Involuntary responses to facial cues as an indicator of personality type across age and culture

Chithra Kannan

A thesis submitted to Swansea University in fulfilment for the requirements for the Degree of Doctor of Philosophy.

Department of Psychology
Swansea University

June 2021

Under the supervision of Prof Jeremy Tree

Abstract

Can we learn something about the personality of a person we first encounter just by looking at their face and do we do this automatically and implicitly? Previous research by Jones et al (2019) has determined that accurate implicit personality trait judgements can be made from faces. However, it remains unclear what the mechanisms that underpin this process might be, and the degree to which they overlap with other face perception processes such as identity recognition and emotional expression processing. The present thesis aimed to investigate using individual differences approach, whether positively regarded traits among the Big-Five such as extraversion, agreeableness; and negatively regarded trait such as neuroticism judgements can be predicted accurately and implicitly using female young adult composite facial stimuli (Caucasian). It was also investigated whether the ageing process has a detrimental effect on accurate implicit personality judgements by testing a group of younger adults, and a group of older adults. Additionally, extraversion trait judgements among Developmental prosopagnosia and other-ethnicity samples were measured. Furthermore, the present thesis also sought to identify whether implicit trait judgement abilities could be driven by other cognitive factors such as autism traits, alexithymia traits, face memory and emotion perception. Specifically, whether self-perception of neuroticism predicted implicit neuroticism performances.

The main findings of this thesis revealed that young adult Caucasian groups were able to form accurate implicit face-based trait judgements of extraversion and neuroticism. A similar pattern of performance was not observed for agreeableness trait judgements. Individuals with Developmental Prosopagnosia were able to form accurate implicit extraversion trait judgements. Older adult groups were able to make accurate implicit judgements of neuroticism, but this pattern was not the same for extraversion. Similarly, other-ethnicity groups did not demonstrate accurate judgements for extraversion. Throughout the empirical studies, the ability to from accurate implicit extraversion, neuroticism and agreeableness personality judgements were unrelated to other cognitive factors such as autism traits, alexithymia traits, face memory and emotion perception. Self-perception of neuroticism was also unrelated to implicit neuroticism trait judgements. On the basis of this pattern of findings, we conclude that face-based implicit trait judgements utilise some independent cognitive process to other face processing abilities, and that the interpretation of particular personality traits is differentially impacted by the ageing process. Based on the findings of this thesis, it is recommended for future research to examine other-ethnicity effects (non-Caucasian stimuli) and age effects (older facial stimuli) on implicit face-trait judgements in conjunction with the neural regions responsible for face-trait judgements (specifically the big-five) using neuroimaging methods.

Keywords: Face-trait judgements, Age, Autism, Alexithymia, Face memory, Emotion Perception, Other-ethnicity

Acknowledgements

Firstly, I would like to thank my Supervisor Prof Jeremy Tree for being extremely supportive and constantly providing insightful discussions and generic guidance throughout my PhD. I would also like to thank my secondary supervisory team Dr John Towler and Dr Alex Jones for the varied inputs provided for the wide range of questions that I have had.

Secondly, I would like to thank the participants of my studies, especially the older adult groups for taking the time to contribute to research in various fields. I would like to thank Swansea University students and every single participant who has taken the time to complete my studies. The Face research team for providing me with the opportunity to develop my research skills and identifying Prosopagnosia groups. My friend Jodie for being so kind and always being so positive and providing new research opportunities.

Thirdly, I am forever grateful to my family and friends back in India. My father Mr Kannan for funding my PhD and constantly believing in me to achieve my goals. My mom Vani and my aunt Uma for showering all the love and prayers I needed throughout and reminding me how to aspire for more in life. My brother Shiva and my sister Varrshaa for constantly being supportive and keeping me sane. Without their support and everything they have done for me, I wouldn't be in a different country achieving my dreams.

Lastly, I would like to thank all my friends in Swansea for making my life a lot easier and my PhD a lot more enjoyable, without whom this PhD would have been unimaginably difficult. I would specifically like to thank my friend Rhian for being so kind and taking care of me like her own family, and my friend Alecia for constantly motivating me to complete my PhD. My friends Sam, Paula, Katherine, Ceri, Tanisha, Sebastian, Kyle, James and Chloe for always being helpful and supportive. All my friends in Swansea celebrate each other's victories and can't wait to celebrate this one. My friends deserve all the credits for keeping me sane and happy throughout.

