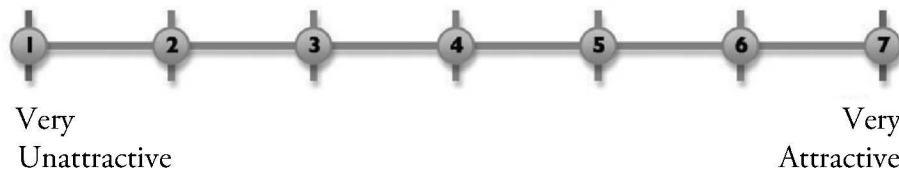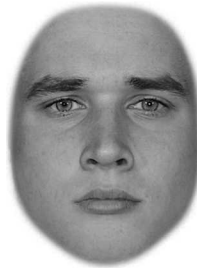
Figure 2   Instruction screen and sample item for ratings of attractiveness of face stimuli

You will be asked to provide a rating of the **emotional valence** of a series of faces using the 7-point scale that is pictured below. Please rate each face based on the degree to which it is expressing positive or negative emotion. Press the number key (1-7) that matches your rating of the face to assign a rating.

The **more negative** the emotion, the further to the **left** you should rate it on the scale. For example, a rating of "1" would be applied to a face that is expressing "very negative" emotion.

The **more positive** the emotion, the further to the **right** you should rate it on the scale. For example, a rating of "7" would be applied to a face that is expressing "very positive" emotion.

If a face is neutral (i.e., expressing neither positive nor negative emotion), a rating of "4" should be applied.

Press the space bar when you are ready to begin.

Very
Negative

Neutral

Very
Positive

What is the emotional valence of this face?

Very
Negative

Neutral
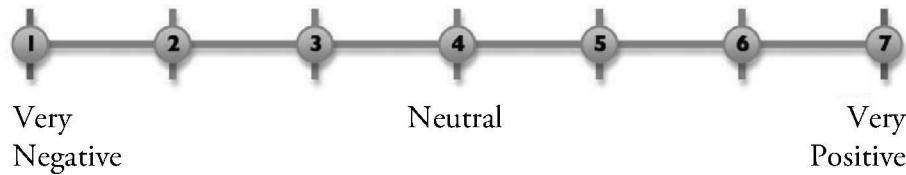
Very
Positive
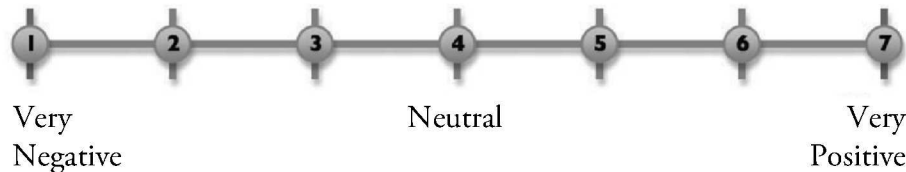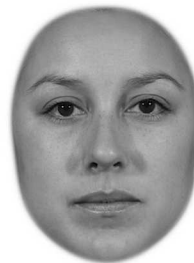
Figure 3   Instruction screen and sample item for ratings of emotional valence of face
             stimuli

Instruction Screen

Hello and welcome to the experiment!

You will be shown a series of [shapes/faces/drawings]. The [shapes/faces/drawings] will be presented very quickly, so it is important that you watch the screen carefully and pay attention to every picture.

Please let the experimenter know if you have any questions.

Press the space bar when you are ready to begin.

Sample Trial

100 ms

1500 ms

500 ms

100 ms

Single Trial

Figure 4   Instruction screen and sample item for the exposure phase of mere repeated exposure task

Thank you for your attention!

You will now be presented with a series of [shapes/faces/drawings]. You will be asked to provide a rating of how much you like each [shape/face/drawing] using the 7-point scale that is pictured below.

To provide your rating, press the number key (1 to 7) that matches your rating of the [shape/face/drawing]. If you make an error, just press the "delete" button and then retype your answer. Press the "enter/return" button once you are satisfied with your rating.

Please let the experimenter know if you have any questions.

Press the space bar when you are ready to begin.

1 — 2 — 3 — 4 — 5 — 6 — 7

Dislike   Like
Very Much   Very Much
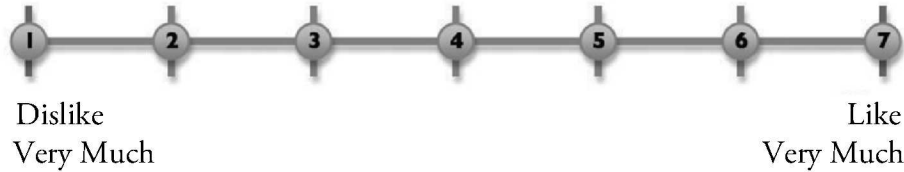
How much do you like this drawing?

1 — 2 — 3 — 4 — 5 — 6 — 7

Dislike   Like
Very Much   Very Much
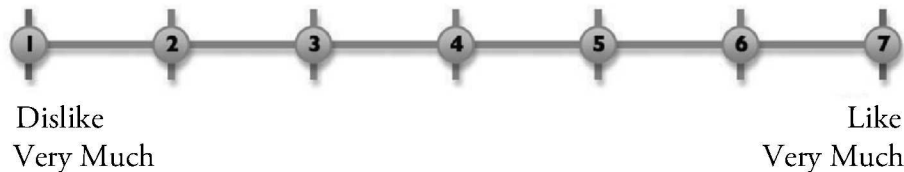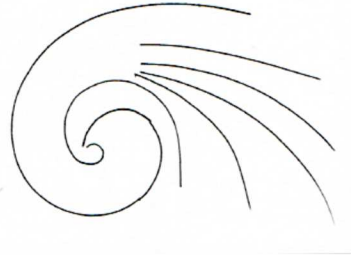
Figure 5   Instruction screen and sample item for the rating phase of the mere repeated exposure task

Instruction Screen

Now you will be shown a series of pictures. Your task is to answer the question "Have you seen this picture before?" You will press the "yes" key if you have seen the picture before and the "no" key if you have not seen the picture before.

Please let the examiner know if you have any questions.

Press the space bar when you are ready to begin.

Sample Item

Have you seen this picture before?
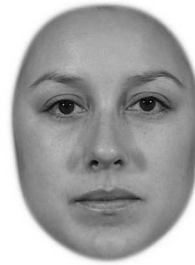
Figure 6   Instruction screen and sample item for the recognition task

Instruction Screen

You will now be presented with one picture at the top of the screen and four pictures at the bottom of the screen. Your task is to tell us which of the bottom pictures is the same as the top picture.

To enter your answer, type the number (1 to 4) of the matching picture. If you make an error, just press the "delete" button and then retype your answer. Press the "enter/return" button once you are satisfied with your response.

Please let the experimenter know if you have any questions.

Press the space bar when you are ready to begin.

Sample Item

1   2   3   4
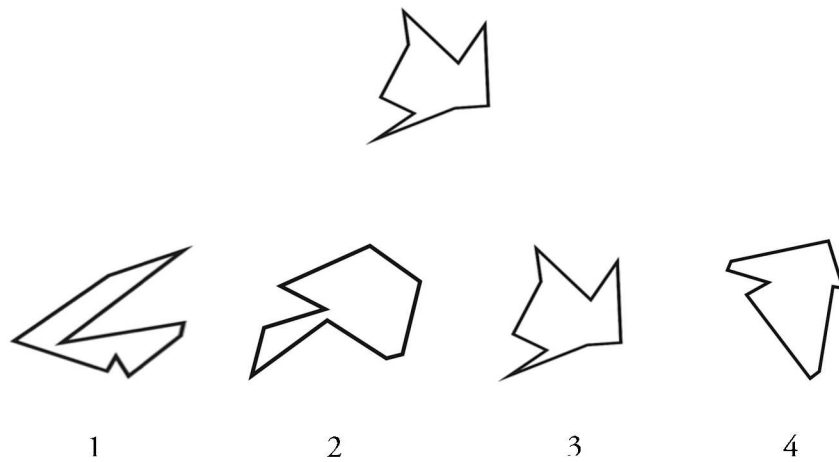
Figure 7   Instruction screen and sample item for the discrimination task
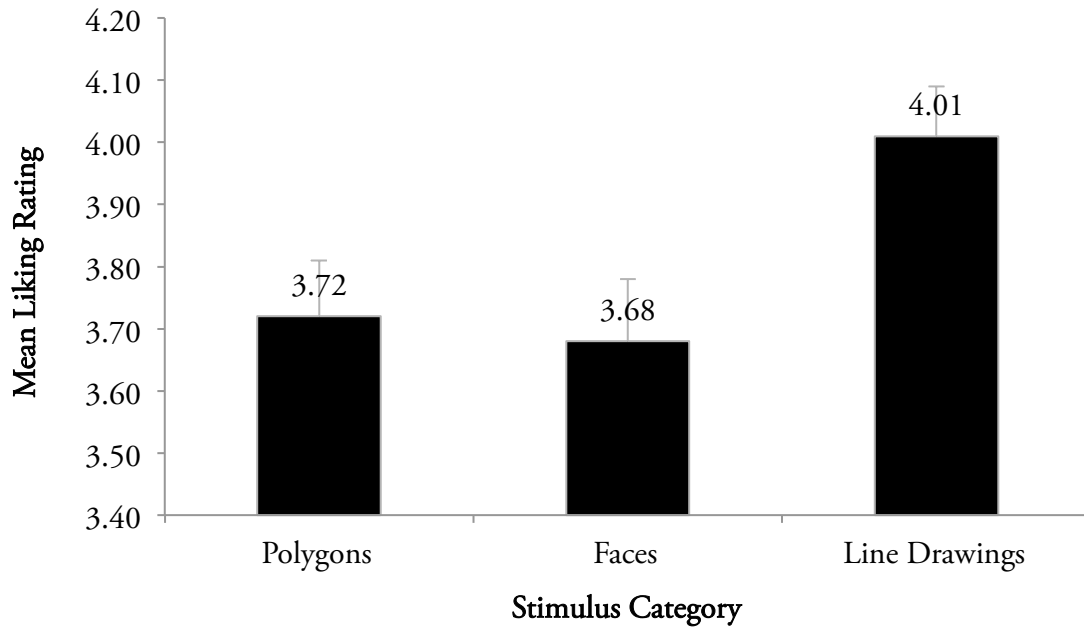
Figure 8   Mean liking ratings presented by stimulus category and collapsed across exposure frequency, including 0, for pilot study

Note. Error bars represent standard error of the mean.
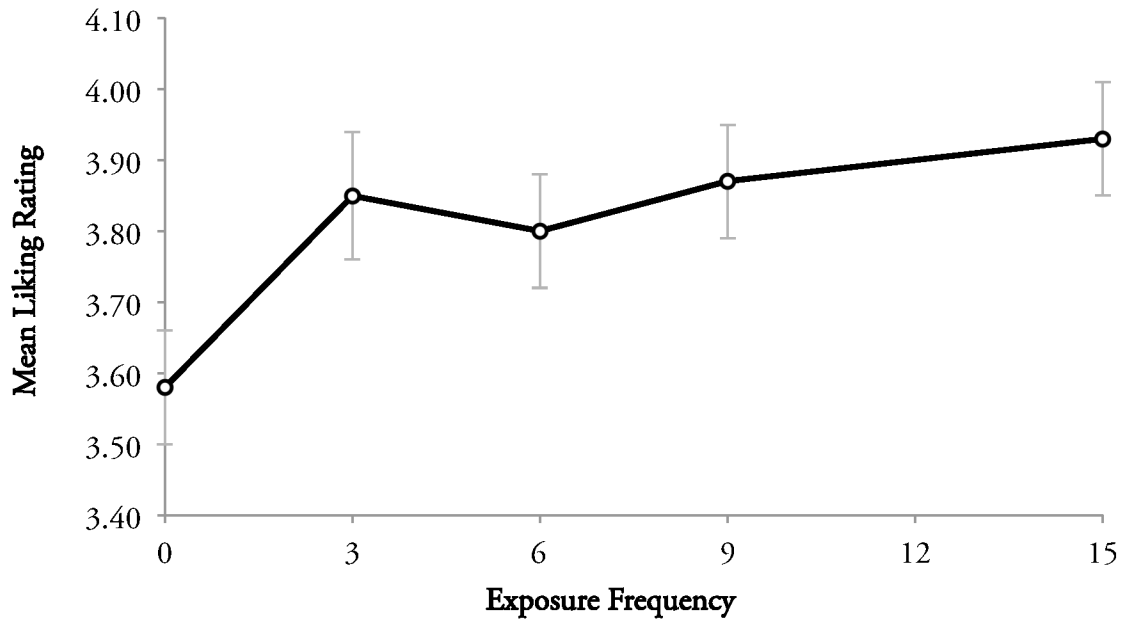
Figure 9   Mean liking ratings presented by exposure frequency and collapsed across
stimulus category for pilot study

Note. Error bars represent standard error of the mean.