Declarations and Statements

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed ....[redacted]................... (candidate)

Date ....01/06/2021...

STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated. Where correction services have been used, the extent and nature of the correction is clearly marked in a footnote(s).

Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

Signed .... [redacted].................. (candidate)

Date ....01/06/2021...

STATEMENT 2

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations.

Signed .... [redacted]................. (candidate)

Date ....01/06/2021...

NB: *Candidates on whose behalf a bar on access has been approved by the University (see Note 7), should use the following version of Statement 2:*

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loans **after expiry of a bar on access approved by the Swansea University.**

Signed .... [redacted].................... (candidate)

Date ....01/06/2021..

Table of Contents

List of Tables

Chapter VI

Chapter VII

Chapter IX

Chapter X

List of figures

Chapter VI

Chapter VII

Chapter I
General Overview

1.1 Introduction

Throughout life, we tend to make characteristic judgements of people at the first instance; but when asked explicitly, the answer is mostly socially desirable. When a face is seen, several cognitive processes are activated in the neural system, but what drives this implicit mechanism is yet to be widely understood. With this in mind, the purpose of this thesis was to examine whether faces convey accurate implicit trait judgements, if so, whether other cognitive and behavioural factors such as autism traits, alexithymia traits, face memory and emotion perception can predict these face-based trait judgements. As such, using an individual differences approach, this thesis investigated accurate implicit personality trait judgements linked to the Big-Five: (a) the positive traits, extraversion and agreeableness were tested across ages (young and older adults), and developmental populations such as prosopagnosia and (b) the negatively regarded trait, neuroticism, was also tested across ages (young and older adults) and (c) extraversion trait judgements were also tested among other-ethnicity samples. An overview of this thesis has been presented below.

1.2 Thesis Overview

A general overview of the current thesis is presented in this chapter. This thesis is organised as follows:

Chapter 2 firstly introduces the concept of personality traits and presents a literature review on how faces act as a 'window' that signals cues to personality traits. Secondly, a review on the overlap between other face processing mechanisms and the process of personality trait judgements has been considered. Thirdly, a review is presented on the literature available on facial personality judgements which have predominantly used explicit methodology. Since the explicit bias paradigm produced mixed effects, this provided the motivation to explore the effects of implicit personality judgements. Additionally, the theoretical aspects of face processing and trait judgements have been explained in detail.

Given that the underlying mechanisms involved in personality judgements are rather unclear, in ***Chapter 3***, two key concepts have been introduced - the implicit paradigm of facial first impressions; and the concept of using an individual differences approach to understand the underlying mechanisms that underpin the process of recognizing personality from faces. Can this ability to identify personality from faces be explained: using a general face recognition process? To answer this question, a review has been presented on personality judgements and facial memory; is it using a face emotion system? To answer this question, a review has been presented on first impressions and facial expressions; is it a social interaction issue? To answer this, a review has been presented on first impressions and autism traits; is it difficulty with interpreting one's own feelings? To answer this, a review has been presented on personality judgements and alexithymia traits.

Chapter 4 describes the general methodology for the studies employed within this thesis. This chapter includes a description of the participants recruited; an experimental procedure; materials used such as questionnaires measuring autism traits, alexithymia traits, personality inventory, and cognitive tasks such as the Implicit Association Task, Cambridge face memory task and Emotion matching task. Differences in methodology have been reported in relevant empirical chapters. The analysis procedure for all the measures employed within this thesis, and a brief description of the Bayesian statistical approach has also been described.

Empirical ***Chapters 5, 6 and*** *7* explored implicit trait judgements of positively regarded traits among the Big-Five such as extraversion, agreeableness and negatively regarded traits such as neuroticism respectively using composite facial stimuli among non-clinical young adult Caucasian groups and Developmental Prosopagnosia (DP) groups (Chapter 5). Furthermore, across these chapters, we also explored whether other cognitive and behavioural factors such as face memory, emotion perception, autism traits and alexithymia traits predicted implicit trait judgements of extraversion, agreeableness, and neuroticism. Additionally, it was explored whether self-perception of neuroticism predicted implicit neuroticism judgements from faces. The findings of these chapters revealed that young adult groups are able to make accurate implicit judgements of extraversion and neuroticism from faces. This finding was not replicated for agreeableness traits, as such the participants from Chapter 6 constantly associated cues to high agreeableness faces with low agreeableness trait words and similarly for low agreeableness faces with high agreeableness trait words (effectively a reverse pattern from what was expected). Participants with facial identity impairment such as the DPs were able to form accurate first impressions of extraversion personality traits from faces; however, this finding must be interpreted with caution given the varied age range and small sample size. Throughout these chapters, the ability to form accurate implicit trait judgements for extraversion, agreeableness and neuroticism were unrelated to other cognitive and behavioural factors. Correlational analysis between factors has been reported in the chapters.

Chapter 8 presents a summary of key findings of Chapters 5, 6 and 7. Given that none of the key measures (such as autism, alexithymia, facial memory, and emotion perception) seems a good candidate to explain how the process of personality from faces works, this provided motivation to explore based on previous literature, whether we can replicate our findings with two different additional populations, (a) other-ethnicity participants and (b) older adults' participants.

Chapter 9, using an *other-ethnicity (Indian)* young adult sample, we explored implicit personality judgements of extraversion personality traits and their relationship with autism and alexithymia traits. The findings of this chapter have reported novel findings in that the Indian sample did not replicate our previous work exploring implicit personality judgements of extraversion personality traits using Caucasian facial stimuli. A group difference in the performances of Indian and Caucasian samples supported previous evidence that own ethnicity samples were better at identifying own ethnicity faces. Furthermore, these findings suggest that implicit extraversion trait judgements appear to be "culture" specific. This study is the first to report such findings.

In ***Chapter 10***, using an *Older* adult Caucasian sample, we explored implicit personality judgements in particular for extraversion and neuroticism personality traits in two studies respectively. We further explored the relationship between implicit personality trait judgements with autism traits, alexithymia traits, self-perception of neuroticism, facial memory, and emotion perception. The key findings of this Chapter revealed that older adults were able to make implicit and accurate judgements of neuroticism personality traits but not extraversion personality traits. This ability was also unrelated to other factors such as autism traits, alexithymia traits, self-perception of neuroticism, facial memory, and emotion perception. To measure comparative performance, we have reported group differences between young adults (from Chapters 5 and 7) and older adult participants.

Chapter 11 presents a summary of the key findings of Chapters 9 and 10.

Chapter 12 presents a discussion of the main findings of this thesis, theoretical implications, limitations of the studies presented and a list of possible directions for future research and conclusions.

Chapter II

Literature Review Part – I

Are trait judgements available from faces?

2.1 What is personality?

For centuries, information about one's personality has been of interest in various fields of psychology. Allport and Allport (1920) considered characteristic traits such as intelligence, temperament (emotional breadth and emotional strength), self-expression (extroversion-introversion, ascendance-submission, expansion-reclusion, compensation, insight, and self-evaluation) and sociality (social participation, self and aggressive seeking, susceptibility to social stimuli) as the fundamental and prevalent tendencies that form human personality. According to Costa and McCrae (1990), personality traits are defined as '*'dimensions of individual differences in tendencies to show consistent patterns of thoughts, feelings and actions''*.

A theoretical framework of personality known as the Five-Factor Model (FFM) was developed based upon the definition and measurement of traits that are habitual patterns of behaviour, thought and emotions relatively stable over time (Costa & McCrae, 1992). The FFM is the most prominent model that structured personality traits. Over the years, personality dimensions have been narrowed down into Big-Five personality traits forming the FFM: Extroversion, Neuroticism (Emotional Stability), Agreeableness, Conscientiousness and Openness to experience (Costa & McCrae, 1992; Goldberg, 1990). See Table 2.1 for characteristic words describing the Big-Five Personality traits.