Polygons   **Faces**   **Line Drawings**
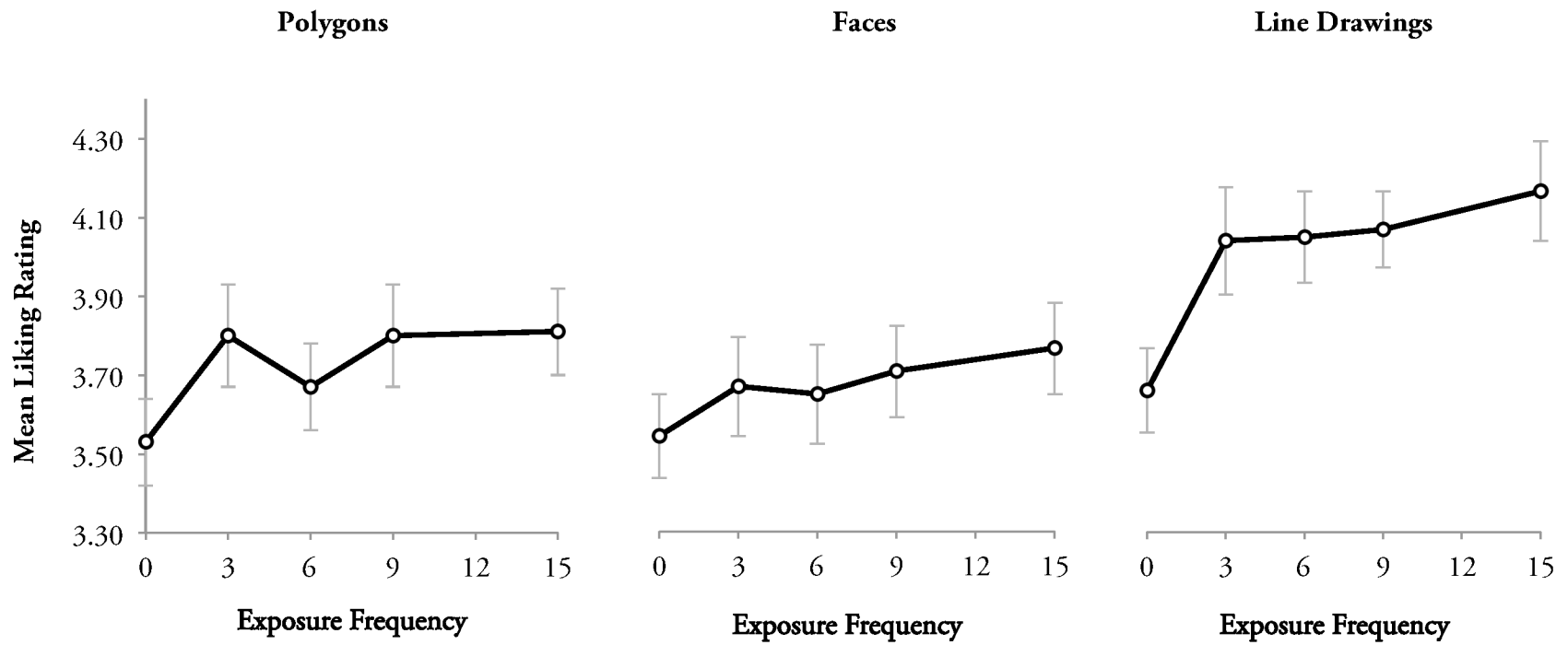
Figure 10   Mean liking ratings presented by stimulus category and exposure frequency for pilot study

Note. Error bars represent standard error of the mean.

CHAPTER 3: METHOD

3.1   PARTICIPANTS

Twenty-nine adolescents (12 to 17 year olds) with autism spectrum disorder (ASD) and 28 typically developing (TD) comparison participants took part in this study. As will be discussed later, it was necessary to exclude the data from one participant with ASD. For the final analysis, twenty-four males and four females comprised each group. Independent samples t-tests revealed no significant differences between the ASD and TD groups with respect to age or cognitive ability (Performance, Verbal, or Full Scale IQ; PIQ, VIQ, or FSIQ), as estimated using the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) or the Wechsler Intelligence Scale for Children - Fourth Edition (WISC-IV; Wechsler, 2003). For descriptive statistics summarizing participant characteristics, please consult Table 3.

Participants in the TD group were recruited through Dr. Johnson's laboratory at Dalhousie University in Halifax, Nova Scotia, while ASD group participants were recruited through both Dr. Johnson's laboratory and Dr. Elizabeth Kelley's laboratory at Queen's University in Kingston, Ontario. Participants with ASD recruited through both laboratories had previously received a diagnosis of Autistic Disorder, Asperger's Disorder, or Pervasive Developmental Disorder - Not Otherwise Specified (DSM-IV; American Psychiatric Association, 2000) or an ASD diagnosis. They had been diagnosed by either a regional ASD diagnostic team or a community-based psychologist with experience in ASD diagnosis.

For ASD participants recruited through Dr. Johnson's laboratory, the Autism Diagnostic Observation Schedule (ADOS; Lord et al., 2000) and/or Autism Diagnostic Interview - Revised (Lord et al., 1994) had been incorporated within participants' initial diagnostic assessment or their eligibility screening for a previous research study. The ADOS is a behavioural observation and coding system and the ADI-R is a parent/guardian interview. Both are considered to be "gold standard" tools for diagnosing ASD. ASD participants recruited through Dr. Kelley's laboratory were all administered the ADOS and the Social Communication Questionnaire (Rutter, Bailey, & Lord, 2003) as part of a previous research study. The SCQ is a diagnostic screening tool used to assess children suspected of having ASD. In cases in which a participant did not meet the cutoffs for ASD on the ADOS and/or for Autistic Disorder (DSM-IV; American Psychiatric Association, 2000) on the SCQ, they were required to meet diagnostic algorithm cutoffs on the ADI-R to be eligible for participation.

To be included in the current study, all participants were required to be English-speaking, have normal or corrected-to-normal vision, and have an estimated FSIQ of at least 80. Participants were excluded from both the ASD and TD groups if they had a parent/guardian-reported history of severe head injury with loss of consciousness of greater than 30 minutes, significant neurological disorder affecting the central nervous system, or major psychiatric disorder (e.g., Schizophrenia or Bipolar Disorder). Figure 11 describes parent/guardian-reported areas of co-occurring difficulties for the ASD group. Please note that the challenges that are listed in Figure 11 are not mutually exclusive; that is, the parent/guardian of some participants reported more than one category of co-occurring

difficulties. For the TD group, three participants were described by their parent/guardian as having symptoms of anxiety, two as having learning difficulties, and two as having chronic illnesses. The participants described as having anxiety symptoms and learning difficulties did not have a formal diagnosis. Further, the chronic illnesses ascribed to TD participants (i.e., diabetes and asthma) were not neurological.

3.2   SAMPLE CHARACTERIZATION MEASURES

An estimate of cognitive ability was obtained for each adolescent who participated in the current study. In cases in which a participant had completed the WASI (Wechsler, 1999) or WISC-IV in the past two years, in either a clinical or research setting, permission was obtained to use previous assessment results. For all other participants, the WASI was administered as part of the study protocol. For each adolescent participant, one parent/guardian completed several questionnaire measures regarding his/her child's behaviour. In cases in which a parent/guardian had completed one of the questionnaires included in the present study as part of another research project in the past year, the previous questionnaire results were employed. Each characterization measure included within the present study is described in detail below.

3.2.1   Wechsler Abbreviated Scale of Intelligence

The WASI (Wechsler, 1999) is a standardized measure designed to provide a brief estimate of cognitive ability in individuals aged 6 to 89 years. The four-subtest version of the WASI was used in the current study. It incorporates Block Design, Matrix Reasoning, Similarities, and Vocabulary subtests and permits the calculation of PIQ, VIQ, and FSIQ scores. While

the WASI, as an abbreviated test, is not as comprehensive as its full-length counterparts (i.e., the WISC-IV or Wechsler Adult Intelligence Scale - Fourth Edition, WAIS-IV; Wechsler, 2008), the four subtests that it includes were specifically selected because they relate strongly to general cognitive ability (Wechsler, 1999). The WASI is also a reliable measure, with split-half reliability coefficients for the PIQ, VIQ, and FSIQ of .93, .94, and .96, respectively, for children aged 6 to 16 (Homack & Reynolds, 2007). WASI scores are quite consistent over time; stability coefficients for the PIQ, VIQ, and FSIQ have been found to range from .88 to .93 across an average test-retest interval of 31 days. Further, correlation coefficients of .85, .78, and .86 have been observed between the WASI's PIQ, VIQ, and FSIQ and the WISC-IV's Perceptual Reasoning Index, Verbal Comprehension Index, and FSIQ, respectively. Finally, the WASI has been described as appropriate for use with individuals with ASD (Goldstein, Naglieri, & Ozonoff, 2009).

3.2.2 Social Responsiveness Scale

The Social Responsiveness Scale (SRS; Constantino & Gruber, 2005) is a questionnaire measure designed to assess ASD-related symptoms (e.g., difficulties with reciprocal social behaviours, communication, restricted and repetitive behaviours) in individuals aged 4 to 18 years. Each of the measure's 65 items takes the form of a statement about a behaviour that is associated with the autism spectrum. The rater, in this case a parent/guardian, is asked to indicate the accuracy of each statement in describing his/her child's behaviour over the past six months by assigning a rating on a four-point Likert scale (1 = "not true," 2 = "sometimes true," 3 = "often true," and 4 = "almost always true").

The SRS has five subscales (Social Awareness, Social Cognition, Social Communication, Social Motivation, and Autistic Mannerisms), as well as a total score. Of particular interest for the purposes of the present study was the total score for all SRS items, which was calculated by adding the Likert scale ratings for all items and deriving a gender-based T-score. For the SRS, T-scores between 60 and 75 are considered to reflect "mild to moderate" symptoms, while scores 76 and higher are deemed indicative of "severe" symptomology (Constantino & Gruber, 2005).

Constantino, Przybeck, Friesen, and Todd (2000) reported high internal consistency for the SRS, as evidenced by a Cronbach's α value of .97. Further, Constantino et al. (2003) observed correlation coefficients ranging from .65 to .77 when comparing maternal SRS scores with ADI-R algorithm scores. As indicated previously, the ADI-R is a caregiver interview considered to be a gold standard tool in the diagnostic assessment of ASD. Constantino, Przybeck, Friesen, and Todd (2000) also noted considerable agreement (i.e., correlation coefficients ranging from .75 to .91) when comparing SRS scores across raters (i.e., fathers, mothers, and teachers). Further, they examined stability of scores in a subsample of participants and found that SRS scores were remarkably consistent across a two-year period, as demonstrated by a correlation coefficient of .83.

3.2.3   Repetitive Behaviour Scale - Revised Edition

The Repetitive Behaviour Scale - Revised Edition (RBS-R; Bodfish, Symons, Parker, & Lewis, 2000) is a rating scale used to examine the restricted and repetitive behaviours associated with ASD across the lifespan. Each of the measure's 43 items describes a specific

behaviour. The rater, in this case a parent/guardian, is required to indicate how often his/her child has demonstrated particular behaviours over the past month by assigning ratings on a four-point Likert scale with two anchor points (0 = "behaviour does not occur" and 3 = "behaviour occurs and is a severe problem").

Initially, the RBS-R's 43 items were "conceptually grouped" (Lam & Aman, 2007, p. 856) into six subscales (Stereotyped Behaviour, Self Injurious Behaviour, Compulsive Behaviour, Ritualistic Behaviour, Sameness Behaviour, and Restricted Behaviour) based on its authors' clinical experience. However, an exploratory factor analysis conducted by Lam and Aman (2007) provided support for a five-factor (Rituals/Sameness, Self Injurious Behaviour, Stereotypic Behaviour, Compulsive Behaviour, and Restricted Interests subscales) solution. For the present study, the Rituals/Sameness and Restricted Interests subscales of Lam and Aman's (2007) five-factor RBS-R solution were considered particularly relevant. These two subscale scores, along with a total score for all items, were calculated by adding the Likert scale ratings for relevant items.

The results of the RBS-R validation conducted by Lam and Aman (2007) indicated good internal consistency for the five-subscale version of this tool, with Cronbach's α values for the subscales ranging from .78 to .91. Reasonable inter-rater reliability between pairs of caregivers was also demonstrated, as evidenced by intraclass correlation coefficients for subscales ranging from .57 to .73. Finally, the RBS-R's total score was found to have a relatively strong relationship with the measure's subscales, with correlation coefficients ranging from .63 to .88. It should be noted that the sample employed in the Lam and Aman

(2007) validation study was characterized by a very large age range (i.e., participants aged 3 to 48). This is important to keep in mind because the preferred factor structure for the RBS-R may differ depending on participant age (Mirenda et al., 2010).

3.2.4 Screen for Child Anxiety Related Emotional Disorders

The Screen for Child Anxiety Related Emotional Disorders (SCARED; Birmaher et al., 1997) was developed to measure a broad range of anxiety symptoms in children and adolescents aged 9 to 18 years. Each of this questionnaire measure's 41 items takes the form of a statement describing a common symptom of anxiety. The parent/guardian completing the SCARED is asked to rate, on a three-point Likert scale (0 = "not true or hardly ever true," 1 = "sometimes true," and 2 = "true or often true"), the accuracy of each statement based on his/her child's behaviour over the past three months. The SCARED has five subscales (Somatic/Panic, Generalized Anxiety, Separation Anxiety, Social Phobia, and School Phobia). Of particular interest for the purposes of the current study was the total score for all SCARED items. This score was calculated by adding the Likert scale ratings for all SCARED items. For the total score, Birmaher et al. (1999) suggested that a score of greater than or equal to 25 was indicative of clinically significant anxiety.

Birmaher et al. (1997) reported that the original 38-item version of the SCARED demonstrated strong internal consistency and median five-week test-retest reliability, as evidenced by a Cronbach's α value of .93 and an intraclass correlation coefficient of .86 for the total score, respectively. The SCARED was also noted to possess good discriminant validity, having the ability to differentiate among various types of anxiety disorders and

between anxiety and other psychiatric disorders. Birmaher et al. (1999) re-evaluated the tool following the addition of three items. This study resulted in a very similar five-factor structure for the SCARED and replicated the initial findings of Birmaher et al. (1997) regarding the psychometric properties of the scale. While TD samples were employed in the initial development and testing of the SCARED, the tool has since been successfully applied within several clinical populations, including children and adolescents with ASD (Reaven, Blakeley-Smith, Culhane-Shelburne, & Hepburn, 2012).

3.2.5   Intolerance of Uncertainty Scale for Children

The Intolerance of Uncertainty Scale for Children (IUSC; Comer et al., 2009) was adapted from the adult Intolerance of Uncertainty Scale (Freeston, Rhéaume, Letarte, Dugas, & Ladouceur, 1994) for use in child samples. The IUSC is a questionnaire measure that assesses individuals' emotional, cognitive, and behavioural responses to uncertain and uncontrollable situations. Each of the measure's 27 items describes a specific reaction to the ambiguity or uncontrollability of life events. The rater, in this case a parent/guardian, is required to indicate the degree to which the statement describes his/her child by assigning a rating on a five-point Likert scale with three anchor points (1 = "not at all," 3 = "somewhat," and 5 = "very much"). Likert scale ratings are summed across all items to yield a total score.

The results of a psychometric evaluation of the IUSC conducted by Comer et al. (2009) indicated high internal consistency for the measure, with a Cronbach's α value of .96. Comer et al. (2009, p. 406) also reported acceptable convergent validity, noting "moderate to large" correlations of the parent/guardian version of the IUSC's total score with children's self-

reports of anxiety on the Multidimensional Anxiety Scale for Children (March, Parker, Sullivan, Stallings, & Conners, 1997) and worry on the Penn State Worry Questionnaire for Children (Chorpita, Tracey, Brown, Collica, & Barlow, 1997). For the total score for all IUSC items, Comer et al. (2009) suggested that cut scores of 52 to 55 were best able to distinguish anxious and non-anxious children.

3.3   EXPERIMENTAL TASKS

Each participant in the main study completed computer tasks identical to those employed in pilot testing and described in Chapter 2. The only methodological difference from the pilot study to the main study was that adolescent participants were video-recorded during the exposure phase using the MacBook Pro's built-in video camera. Participants in the main study were videotaped in order to ensure that they viewed the computer screen throughout the exposure phase. Video-recording was conducted with parent/guardian consent and participant assent. Each participant's video clips were reviewed following his/her testing session to ensure that he/she had been looking at the computer screen for at least 90% of the duration of the exposure phase. It was only necessary to exclude one participant, a member of the ASD group, on the basis of failure to look at the screen for at least 90% of the duration of the exposure phase.

3.4   PROCEDURE

At the outset of each study session, written informed consent was obtained from the adolescent participant's parent/guardian. The adolescent participant was also asked to provide assent on his/her own behalf.

Once consent and assent had been obtained, the participant began the MRE task, starting with the exposure phase. To reduce boredom, the WASI's two verbal subtests (Similarities and Vocabulary) were administered between the three exposure phase blocks. In cases in which it was not necessary to administer the WASI, participants completed questionnaire measures associated with another research study between exposure phase blocks instead. Following the exposure phase of the MRE task, the participant completed the rating phase of the MRE task, followed by the recognition and discrimination tasks, respectively. Then, if the WASI was being completed, the two performance subtests (Block Design and Matrix Reasoning) were administered. While the participant was completing the computer tasks and the WASI, if necessary, his/her parent/guardian filled out the questionnaire measures described previously. The entire experiment took approximately 120 minutes to complete in cases in which the WASI was administered.

When the participant and his/her parent/guardian had completed the experimental protocol, they were debriefed and provided the opportunity to ask any questions. At the end of the session, the participant and his/her parent/guardian were provided with $15 and $10, respectively, as a thank you for their time.

Table 3   Age and estimated Performance, Verbal, and Full Scale Intelligence Quotient
presented by diagnostic group

	ASD		TD	
	M (SD)	Range	M (SD)	Range
Age	15.33 (1.85)	12.67 - 18.75	14.96 (1.93)	12.00 - 18.83
Estimated IQ				
Verbal	111.61 (13.58)	86 - 148	113.14 (13.91)	80 – 138
Performance	113.89 (11.20)	89 - 130	108.79 (11.51)	90 – 131
Full Scale	113.43 (11.77)	88 - 139	112.21 (13.07)	84 – 132
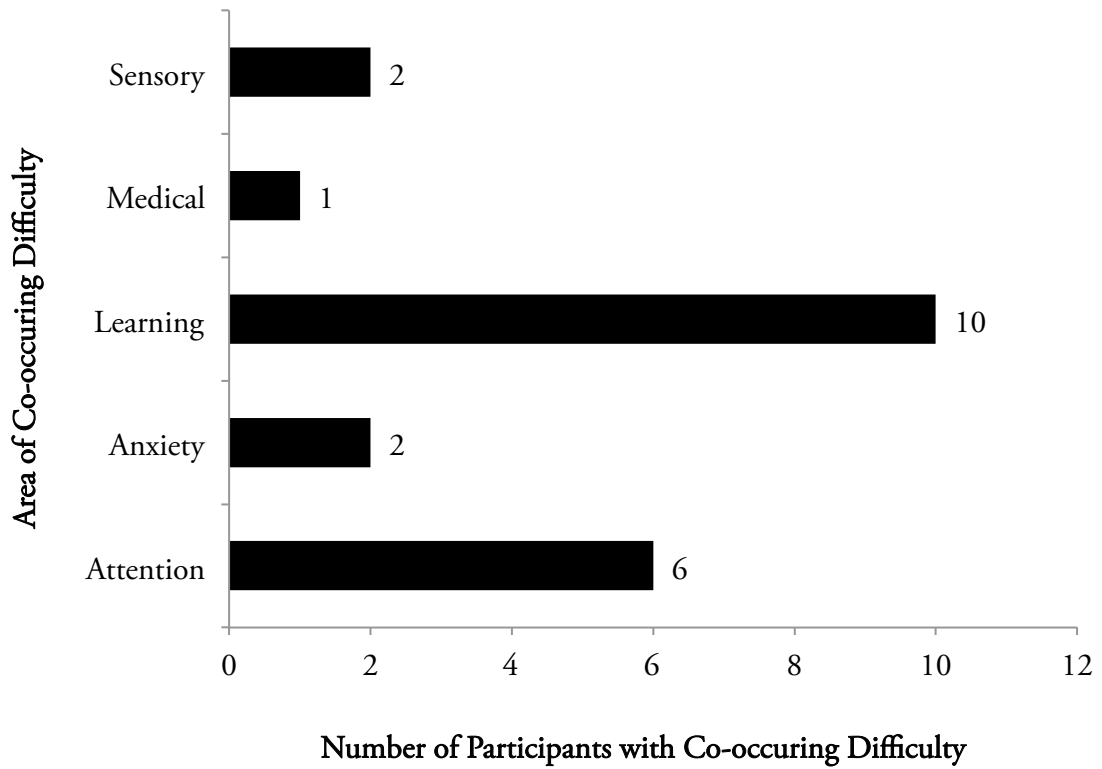
Figure 11   Number of participants in the ASD group with parent/guardian-reported
co-occuring difficulty, presented by area of difficulty

CHAPTER 4: RESULTS

Please note that the results reported in this chapter, and in the rest of this document, are presented according to the conventions described in *Appendix A: Presentation of Statistical Results*.

4.1 MERE REPEATED EXPOSURE TASK

4.1.1 Manipulation Check

Before the main research questions were considered, it was necessary to confirm that the experimental manipulation was successful (i.e., that the TD group demonstrated a MRE effect). To do this, a 3 (Stimulus Category: polygons, faces, and line drawings) x 5 (Exposure Frequency: 0, 3, 6, 9, and 15) repeated measures ANOVA was carried out for the liking ratings provided by TD participants. The ANOVA revealed a significant main effect of Exposure Frequency [$F(4, 24) = 2.83$, $p = .047$; $\eta_p^2 = .32)$]. This main effect indicated the presence of a MRE effect because, as can be seen in Figure 12, the inverted u-shaped MRE relationship between familiarity and affect often described in the literature (e.g., Comer et al., 2009; Lee, 2001) was observed. Paired samples *t*-tests were carried out to investigate further the main effect of Exposure Frequency. These analyses revealed differences between liking ratings at the 0 and 3 [$t(27) = -3.03$, $p = .005$; $d = .58$] and 3 and 9 [$t(27) = 2.13$, $p = .04$; $d = .41$] exposure frequencies. All other comparisons were non-significant (i.e., p ≥ .05). However, a trend-level difference in liking ratings was observed between the 0 and 6 exposure levels [$t(27) = -1.88$, $p = .07$; $d = .36$]. Mean liking ratings for the 0, 3, 6, 9, and 15

exposure levels were 3.70 (SD = .61), 3.89 (SD = .63), 3.85 (SD = .63), 3.74 (SD = .60), and 3.76 (SD = .72), respectively.

A main effect of Stimulus Category was also observed [$F(2, 26)$ = 8.48, p = .001; η_p^2 = .40)]. Follow-up paired samples t-tests revealed significant differences in mean liking ratings between the face stimuli and both the polygon [$t(27)$ = 4.11, p < .001; d = .80] and line drawing [$t(27)$ = -3.30, p = .003; d = .65] stimuli. The polygon and line drawing stimuli did not differ from one another with respect to liking ratings [$t(27)$ = -.74, p = .47; d = .12]. Mean liking ratings for the face, polygon, and line drawing stimulus categories were 3.44 (SD = .66), 3.91 (SD = .50), and 4.01 (SD = .94), respectively. A Exposure x Stimulus category interaction was not observed [$F(8, 20)$ = .44, p = .88; η_p^2 = .15)]. Table 4 presents descriptive statistics for the liking ratings provided by the TD group. Similar data for the ASD group are presented in Table 5.

4.1.2   Omnibus ANOVA

To answer Research Question 1: Is the MRE effect intact in adolescents with ASD? and Research Question 2: Is the MRE effect consistent across stimulus categories in individuals with ASD?, a 2 (Group: ASD and TD) x 3 (Stimulus Category: polygons, faces, and line drawings) x 4 (Exposure Frequency: 3, 6, 9, and 15) repeated measures ANOVA was carried out. A difference score that quantified the magnitude of the MRE effect was used as the dependent variable in this analysis. For each exposure level, within each stimulus category, this difference score was calculated by subtracting the average liking rating at the 0-exposure level from the average liking rating at the exposure level of interest (i.e., 3, 6, 9, or 15).

Difference scores were used because the primary effect of interest was change in liking ratings based on stimulus exposure (i.e., the MRE effect). The use of difference scores removed the influence of potential between-group differences in initial and overall liking ratings. The difference score described above will be referred to as "change in liking."

The ANOVA revealed a significant main effect of Group [$F(1, 54) = 4.43$, $p = .04$; $\eta_p^2 = .08$]. Specifically, participants in the TD group demonstrated a greater change in liking overall ($M = .11$, $SD = .23$) than those in the ASD group ($M = -.02$, $SD = .22$). A significant Exposure Frequency x Group interaction was also observed [$F(3, 52) = 3.07$, $p = .04$; $\eta_p^2 = .15$]. Independent samples t-tests, collapsed across stimulus type, were carried out in order to further investigate this interaction. These analyses revealed a significant between-group difference at the 3 exposure frequency [$t(28) = 3.17$, $p = .003$; $d = .57$), but not at the 6, 9, or 15 exposure frequency. Graphical depictions of the main effect of Group and the Group x Exposure Frequency interaction can be found in Figures 13 and 14, respectively. Figure 15 shows changes in liking ratings presented by stimulus category and exposure frequency. A plot of individual participant data is contained in Appendix B. Visual inspection of this figure indicates relatively similar data distributions across the two groups.

Both the significant main effect of Group and the significant Group x Exposure Frequency interaction are relevant to Research Question 1: Is the MRE effect intact in adolescents with ASD?. Specifically, the main effect of group indicates that the TD group demonstrated a stronger MRE than the ASD group. The Group x Exposure Frequency interaction and follow-up t-tests suggest that this difference is most clear at the 3-exposure frequency. These

findings, combined with the results of the within-group ANOVAs described previously, suggest the absence of a MRE effect in ASD. Of course, this result should be interpreted with some caution as it represents a null effect. As will be discussed later, this result is only partly consistent with our hypothesis.

All other main effects and interactions for the omnibus ANOVA were non-significant. Please see Table 6 for a summary of all of the results of this analysis. The lack of a Group x Stimulus Category x Exposure Frequency interaction was particularly relevant to Research Question 2: Is the MRE effect consistent across stimulus categories in individuals with ASD?, This result indicates that the pattern of liking ratings across exposure frequencies was generally similar within each of the three stimulus categories (polygons, faces, and line drawings) for participants with ASD.

4.2   RECOGNITION TASK

A 2 (Group: ASD and TD) x 3 (Stimulus Category: polygons, faces, and line drawings) x 4 (Exposure Frequency: 3, 6, 9, and 15) repeated measures ANOVA was used to analyze data from the recognition task. As in the pilot study, corrected hit rate was used as a measure of stimulus recognition. The ANOVA revealed a significant main effect of Stimulus Category $[F(2, 53) = 252.46, p < .001; \eta_p^2 = .91]$. While all other main effects and interactions were non-significant (i.e., $p > .05$), trend-level main effects of Group $[F(1, 54) = 3.99, p = .05; \eta_p^2 = .07]$ and Exposure Frequency were observed $[F(3, 52) = 2.46, p = .07; \eta_p^2 = .13]$, as was a trend-level Group x Stimulus category interaction $[F(2, 53) = 2.19, p = .12; \eta_p^2 = .08]$.

Paired samples *t*-tests were used to further explore the significant main effect of Stimulus Category. They revealed significant differences in corrected hit rates between the polygon and face stimuli [$t(55) = 2.06$, $p = .04$; $d = .28$], the polygon and line drawing stimuli [$t(55) = -19.03$, $p < .001$; $d = 2.78$], and the face and line drawing stimuli [$t(55) = -19.54$, $p < .001$; $d = 2.78$]. Mean corrected hit rates for the face, polygon, and line drawing stimulus categories were .24 ($SD = .22$), .31 ($SD = .22$), and .85 ($SD = .12$), respectively. Descriptive statistics for corrected hit rate further divided by group and exposure frequency can be found in Table 7. As in the pilot study, Pearson's correlations were used to examine the association between stimulus recognition and the MRE effect. Again, no significant correlation between corrected hit rates and liking ratings was observed for either the ASD [$r(28) = -.14$, $p = .49$] or TD [$r(28) = .22$, $p = .28$] groups.

4.3   DISCRIMINATION TASK

A 2 (Group: ASD and TD) x 3 (Stimulus Category: polygons, faces, and line drawings) repeated measures ANOVA was used to analyze the discrimination data. As for the pilot study, the proportion of answers that were correct was employed as the dependent variable in this analysis. A significant main effect of Stimulus Category was observed [$F(2, 53) = 3.59$, $p = .04$; $\eta_p^2 = .13$]. However, there was no main effect of Group [$F(1, 54) = .02$, $p = .90$; $\eta_p^2 = .00$], nor a Group x Stimulus Category interaction [$F(2, 53) = 1.01$, $p = .37$; $\eta_p^2 = .04$]. Paired samples *t*-tests used to further investigate the Stimulus Category main effect revealed significant differences in proportions correct between polygon and line drawing stimuli [$t(55) = -2.29$, $p = .03$; $d = .33$] and face and line drawing stimuli [$t(55) = -2.03$, $p = .04$; $d =$

.30]. There was no difference between proportion correct for polygon and face stimuli [$t(55)$ = .22, p =.83; d = .03]. Mean proportions correct for the face, polygon, and line drawing stimulus categories were .97 (SD = .08), .97 (SD = .06), and .99 (SD = .04), respectively.

4.4 CHARACTERIZATION MEASURES

4.4.1 Between-Group Comparisons

Independent samples t-tests were used to compare groups on the basis of their characterization measure scores. For the SRS, the ASD and TD groups were compared on the basis of the gender-based T-score for all items. As expected, the ASD group (M = 79.61, SD = 9.42) had significantly higher total scores on the SRS than did the TD group [M = 42.07, SD = 5.05; $t(54)$ = -18.60, p < .001; d = 5.19]. The ASD group had a mean score of 79.60 (SD = 9.41; Range = 50 - 90), while the TD group had a mean score of 42.07 (SD = 5.05; Range = 34 - 56). Recall that or the SRS, T-scores between 60 and 75 are considered to reflect "mild to moderate" symptoms, while scores 76 and higher are deemed indicative of "severe" symptomology (Constantino & Gruber, 2005). On the SRS, 0 and 27 participants in the TD and ASD groups, respectively, had T-scores greater than or equal to 60. There were also significant between-group differences on the SCARED for the total score [$t(54)$ = -3.69, p = .001; d = 1.04]. The ASD group had a mean score of 17.92 (SD = 10.17; Range = 3 - 40), while the TD group had a mean score of 8.96 (SD = 7.09; Range = 0 - 31) and 3.08 (SD = 3.26), respectively. For reference, Birmaher et al. (1999) suggested that a total score of greater than or equal to 25 was indicative of clinically significant anxiety. On the SCARED,

1 and 7 participants in the TD and ASD groups, respectively, had total raw scores greater than or equal to 25.

For the RBS-R, the two groups were compared on the basis of the total score, as well as the Rituals/Sameness and Restricted Interests factors described by Lam and Aman (2007). Each of these analyses revealed significant differences between the ASD and TD groups, with the ASD group obtaining higher scores. For the total score, the ASD group had a mean score of 17.19 (SD = 9.20; Range = 3 - 42), while the TD group had a mean score of 2.31 [SD = 3.56; Range = 0 - 15; $t(54)$ = -7.70, p < .001; d = 3.21]. On the Rituals/Sameness factor, the ASD group had a mean score of 8.22 (SD = 6.91) and the TD group had a mean score of 1.35 [SD = 2.42; $t(54)$ = -4.80, p < .001; d = 1.99]. On the Restricted Interests factor, the ASD group had a mean score of 2.33 (SD = 1.90) and the TD group had a mean score of .43 [SD = .08; $t(54)$ = -5.80, p < .001; d = 1.94]. For comparison, in the validation study conducted by Lam and Aman (2007), individuals aged 13 to 20 with ASD had mean scores of 37.03 (SD = 22.18), 12.78 (SD = 8.09), and 4.82 (SD = 2.97) overall and for the Rituals/Sameness and Restricted Interest factors, respectively. For the RBS-R total score, 0 and 1 participants in the TD and ASD groups, respectively, had raw scores greater than or equal to 37.

For the IUSC, an error associated with the Internet-based questionnaire administration system resulted in the invalidation of data for the first eight and nine participants in the TD and ASD groups, respectively. It is not anticipated that this data loss had any systematic effects on IUSC results. However, as a result, analyses involving IUSC data include a smaller subset of participants (i.e., 18 participants with ASD and 17 TD comparison participants).

Within the subgroup of participants with valid IUSC scores, the ASD and TD groups were well-matched; the two groups did not differ on the basis of age or cognitive ability (PIQ, VIQ, or FSIQ; all $p > .40$). Please see Table 8 for descriptive statistics regarding this subsample. Further, the sex ratios for the two groups were very similar, with one female in each of the ASD and TD groups [$\chi^2(1, N = 35) = .002, p = .97.$]. There was a significant between-group difference for the IUSC total score; the ASD group had a mean score of 73.06 ($SD = 19.42$), while the TD group had a mean score of 40.88 [$SD = 16.77; t(33) = -5.23, p < .001; d = 1.78$]. For reference, Comer et al. (2009) suggested that cut scores of 52 to 55 were best able to distinguish anxious and non-anxious children. For the IUSC total score, 2 and 15 participants in the TD and ASD groups, respectively, had raw scores greater than or equal to 52. For a graphical depiction of characterization measure results, please consult Figure 16.

4.4.2   Correlational Analyses

A number of correlational analyses were carried out in order to answer Research Question 3: Is there a relationship between the MRE effect and clinical features of ASD? Two sets of Pearson's correlations were completed. For one set of analyses, relationships were evaluated between characterization measure scores and the mean change in liking ratings collapsed across exposures and stimuli. For the other, correlations between characterization measure scores and the mean change in liking ratings collapsed across stimuli at the 3-exposure frequency were considered. Recall that the ASD and TD groups' mean change in liking differed only at the 3-exposure frequency.

The following characterization scores were paired with the variables described above in the bivariate correlations: SRS total score, SCARED total and Generalized Anxiety subscale scores, RBS-R total and Rituals/Sameness and Restricted Interests factor scores, and IUSC total score. Correlational analyses were conducted for the ASD and TD groups separately. These analyses generated several significant results. Only significant and trend-level relationships are described here, but all correlational results are summarized in Figure 17.

Overall Mean Change in Liking Ratings

Overall mean change in liking ratings was not related, either significantly or at a trend level, to any characterization measure score for the ASD group. For the TD group, a significant positive correlation was observed between overall mean change in liking ratings and RBS-R Restricted Interests subscale scores [$r(56) = .42$, $p = .03$]. This means that adolescents whose parent/guardian rated them as displaying more restricted interests exhibited more robust MRE effects.

Mean Change in Liking Ratings at the 3-Exposure Frequency

Mean change in liking ratings at the 3-exposure frequency was not related, either significantly or at a trend level, to any characterization measure score for the ASD group. However, significant negative correlations were observed between mean change in liking ratings at the 3-exposure frequency and both SCARED [$r(56) = -.45$, $p = .02$] and IUSC total scores [$r(56) = -.43$, $p = .03$] for the TD group. This means that participants whose parent/guardian indicated that they were less anxious or less intolerant of uncertainty demonstrated greater increases in liking across exposures. Also for the TD group, mean

changes in liking ratings at the 3-exposure frequency were related, at a trend-level, to SCARED Generalized Anxiety subscale scores [$r(56) = -.29$, $p = .15$], as well as to RBS-R total [$r(56) = -.36$, $p = .07$], Rituals/Sameness subscale [$r(56) = -.31$, $p = .12$], and Restricted Interests subscale scores [$r(56) = -.31$, $p = .12$]. That is, TD adolescents whose parent/guardian reported that they exhibited less generalized anxiety and a variety of repetitive behaviour (e.g., ritualistic behaviour, preference for sameness, and restricted interests) demonstrated stronger MRE effects.

Table 4   Mean liking ratings (and SDs) presented by stimulus category and exposure frequency for TD group in main study

Exposure Frequency	0	3	6	9	15
Polygons	3.76 (.55)	4.05 (.68)	4.06 (.68)	3.86 (.65)	3.82 (.81)
Faces	3.37 (.73)	3.52 (.75)	3.46 (.79)	3.41 (.75)	3.45 (.86)
Line Drawings	3.98 (1.04)	4.09 (1.01)	4.02 (1.15)	3.96 (1.12)	3.99 (1.09)

Table 5   Mean liking ratings (and SDs) presented by stimulus category and exposure frequency for ASD group in main study

Exposure Frequency	0	3	6	9	15
Polygons	3.93 (.80)	3.93 (.72)	4.04 (.76)	3.98 (.77)	4.02 (.93)
Faces	3.63 (.60)	3.56 (.73)	3.66 (.71)	3.64 (.62)	3.46 (.70)
Line Drawings	4.27 (.77)	4.10 (.86)	4.16 (.97)	4.33 (.83)	4.22 (.93)

Table 6   Summary of main effect and interaction results for omnibus ANOVA for main study

	F value	*p* value	η_P^2
Group	4.43	.04	.08
Stimulus Category	1.84	.17	.07
Exposure Frequency	.43	.73	.02
Group x Stimulus Category	.45	.84	.05
Group x Exposure Frequency	3.07	.04	.15
Stimulus Category x Exposure Frequency	.45	.84	.05
Group x Stimulus Category x Exposure Frequency	.58	.74	.07

Table 7   Mean corrected hit rates (and SDs) for recognition task presented by stimulus category and exposure frequency for main study

	ASD				TD			
Exposure Frequency	3	6	9	15	3	6	9	15
Polygons	.23 (.32)	.31 (.25)	.33 (.26)	.34 (.22)	.30 (.31)	.34 (.29)	.33 (.30)	.31 (.29)
Faces	.15 (.33)	.13 (.36)	.15 (.32)	.23 (.31)	.27 (.30)	.32 (.27)	.33 (.27)	.35 (.32)
Line Drawings	.83 (.13)	.84 (.15)	.82 (.11)	.83 (.14)	.86 (.16)	.89 (.13)	.87 (.20)	.86 (.16)

Table 8   Age and estimated Performance, Verbal, and Full Scale Intelligence Quotient presented by diagnostic group for IUSC subgroup

	ASD		TD	
	M (SD)	Range	M (SD)	Range
Age	15.41 (1.61)	12.67 - 18.25	15.17 (1.72)	12.00 - 18.25
Estimated IQ				
Verbal	110.06 (13.79)	86 - 148	111.12 (15.32)	80 - 138
Performance	112.28 (12.18)	89 - 130	109.12 (13.41)	90 - 131
Full Scale	111.11 (12.38)	88 - 139	111.00 (15.01)	84 - 132
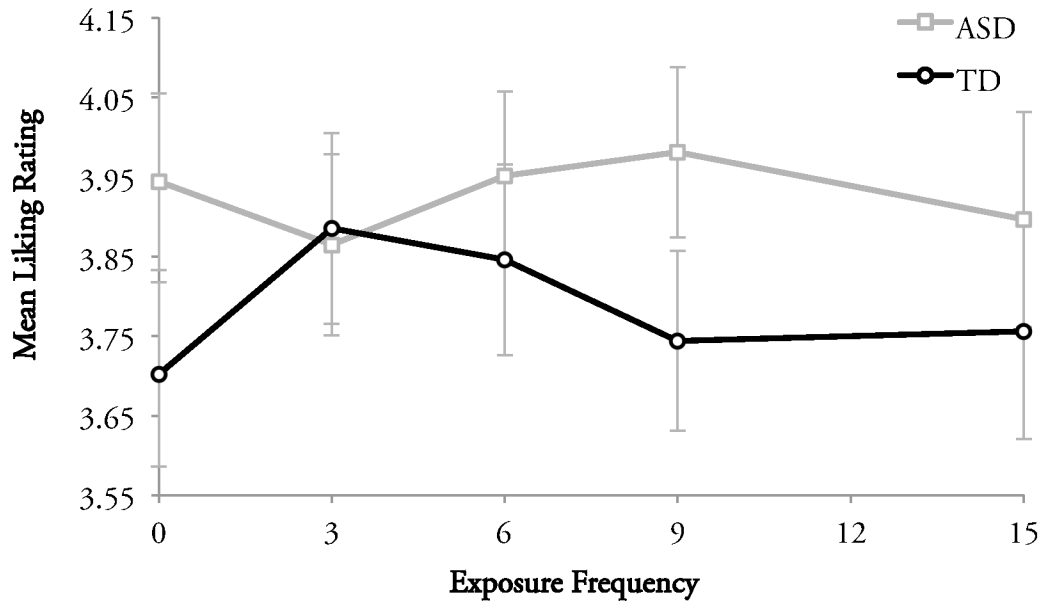
Figure 12   Mean liking ratings presented by group and exposure frequency for main study

Note. Error bars represent standard error of the mean.
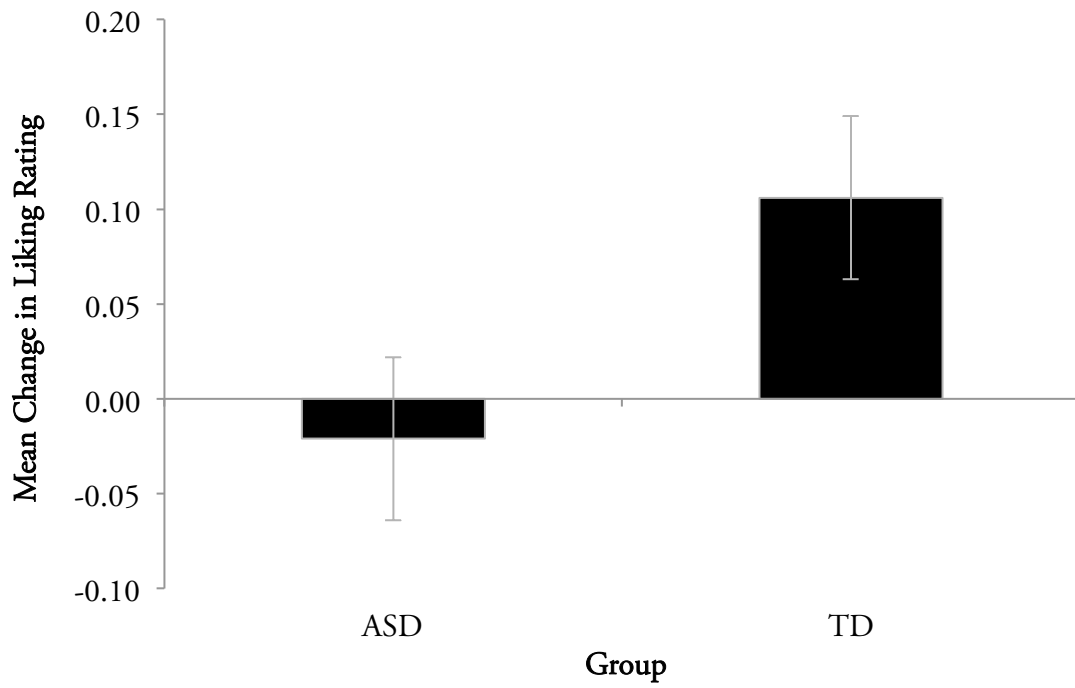
Figure 13   Mean change in liking ratings presented by group and collapsed across
exposure frequency and stimulus type for main study

Note. Error bars represent standard error of the mean.
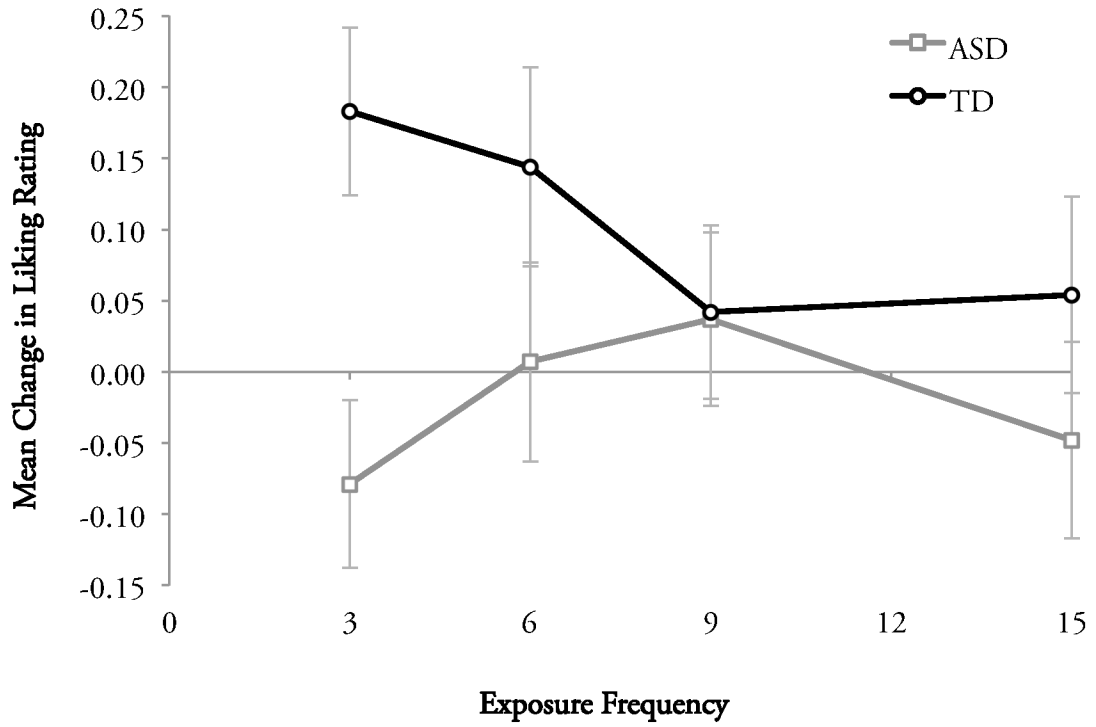
Figure 14 Mean changes in liking ratings presented by group and exposure frequency and collapsed across stimulus type for main study

Note. Error bars represent standard error of the mean.

Polygons   Faces   Line Drawings
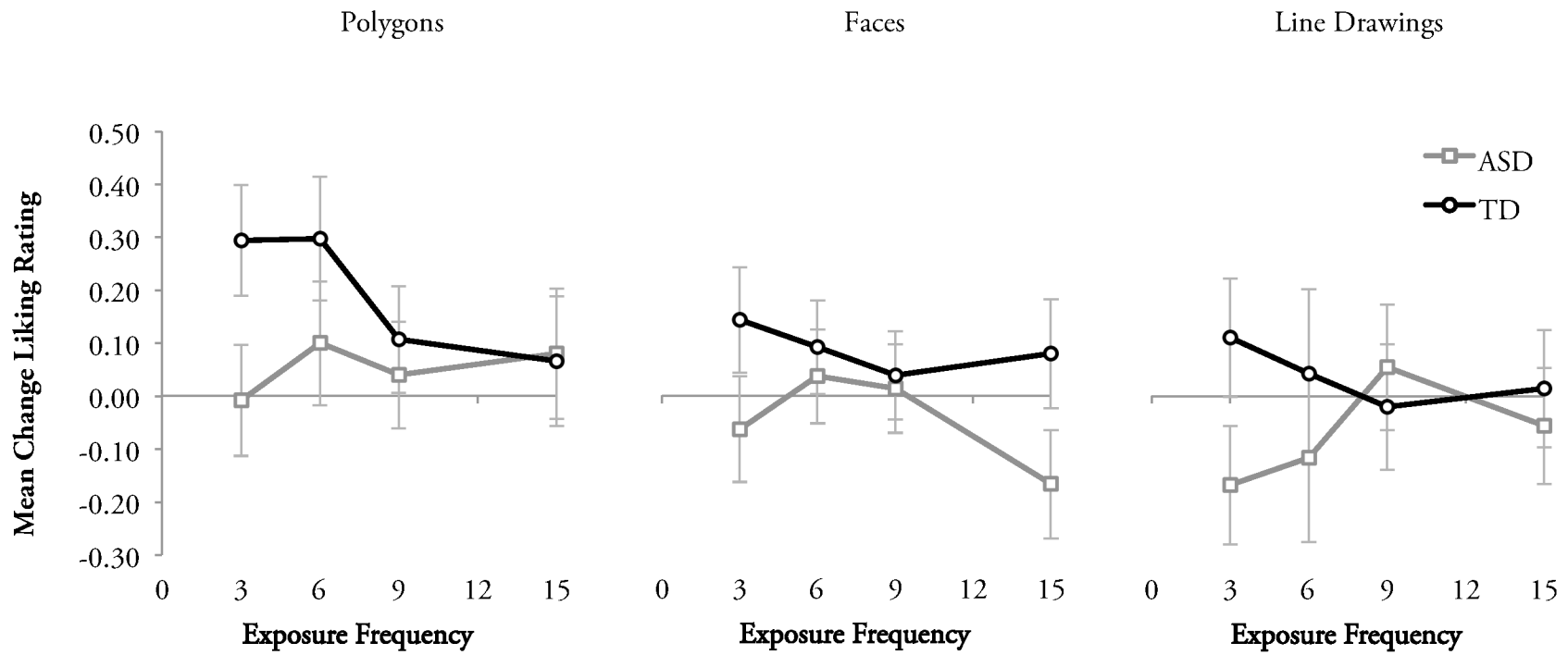
Figure 15 Mean changes in liking ratings presented by stimulus category and exposure frequency for main study

Note. Error bars represent standard error of the mean.

Raw Scores
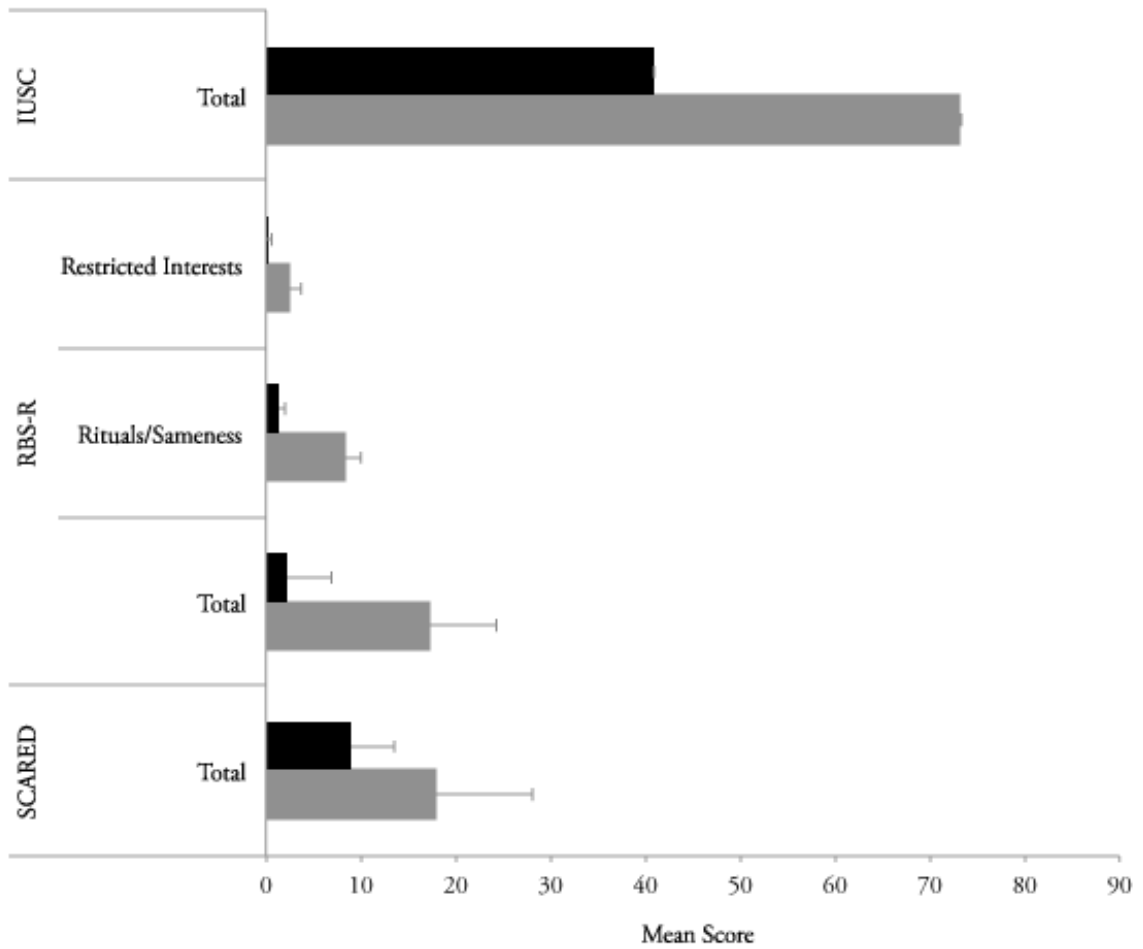
T-scores
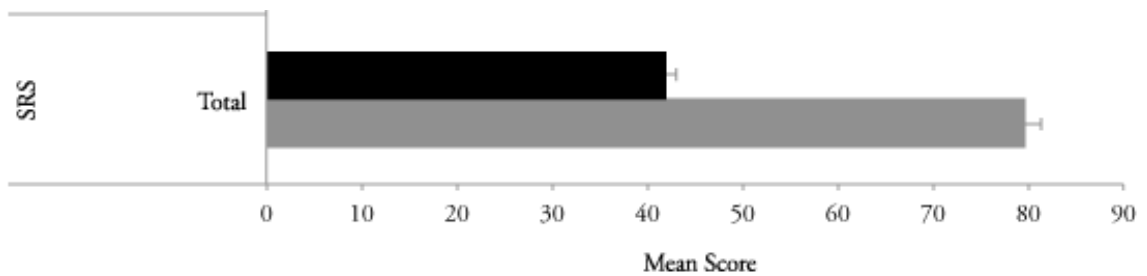
Figure 16   Mean scores for main study characterization measures presented by score type and group

> *Note.* Error bars represent standard error of the mean. See *Section 3.2* for a thorough description of the specific scores calculated for each measure.

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		SRS	SCARED	RBS-R			IUSC
		Total	Total	Total	Rituals/ Sameness	Restricted Interests	Total
Mean Change in Liking Rating (Overall)	TD	-.14 (.47)	-.20 (.34)	-.07 (.75)	-.10 (.64)	.42 (.03)	.01 (.97)
	ASD	.14 (.47)	-.11 (.60)	.19 (.35)	.02 (.91)	-.11 (.60)	.00 (.99)
Mean Change in Liking Rating (Peak)	TD	-.10 (.61)	-.25 (.22)	.21 (.31)	.16 (.44)	.48 (.01)	.03 (.88)
	ASD	.16 (.42)	.06 (.77)	.24 (.23)	.14 (.50)	-.02 (.92)	.10 (.63)

Figure 17   Pearson's correlations (and *p* values) for characterization measures the main study presented by group

Note. Light grey, medium gray, and dark grey boxes represent absent to small (*r* = .1 to .10), small to medium (*r* = .10 to .30), and medium to large (*r* ≥ .30) correlations, respectively.

CHAPTER 5: DISCUSSION

5.1   REVIEW OF RESEARCH QUESTIONS AND APPROACH

Studies numbering in the hundreds have demonstrated that, for TD individuals, increased familiarity with stimuli generally results in greater affinity toward them (Houston-Price et al., 2009). The main purpose of the current project was to test the hypothesis that this familiarity-affect relationship, measured through the MRE effect, is disrupted in adolescents with ASD. Specifically, we expected that youth with ASD would demonstrate a delayed MRE effect. This prediction was informed by several clinical observations and findings in the scientific literature. First, people with ASD have often been described as having a stronger preference for familiar stimuli (e.g., Croonenberghs et al., 2002; Gopnik et al., 2000; Gustafsson & Papliński, 2004; Pascualvaca et al., 1998; Pellicano & Burr, 2012) and demonstrating less exploratory behaviour (e.g., Kawa & Pisula, 2013; Pierce & Courchesne, 2001; Pisula, 2003) than their TD peers. Second, a number of studies have found that individuals with ASD take longer than TD participants to habituate to novel stimuli (e.g., Guiraud et al., 2011; James & Barry, 1984; Musurlian, 1995; Perry et al., 2007). Importantly, stimulus habituation is one of two arousal processes that have been hypothesized to underlie the MRE effect (Berlyne, 1970; Bornstein, 1989; Stang, 1974). Third, several authors have reported evidence indicating that the brain's reward circuitry, which is thought to be involved in the MRE effect, is atypical in ASD (Dichter, Felder, et al., 2012; Kawa & Pisula, 2013; Kohls et al., 2013; Pierce & Courchesne, 2001; Pisula, 2003; Schmitz et al., 2008; Scott-Van Zeeland et al., 2010).

In addition to determining whether the familiarity-affect relationship is intact in ASD, we were also interested in examining the nature of the MRE effect across stimulus categories. In that atypical processing of social information is a central characteristic of ASD (American Psychiatric Association, 2013), we were particularly interested in the social/non-social stimulus dimension. However, as previous studies have indicated abnormalities in familiarity preferences, exploratory behaviour, stimulus habituation, and reward circuitry function across both social and non-social stimulus categories in ASD (e.g., Guiraud et al., 2011; Kawa & Pisula, 2013; Kohls et al., 2013; Perry et al., 2007; Pisula, 2003; Scott-Van Zeeland et al., 2010), we predicted that any differences in the MRE effect would be domain-general as well. Finally, we examined whether particular individual-difference variables are associated with atypicalities in the familiarity-affect relationship in ASD. Based on previous findings in the MRE literature (Crandall, 1968; Schick et al., 1972) and knowledge of the symptoms and comorbidities associated with ASD (South, White, et al., 2013; van Steensel et al., 2011), we expected that participants with higher levels of ASD-related characteristics, restricted and repetitive interests, anxiety, and intolerance of uncertainty would demonstrate a more atypical (i.e., delayed) MRE effect.

In order to answer the research questions described above, we administered several experimental tasks and characterization measures to a group of adolescents with ASD and matched TD comparison participants. The main experimental task that we employed, a MRE paradigm, was developed based on a thorough review of the MRE literature and extensive pilot testing. The remainder of this chapter will provide a summary of the results

that we obtained, a discussion of their theoretical and practical implications, and a roadmap for next steps in this research area.

5.2   SUMMARY OF KEY FINDINGS

5.2.1   Research Question 1

As indicated above, the primary goal of the current study was to answer Research Question 1: Is the MRE effect intact in adolescents with ASD? We predicted that individuals with ASD would require more stimulus presentations than their TD peers before they began to demonstrate the increasingly positive stimulus evaluations associated with the MRE effect. Our results were only partially consistent with this hypothesis. As expected, we found a significant between-group difference in the familiarity-affect relationship. Specifically, we observed that, overall, TD adolescents demonstrated a stronger MRE effect (i.e., a greater increase in liking ratings for previously exposed stimuli) than did youth with ASD. We also found that the pattern of liking ratings across exposure frequencies differed between the TD and ASD groups. As predicted, we observed a typical inverted u-shaped MRE effect for TD participants, with liking ratings increasing and then decreasing across exposure frequencies. However, contrary to our prediction of a delayed familiarity-affect relationship in adolescents with ASD, the liking ratings of participants in this group did not increase, even at the highest exposure frequencies.

5.2.2   Research Question 2

With respect to Research Question 2: Is the nature of the MRE effect consistent across stimulus categories (i.e., social and non-social) in individuals with ASD?, the findings of the present study were consistent with our hypothesis. That is, a MRE effect was not observed for any stimulus categories in individuals with ASD. This finding is in keeping with results indicating that those with ASD demonstrate familiarity preferences and a lack of exploratory behavior for both social and non-social stimuli (e.g., Kawa & Pisula, 2013; Pierce & Courchesne, 2001; Pisula, 2003). This result is also consistent with reports of domain-general differences in neural reward circuitry (Dawson et al., 2005; Dichter, Felder, et al., 2012; Kohls et al., 2013; R. T. Schultz, 2005) and stimulus habituation (James & Barry, 1984; Musurlian, 1995; Webb et al., 2010) in participants with ASD symptoms.

5.2.3   Research Question 3

In addition to examining the nature of the MRE effect in adolescents with ASD, we also sought to answer Research Question 3: Is there a relationship between the MRE effect and clinical features of ASD? Recall that our initial hypothesis was that participants with more symptoms of ASD and associated comorbidities would demonstrate a more atypical (i.e., delayed) MRE effect. However, as the main finding of our study was the absence, rather than the delay, of the MRE effect in participants with ASD it was necessary to revise our hypothesis for Research Question 3 slightly. Specifically, our adjusted prediction was that individuals with more symptoms of ASD and associated comorbidities would demonstrate less evidence of a MRE effect, as measured by change in liking ratings. Unfortunately, the correlational analyses that were conducted generated few significant results. In fact, for the

ASD group, no significant associations between characterization measure scores and MRE effect magnitude were observed. For the TD group, several significant correlations were revealed and they generally indicated that participants who exhibited less anxiety, intolerance of uncertainty, and repetitive behaviours demonstrated stronger MRE effects. These TD group results are interesting because they contradict previous findings in the MRE literature. Factors that may have contributed to this discrepancy, as well as our failure to observe relationships between MRE and individual difference variables within ASD group, are described later in this chapter.

5.3 INTERPRETATION AND IMPLICATIONS

The main finding of our study, that participants with ASD did not demonstrate a MRE effect, could be interpreted in a number of ways. One possibility is that those with ASD actually do not exhibit a MRE effect. That is, for people with ASD, evaluations of stimuli are not influenced by prior exposures and preferences are, instead, formed through other mechanisms (e.g., the innate attractiveness of certain stimulus properties or classical or operant conditioning). An alternative interpretation is that the MRE effect is more delayed in people with ASD than we had originally suspected and that the number of exposures presented in the current study was not sufficient to elicit increased stimulus liking in this group. While the data obtained in the current experiment do not suggest an increase in liking ratings for the ASD group, even at the highest exposure frequencies, the notion of a delayed MRE effect remains more consistent with clinical observations of individuals with ASD. For example, it would be difficult to explain the presence of strong familiarity

preferences in ASD (e.g., Croonenberghs et al., 2002; Gopnik et al., 2000; Gustafsson & Papliński, 2004; Pascualvaca et al., 1998; Pellicano & Burr, 2012) if the stimulus evaluations of those with this disorder were independent of familiarity. While additional data will be required in order to determine whether the MRE effect is absent or extremely delayed in ASD, the results of the current study do suggest an atypical MRE effect in individuals with ASD.

5.3.1 Theoretical Accounts of the MRE Effect

As indicated previously, there are three main theoretical accounts of the MRE effect (i.e., the PF/AM, the HFM, and the URM). Recall that, through the PF/AM, Bornstein and D'Agostino (1992, 1994) hypothesized that stimuli that have been previously encountered are easier to perceive, encode, and process than novel stimuli. They suggested that people often misattribute this processing ease (i.e., perceptual fluency) to stimulus liking, resulting in the MRE effect. Winkielman and Cacioppo's HFM (2001) is similar to the PF/AM in that it builds upon the concept of perceptual fluency. However, whereas Bornstein and D'Agostino (1992, 1994) proposed that perceptual fluency is affectively neutral, Winkielman and Cacioppo (2001) suggested that it elicits genuine positive emotion, which is reflected in the favourable stimulus evaluations associated with the MRE effect. Unlike the PF/AM and the HFM, Bornstein's URM (1989) does not rely on the concept of perceptual fluency. Rather, through the URM, Bornstein (1989) proposed that the antagonistic arousal processes of habituation and boredom combine to produce the MRE effect. Recall that, at present, the MRE literature favours the two theoretical models that incorporate affective

components (i.e., the HFM and URM), but has not conclusively established the processes that underlie the familiarity-affect relationship.

While the results of the present study cannot definitively answer the question of which theoretical account of the MRE effect is most plausible, they have important implications for MRE theory. First, our results call into question one of the main assumptions of the PF/AM. Recall that a negative relationship between stimulus recognition and liking is one of the pillars of Bornstein & D'Agostino's (1992) PF/AM account of the MRE effect. That is, Bornstein and D'Agostino (1992) suggested that when individuals are not aware of repeated stimulus exposures (i.e., when recognition is low), they are more likely to misattribute the experience of processing ease to stimulus properties and, therefore, demonstrate a strong MRE effect. Bornstein and D'Agostino (1992) proposed that, in contrast, when recognition is high (i.e., participants are aware that they have been repeatedly exposed to stimuli), they are less likely to engage in cognitive misattribution and subsequently less likely to display a MRE effect.

In the current study, we observed higher corrected hit rate values for line drawings than for polygons and faces for the TD participants included in both the pilot and main studies. However, despite these recognition differences, the pattern of liking ratings across exposure frequencies did not differ based on stimulus category. Further, we observed no significant correlation between corrected hit rates and liking ratings. These results are consistent with recent findings indicating that poorer recognition is not universally associated with greater stimulus liking (Newell & Shanks, 2007; Stafford & Grimes, 2012), as was previously suggested (e.g., Bornstein, 1989; Bornstein & D'Agostino, 1992), and cast further doubt on

the ability of the PF/AM to adequately describe and account for the familiarity-affect relationship.

Second, in that we have identified a population in which perceptual fluency is most likely intact and the MRE effect is atypical, we have opened up an exciting avenue for future research into the mechanisms that underlie this long-studied phenomenon. This is particularly notable because, while the MRE effect has been examined across a broad range of clinical diagnoses (e.g., Korsakoff syndrome, Schizophrenia, and Alzheimer disease; M. K. Johnson, Kim, & Risse, 1985; Marie et al., 2001; Winograd et al., 1999, respectively), it has been found to be disrupted in only a minority of the clinical populations studied (e.g., individuals with head injuries associated with executive function deficits and those with selective amygdala damage; Barker et al., 2006; Chiba et al., 2013). Certainly, identifying clinical groups with atypical performance is one of the key cognitive neuropsychological approaches to understanding the mechanisms underlying cognitive processes in TD individuals (Cocchini, 2012). A number of studies that could be conducted with individuals with ASD to further our theoretical understanding of the MRE effect are described later in this chapter.

5.3.2   Neural Basis of the MRE Effect

Although it was not the goal of the current study to add to our understanding of the neural underpinnings of the MRE effect, our results may also have some important implications for this work. As described above, we have identified an additional population (i.e., adolescents with ASD) in which the familiarity-affect relationship is atypical. Therefore, it is possible

that incorporating neuroimaging techniques into future MRE research with individuals with ASD will add to our existing knowledge of the brain basis of the familiarity-affect relationship. Further, while our findings provide no direct evidence regarding the neural substrates of the familiarity-affect relationship, they are interesting to consider in relation to Zebrowitz and Zhang's (2012) hypothesis that the MRE effect relies upon the brain's reward circuitry. Specifically, our observation of an atypical MRE effect in ASD represents the third finding of an atypical familiarity-affect relationship in a population with suspected reward system dysfunction (Barker et al., 2006; Chiba et al., 2013). Interestingly, there is some overlap with respect to the cognitive and social cognitive difficulties observed in ASD and in the other two populations reported to demonstrate atypicality in the MRE effect (i.e., individuals with head injuries associated with executive function deficits and those with selective amygdala damage).

5.3.3   MRE Effect in TD Adolescents

As discussed previously, the results of previous studies that have examined the MRE effect in children and adolescents have been relatively inconsistent for a number of reasons, including the use of lengthy stimulus presentations, already familiar stimuli, and non-traditional affect measures. Therefore, the current study, which employed a rigorously controlled methodology developed following a thorough review of the extant MRE literature, represents an important addition to our understanding of the familiarity-affect relationship in TD youth. Our finding of a MRE effect across three stimulus categories in TD adolescents has implications for several of lines of inquiry, including research regarding the susceptibility of

youth to the advertisements that pervade modern life (e.g., Auty & Lewis, 2004; Morgenstern et al., 2012).

Also potentially valuable to our understanding of the MRE effect in adolescents are the results of our individual difference analyses. Recall that we found that TD adolescents who were described by their parent/guardian as displaying less anxiety, intolerance of uncertainty, and restricted and repetitive behaviours demonstrated stronger MRE effects. These results are in direct contrast to results reported in the adult MRE literature indicating that higher levels of intolerance of uncertainty and anxiety are associated with more robust MRE effects (Crandall, 1968; Schick et al., 1972, respectively). Several potential explanations for the difference between our findings and those of Crandall (1968) and Schick et al. (1972) are readily apparent. First, it could be that relationships between the MRE effect and individual differences variables do, in fact, develop across childhood. Second, it is possible that our individual difference measures tapped slightly different constructs than the tools employed by Crandall (1968) and Schick et al. (1972) and that this contributed to the divergence in our results. Specifically we chose to use modern anxiety and intolerance of uncertainty scales that were not available to Crandall (1968) and Schick et al. (1972) because these newer measures had been validated in adolescent samples.

Finally, it is conceivable that the results of the current study provide us with a more accurate window into the relationship between individual difference variables and the MRE effect than the findings of Crandall (1968) and Schick et al. (1972). This is because the experimental paradigms employed by both Crandall (1968) and Schick et al. (1972) differed in several ways from current MRE methods, which have evolved considerably across the past

four decades. For example, one of the familiarity manipulations employed by Schick et al. (1972) was non-experimental (i.e., stimuli were "Peanuts" or novel cartoons). Schick et al. (1972) also asked participants to rate how humorous they found stimuli rather than how much they liked them. Also divergent from modern MRE methods was Crandall's (1968) requirement that participants rate stimuli on bipolar adjective scales during exposure trials. Finally, Crandall's (1968) use of "good-bad" rather than liking ratings as a dependent measure was also somewhat atypical (p. 74). Certainly, it would be valuable for future research to further investigate the relationship between the MRE effect and individual difference variables in TD samples using modern MRE methods.

5.3.4   Symptoms and Clinical Management of ASD

We believe that the main finding of the current study (i.e., a compromised MRE effect in adolescents with ASD) may help us to understand why some people with ASD demonstrate a preference for familiarity and an aversion to novelty (e.g., Croonenberghs et al., 2002; Gopnik et al., 2000; Gustafsson & Papliński, 2004; Pascualvaca et al., 1998; Pellicano & Burr, 2012). Recall that, through the MRE effect, TD individuals are continuously expanding the range of stimuli with which they are comfortable interacting. Our results suggest that people with ASD may demonstrate an atypical (i.e., delayed or absent) familiarity-affect relationship. This is significant because it has been found that individuals are more likely to approach and less likely to avoid stimuli familiarized through MRE (Bornstein et al., 1987; Burger et al., 2001; Jones et al., 2011). The results of the current study are also important to our understanding of ASD because they provide an initial indication that differences in the MRE effect may be present across multiple stimulus

categories. This suggests that differences in the familiarity-affect relationship may have wide-reaching effects for individuals with ASD.

While the results of the current study have provided us with a glimpse into one of the mechanisms that may underlie familiarity preference and novelty aversion in ASD, additional research will be required in order to determine precisely how these findings could influence clinical practice. Specifically, clinical recommendations for expanding the range of stimuli with which individuals with ASD are comfortable will differ depending on whether the familiarity-affect relationship is entirely absent or simply delayed in this population. If future data indicate that a MRE effect is present but extremely delayed in ASD, we would expect that we could help individuals with this disorder to feel comfortable with new people, foods, sounds, objects, etc. simply by making these stimuli available to their perception frequently and over an extended period of time. Importantly, the knowledge that acceptance of a new stimulus would develop eventually may help caregivers persist in their presentation of stimuli across a prolonged interval. If future research instead indicates that the MRE effect is absent, rather than delayed, in individuals with ASD, different implications for clinical practice will be indicated. Specifically, we would anticipate that reliance on other mechanisms of preference development (e.g., classical or operant conditioning principles) would be more effective than MRE methods for expanding the range of stimuli with which individuals with ASD are comfortable interacting.

In addition to furthering our understanding of preferences in ASD, this line of research has the potential to increase our knowledge of several other aspects of this disorder. For example, if the research projects outlined later in this chapter favour a HFM model of the MRE effect,

our insight into executive function difficulties in ASD (Ozonoff, South, & Provencal, 2007) could benefit considerably. Recall that Winkielman and Cacioppo (2001) suggested that the experience of positive affect associated with perceptual fluency may assist in the internal monitoring of cognitive processes [e.g., progress toward recognizing and interpreting a stimulus (Carver & Scheier, 1990) or possession of the knowledge structures required to complete the task at hand (Bless & Fiedler, 1995)]. If positive affect is not experienced along with perceptual fluency in ASD, this could contribute to the difficulty monitoring and regulating cognitive processes that have been reported in individuals with this disorder (e.g., Endedijk, Denessen, & Hendriks, 2011; Robinson, Goddard, Dritschel, Wisley, & Howlin, 2009). Alternatively, if future research supports the URM model of the MRE effect, the current findings will be interesting to consider in the context of research suggesting a risk-averse cognitive style in ASD (S. A. Johnson, Yechiam, Murphy, Queller, & Stout, 2006; South, Chamberlain, et al., 2013). As outlined previously, Bornstein (1989) proposed that novel stimuli are inherently associated with risk because we have not previously encountered them. Further, the URM is based on the premise that uncertainty regarding novel stimuli is associated with high levels of arousal that are reduced through MRE. This arousal moderation is thought to be perceived as pleasant and is hypothesized to produce the MRE effect. If the resolution of feelings of uncertainty and apprehension about novel stimuli is compromised in ASD, consistent with an URM explanation of the MRE effect, this could contribute to the risk avoidance described by previous researchers.

5.4   OTHER FINDINGS OF INTEREST

5.4.1   Stimulus Category

In addition to findings related to the main research questions, several other results of interest were noted. One of these findings concerned the overall liking ratings assigned to exemplars from each of the three stimulus categories. Specifically, both the TD and ASD groups evaluated the face stimuli considerably less favourably than the polygon and line drawing stimuli. There are several reasons why participants may have rated face stimuli negatively. Our primary hypothesis is that they disliked the appearance of faces cropped at the hair and jawlines. While we continue to believe in the importance of controlling for stimulus features that might differentially distract participants with ASD (Chawarska & Shic, 2009; Pelphrey et al., 2002), there are several alternative methods that might be used to accomplish this goal in future studies. For example, photographs of faces could be altered digitally to have similar hairstyles. Alternatively, high quality computer-generated face stimuli with identical external features could be employed. However, it would be important to consider all aspects of this decision carefully. For example, while computer-generated face stimuli permit a high degree of experimental control, Craig, Mallan, and Lipp (2012) encourage caution in the use of these images, which sometimes produce experimental results that differ from those obtained using photographs.

5.4.2   Stimulus Discrimination

As indicated previously, a discrimination task was included in the current study to ensure that all participants were able to differentiate between stimuli on a perceptual basis. If

participants with ASD were not able to distinguish stimuli from one another, we would not expect to observe any stimulus-specific MRE effects. Our results indicated that both groups were slightly better at discriminating line drawing stimuli than polygon or face stimuli. This result, like the stimulus recognition finding described above, is likely due to the greater degree of within-category distinctiveness for line drawings than for polygons and faces. Again, it is interesting to note that, despite differences in stimulus discriminability, the pattern of liking ratings across stimulus exposures did not differ based on stimulus category in our main analysis. Further, while participants' ability to discriminate between stimuli varied based on stimulus category, their discrimination scores for all three stimulus types were outstanding (i.e., 97% or higher for all three categories). Most importantly, no between-group differences were observed on the discrimination task. This is critical because it rules out the possibility that the diminished MRE effect in the ASD group can be accounted for by poorer stimulus discrimination in this sample. This finding strengthens the argument that our central findings represent an actual difference in the familiarity-affect relationship in ASD.

5.5   STRENGTHS AND LIMITATIONS

The current study represents a significant contribution to the MRE and ASD literatures for several reasons. One strength of our study is that it employed a well-controlled MRE task that was developed following a thorough review of the MRE literature. As indicated previously, the majority of MRE studies that have been conducted with youth samples were either carried out before the major methodological papers on the MRE effect were written

(Busse & Seraydarian, 1978; G. N. Cantor, 1968, 1972; G. N. Cantor & Kubose, 1969; Colman et al., 1975) or emphasized ecological validity over experimental control (Auty & Lewis, 2004; Houston-Price et al., 2009; Morgenstern et al., 2012). Therefore, our finding of a MRE effect in 12- to 18-year-old TD adolescents using methods similar to those employed in the adult MRE literature represents a step forward in our understanding of the MRE effect in youth. A second strength of our study is that it was only the second examination of the MRE effect in a sample of individuals with ASD. Further, the MRE effect was the main phenomenon considered within the current research project, whereas it was one of several tasks in the previous ASD study (i.e., South et al., 2008). Our focused research approach allowed us to conduct a more thorough examination of the MRE effect and also to employ methods that were more consistent with standard MRE methods than the paradigm employed by South et al. (2008).

While the present research project has many strengths, it is not without its limitations. For example, as indicated previously, it is not possible to determine whether individuals with ASD demonstrate an absent or considerably delayed MRE effect based on the current results. In that our data suggest that TD adolescents evaluated stimuli that they had seen 3 to 6 times most positively, we expected that including exposure frequencies of 9 and 15 would be sufficient to capture a delayed MRE effect in youth with ASD. However, in order to be certain that an extremely delayed effect is not present, it would be valuable to collect additional data using even higher exposure frequencies (e.g., 30 to 50 exposures).

Another potential limitation of the current study is the fact that we cannot be completely certain that participants were attending to the computer screen during the presentation of

stimuli. We did attempt to address this issue by video recording them during the exposure phase using the laptop's built-in video camera. Based on the video clips reviewed, participants were judged to be looking at the computer screen for at least 90% of trials. Some assurance that participants were looking at the computer screen during exposure trials is also provided by the relatively high corrected hit rates (i.e., greater than .80) for both groups for the line drawing stimuli. Nonetheless, the video-recording measure that we used to ensure that participants were looking at the screen was somewhat coarse and it would be valuable for future studies to use eye-tracking technology.

Another limitation of the current study relates to the generalizability of its results. As indicated previously, in order to participate in this research project, participants were required to have a FSIQ of at least 80. This inclusion criterion was established in order to ensure that participants would be able to attend throughout the three 9.2-minute exposure sequences that comprised the exposure phase and evaluate stimuli on the Likert scales provided within the rating phase. In the final sample for the main study, the average FSIQs for the ASD and TD groups were 113.43 (SD =11.77) and 112.21 (SD = 13.07), respectively. It is important to acknowledge that our sample is a high-functioning one and that, therefore, our results cannot be generalized across the full autism spectrum. In order to investigate the familiarity-affect relationship in lower functioning individuals with ASD, it would be necessary to modify the MRE task to be more developmentally appropriate. This could be accomplished by presenting more tangible stimuli similar to those used by Houston-Price et al. (2009; i.e., picture books) and/or implementing a forced-choice paradigm similar to the one employed by South et al. (2008). However, as indicated

previously, each of these approaches has drawbacks (e.g., compromising experimental control and ability to interpret results within the context of the existing literature).

The issue of experimental control versus ecological validity is an important one to consider and, certainly, a potential limitation of the current study. The balance between these two factors is one that all researchers must consider when designing experiments. In developing the methodology for the current study, we decided to weight experimental control more heavily than ecological validity for two main reasons. First, a review of the previous MRE literature highlighted the possibility that the inconsistency with which MRE effects have been observed in youth samples could be a result of the variability in experimental methods that have been employed in this population. Second, the current study is only the second one to examine the MRE effect in a sample of individuals with ASD and the previous study (i.e., that of South et al., 2008) used an atypical MRE paradigm. For these two reasons, we believed that a study that emphasized methodological soundness would make the most meaningful contribution to the existing literature.

5.6   FUTURE RESEARCH DIRECTIONS

Given that the current study has begun a relatively new line of inquiry in the field of ASD research, numerous exciting research directions could be pursued in its wake. In this section, the research projects that most logically extend from our findings are described. The proposed studies aim to: 1) broaden our knowledge of the familiarity-affect relationship in ASD and 2) further investigate the mechanisms that underlie the MRE effect.

5.6.1 MRE Effect in Individuals with ASD

The primary outstanding question raised by the results of the current study is whether the MRE effect is absent or simply delayed in adolescents with ASD. Therefore, it will be important for future researchers to build upon our findings by administering MRE tasks that include higher exposure frequencies (i.e., 30 to 50 presentations) to participants with ASD. In designing these studies, it will be particularly important for investigators to ensure that they present stimulus exposures in a manner that protects against participant boredom. One way in which this could be achieved is by presenting stimuli across multiple sessions. Such an experimental design would have the added benefit of increased external validity as encounters with new stimuli in the real world do not usually occur within a single concentrated exposure sequence.

To better understand the pervasiveness of atypicalities in the familiarity-affect relationship in individuals with ASD, it will also be important to examine the MRE effect across a broader range of stimuli. For example, while the MRE effect has been demonstrated within multiple sensory modalities in TD individuals (Houston-Price et al., 2009), the current study only employed visual stimuli. Knowledge of whether an atypical familiarity-affect relationship extends to the gustatory and auditory modalities might provide us with additional insight into characteristics such as food selectivity (Bandini et al., 2010) and sensitivity to sounds (Bhatara, Quintin, Fombonne, & Levitin, 2013) that have previously been described in the ASD literature.

Also valuable in determining the implications of differences in the MRE effect for those with ASD would be an examination of the behavioural consequences of the MRE effect in this population. For example, a study similar to that of Jones et al. (2011), who examined joystick movements in response to stimuli, would provide valuable information about whether differences in the familiarity-affect relationship in ASD also affect approach and avoidance behaviours in this population. Further, a more ecologically valid experiment like Houston-Price et al.'s (2009) picture book study, while affording less experimental control, would help us to better understand the implications of a disrupted MRE effect outside the laboratory context.

5.6.2 Theoretical Accounts of the MRE Effect

Recall that there are three main theories of the MRE effect: the PF/AM, the HFM, and the URM. The identification of adolescents with ASD as a population in which the MRE effect is atypical may provide a unique opportunity for researchers to begin to determine which of these proposals best accounts for the familiarity-affect relationship. This is because there are relatively few populations in which the MRE effect has been found to be compromised (e.g., Barker et al., 2006; Chiba et al., 2013), but also because one of the processes that the PF/AM and HFM hypothesize to underlie the MRE effect (i.e., perceptual fluency) is likely intact in individuals with ASD. The following are studies that could serve as starting points for investigating each of the three main theories of the MRE effect using samples of individuals with ASD.

PF/AM. Within the PF/AM, Bornstein and D'Agostino (1992, 1994) proposed that the MRE effect results from the misattribution of the processing ease (i.e., perceptual fluency) generated by MRE to properties of the stimulus itself. If perceptual fluency is intact in ASD, as is suggested by previous repetition priming studies (Bowler et al., 1997; Gardiner et al., 2003; Renner et al., 2000), proponents of the PF/AM would predict that findings of an atypical MRE effect in ASD would result from a difference in their hypothesized misattribution process. That is, individuals with ASD could experience perceptual fluency typically, but unlike their TD peers, correctly attribute processing ease to stimulus familiarity. This explanation would be somewhat consistent with previous findings indicating that individuals with ASD are less susceptible to the misinterpretation of perceptual information (e.g., visual illusions; Chouinard, Noulty, Sperandio, & Landry, 2013; Happé, 1996; Mitchell, Mottron, Soulières, & Ropar, 2010). One way to begin to examine whether individuals with ASD are less likely than their TD peers to attribute the experience of perceptual fluency to stimulus properties would be to conduct an experiment similar to that of Mandler et al. (1987) with participants with ASD. Specifically, Mandler et al. (1987) found that TD participants misattributed processing ease to stimulus characteristics (e.g., brightness and darkness) other than liking. If individuals with ASD are, indeed, more accurate in their attributions of perceptual fluency, we would expect that ratings of factors other than liking (e.g., disliking, brightness, and darkness) would also be less influenced by MRE in participants with ASD than in their TD peers. That is, under the PF/AM, we would expect to observe similar results regardless of the dimension upon which participants were asked to rate stimuli.

HFM. As discussed previously, Winkielman and Cacioppo's (2001) HFM is similar to the PF/AM in that it incorporates the concept of perceptual fluency. However, unlike the PF/AM, the HFM is based on the premise that fluency elicits a genuine positive affective reaction, which leads participants to evaluate previously encountered stimuli more favourably. Again, assuming perceptual fluency is intact in ASD, proponents of the HFM would likely suggest that differences in the affective experience of perceptual fluency in ASD are responsible for the findings of the current study. Certainly, ASD has often been associated with differences in the recognition and expression of others' emotions (Nuske, Vivanti, & Dissanayake, 2013); however, as indicated previously, our understanding of the subjective experience of emotion in people with ASD is relatively limited (Losh & Capps, 2006). In order to determine whether individuals with ASD experience perceptual fluency as affectively positive, a facial EMG studies similar to those of Winkielman and Cacioppo (2001) and Harmon-Jones and Allen (2001) could be useful. If the cheek muscles of individuals with ASD were less active than those of their TD peers when viewing familiar stimuli, this could provide some perspective on whether individuals with ASD experience perceptual fluency as affectively positive. However, it would be necessary to consider these findings within the context of the existing mixed evidence regarding the typicality of MRE responses in participants with ASD (e.g., Mathersul, McDonald, & Rushby, 2013; Rozga, King, Vuduc, & Robins, 2013).

URM. Recall that, through his URM, Bornstein (1989) proposed that the combined effects of two antagonistic arousal processes, habituation and boredom, produce the MRE effect through both conscious and unconscious learning mechanisms. This account of the

familiarity-affect relationship is particularly interesting in relation to ASD because of previous findings suggesting that habituation is slowed in individuals with this disorder (e.g., Guiraud et al., 2011; James & Barry, 1984; Musurlian, 1995; Perry et al., 2007). To further examine whether arousal processes contribute to the MRE effect, participants with ASD and typical development could be administered a standard MRE task while a measure of physiological arousal (e.g., EDR) was collected. In this way, researchers could examine the relationship between measures of arousal and positive affect. Evidence of an association between atypical patterns of habituation and liking ratings in participants with ASD, while correlational and not causal, would point to the involvement of arousal processes in the MRE effect. The validity of the URM model of the MRE effect could be further evaluated by replicating the fMRI study conducted by Zebrowitz and Zhang (2012) within an ASD sample. Recall that the MOFC and LOFC have been associated with the presentation of positively and negatively valenced stimuli, respectively, and that Zebrowitz and Zhang (2012) found less activation in the LOFC for previously presented stimuli than for novel stimuli, but no difference in the MOFC. They interpreted this finding as indicating that a decrease in negative affect, but not an increase in positive affect, underlies the MRE effect. If such an examination revealed a smaller decrease in LOFC activation based on stimulus familiarity for participants with ASD than their TD peers, this would provide further support for a URM account of the familiarity-affect relationship.

5.7   CONCLUSION

The current findings suggest that the relationship between familiarity and affect is disrupted in adolescents with ASD. That is, we observed that TD participants demonstrated rising and then falling liking ratings across a range of stimulus exposure frequencies (i.e., a MRE effect), but youth with ASD did not. This pattern of results was similar across three categories of visual stimuli (i.e., polygons, line drawings, and faces). Additional research will be required in order to clarify whether our findings reflect the protraction or absence of the MRE effect in ASD. However, regardless of the outcomes of future studies, the results described herein have several important implications.

First, and perhaps most importantly, our findings provide a valuable window into one of the processes that may contribute to familiarity preference and novelty aversion in ASD (i.e., a disrupted MRE effect). Second, through identifying a population in which the familiarity-affect relationship is disrupted and perceptual fluency is likely intact, the present study has created new opportunities for researchers examining theoretical accounts of the MRE effect and hypotheses regarding its neural underpinnings. Third, through its use of highly controlled, empirically sound methodology, the current study represents an important contribution to our collective understanding of the familiarity-affect relationship in TD youth.

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APPENDIX A: DATA ANALYSIS AND PRESENTATION

Analytic Approach. The primary analyses presented in this document follow the approach that Maxwell and Delaney (2004) recommend for higher-level designs that incorporate within subjects factors. Specifically, Maxwell and Delaney suggest the use of a multivariate (i.e., MANOVA), rather than univariate (i.e., analysis of variance; ANOVA), approach to analyzing repeated measures data. They advise the use of MANOVA because it does not assume the presence of sphericity (i.e., the homogeneity of the variances of the differences between within subject levels). This is important because, within univariate analyses, violations of sphericity can considerably increase the probability of incorrectly rejecting the null hypothesis (McCall & Appelbaum, 1973). While it is possible to statistically evaluate, and correct for, violations of the sphericity assumption within the univariate ANOVA approach, there is some question regarding the utility of traditional measures of sphericity (e.g., Mauchly's Test of Sphericity; Keselman, Rogan, Mendoza, & Breen, 1980). Further, Maxwell and Delaney suggest that statistical corrections for violations of sphericity in ANOVA are only approximate and may not permit the maintenance of the desired nominal α value.

Statistical Significance. As a general rule, all results with $p < .05$ were considered to be "statistically significant." Results that approached statistical significance (i.e., those with p values between .05 and .15) were described as "trend-level" effects. It is important to note that trend-level findings did not meet criteria for statistical significance (i.e., $p < .05$) and should be interpreted accordingly.

Effect Size. In keeping with recent recommendations, effect size estimates were presented alongside the results of significance tests. For ANOVA results, effect sizes were reported as η_p^2 values and were interpreted as follows: .01 = small, .06 = medium, .14 = large. For t-test findings, effect sizes were conveyed as Cohen's d values and were interpreted according to the following benchmarks: .20 = small, .50 = medium, .80 = large. Finally, for correlational analyses, r values were interpreted as follows: .10 = small, .30 = medium, .50 = large. Each of these approaches to effect size interpretation is based on the guidelines proposed by Cohen (1988).

Multiple Comparisons. The current study was exploratory as it was the first to examine the MRE effect in youth with ASD. Therefore, corrections for multiple comparisons were not made for t-test and correlational analyses. This decision was made based on a determination that the risk of committing Type I error (i.e., a false negative or not rejecting the null hypothesis when the alternative hypothesis is true) outweighed the risk of committing Type I error (i.e., a false positive or rejecting a true null hypothesis). It also took into account suggestions that traditional corrections to the alpha level are too conservative and disproportionately increase the likelihood of Type II errors (Perneger, 1998; Rothman, 1990). Instead, estimates of effect size were provided for all relevant `analyses to add to the information provided by null hypothesis significance testing.
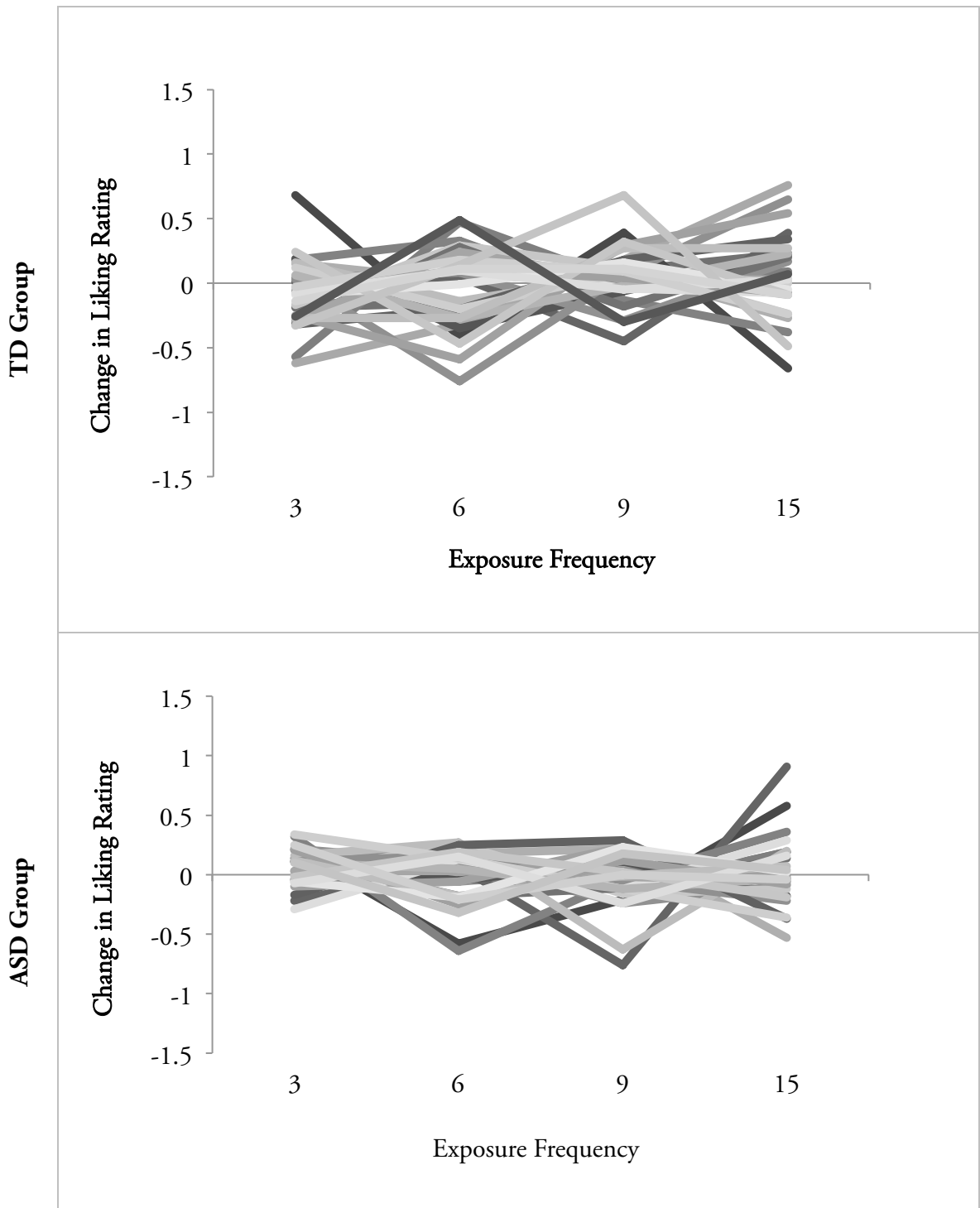
Individual participant changes in liking ratings divided by group and exposure frequency for main study

APPENDIX C: INTERCORRELATIONS FOR CHARACTERIZATION MEASURES

		SCARED	RBS-R			IUSC
		Total	Total	Rituals/ Sameness	Restricted Interests	Total
SRS	Total	.21 (.31)	.62 (.001)	.44 (.02)	.52 (.006)	.56 (.002)
SCARED	Total		.13 (.54)	.12 (.58)	.39 (.05)	.50 (.009)
RBS-R	Total			.91 (<.001)	.55 (.003)	.64 (<.001)
	Rituals/ Sameness				.43 (.03)	.59 (.001)
	Restricted Interests					.46 (.02)

Pearson's correlations (and *p* values) for characterization measures for ASD participants in the main study

Note. Light grey, medium gray, and dark grey boxes represent absent to small (*r* = 0 to .10), small to medium (*r* = .10 to .30), and medium to large (*r* ≥ .30) correlations, respectively.

| | | SCARED | RBS-R | | | IUSC |
		Total	Total	Rituals/ Sameness	Restricted Interests	Total
SRS	Total	.58 (.005)	.43 (.03)	.39 (.05)	-.01 (.95)	.42 (.03)
SCARED	Total		.20 (.34)	.27 (.18)	-.20 (.34)	.54 (.005)
RBS-R	Total			.96 (<.001)	.39 (.05)	.38 (.06)
	Rituals/ Sameness				.38 (.05)	.36 (.08)
	Restricted Interests					-.02 (.94)

Pearson's correlations (and p values) for characterization measures for TD group participants in the main study

Note. Light grey, medium gray, and dark grey boxes represent absent to small (r = 0 to .10), small to medium (r = .10 to .30), and medium to large ($r \geq$ .30) correlations, respectively.