Table 2.1: Labels and adjective definers of the Big-Five Personality Traits

Factor	Label	Adjective Definers
N	Neuroticism, Negative Affectivity vs. Emotional Stability	Calm - Worrying; Comfortable - Self Conscious; Emotional - Unemotional
E	Extraversion, Surgency, Social Activity vs. Introversion	Quiet – Talkative; Reserved – Affectionate; Timid - Bold
O	Openness to experience, Intellect, Culture vs. Closedness	Uncreative – Creative; Conservative-Liberal; Ignorant - Knowledgeable
A	Agreeableness, Friendly, Compliance, Socialization vs. Antagonism	Ruthless – Soft hearted; Stingy – Generous; Distrustful - Trustful
C	Conscientiousness, Will to achieve, Constraint vs. Undirectedness	Lazy – Hardworking; Late – Punctual; Disorganized - Organized

Note: Adapted from Costa, McCrae & Dye (1991); and Goldberg (1992)

Information about an individual's personality can be assessed using objective methods (e.g., Eysenck Personality questionnaire, Myer-Briggs Type Indicator) and projective methods (e.g., Rorschach inkblot test, behavioural observations). Apart from these methods, researchers have also demonstrated that faces convey a wealth of information about one's personality (Hassin & Trope, 2000). Judgements based on facial appearance, for example, help with decision making to predict financial lending online (Yang, 2014), voting choices (Little et al., 2007; Todorov et al., 2005), facial attractiveness and personality trait inferences (Perrett et al., 1998; Zebrowitz, 1997). Researchers have suggested that personality trait judgements can be inferred from faces, and specifically, perception of facial features provide cues to an individual's personality type (e.g., Kramer & Ward, 2010; Penton-Voak et al., 2006; Todorov et al., 2008). Previous research suggests that personality traits can be recognized from facial appearance merely by looking at photographs of faces (Borkenau et al., 2009; Gosling et al., 2011; Little & Perrett, 2007; Naumann et al., 2009; Penton-Voak, et al., 2006).

Recent work by Kocsor and Bereczkei (2017) has revealed that perceptions of trait judgements for unfamiliar faces are driven by previously defined associations between facial features and behaviour. Hence, observers learn to associate socially relevant information such as personality trait judgements with face shapes and in turn, use this information onto unfamiliar face trait judgements. Hormones such as testosterone, cortisol, growth hormone, and oestrogen have been considered to relate to face shape and behaviour (e.g., Penton-Voak et al., 2006). Furthermore, evidence as such also suggests that faces convey accurate judgements of aggressiveness (Carre et al., 2009; Sell et al., 2009).

For decades, psychologists have been interested in constructing models on how individuals form first impressions; it has been specified that the relationship between cues and traits are learnt using the overgeneralization hypothesis (Secord, 1958). For example, empirical evidence examining trait judgements and emotions have associated emotional expressions such as anger (from neutral faces) with low affiliation trait, and happiness (from neutral faces) with high affiliation trait (Montepare & Dobish, 2003; Said et al., 2009). This further suggests that an individual's perception of certain facial features can develop as a product of the generalizations of observed behaviour and face shape. Under this hypothesis, it has also been suggested that certain facial features such as age, emotion or identity are associated with trait-specific judgements, which are then inaccurately perceived in people who simply resemble one of those categories (Zebrowitz & Collins, 1997).

Evidence suggests that individuals may well make automatic trait judgements of others from faces, including traits such as extraversion, self-esteem, and religiosity – and such judgements are in fact accurate. It is evident that observers seem to be better than chance at identifying most of the Big-Five personality traits (e.g., Borkenau & Liebler, 1992; Little & Perrett, 2007; Penton-Voak et al., 2006). This, therefore, provides a "kernel of truth" (Berry, 1990; Penton-Voak et al., 2006) with the notion that accurate judgements of individuals' dispositions are plausible from faces or other minimal information. However, if accurate personality judgements are formed merely from looking at facial appearance, then faces should contain fundamental structural information indicative of personality traits.

2.2 ''Window into traits'' Are cues to personality present from the face? – a review of studies on face-based judgements of personality.

The concept of forming first impressions of an individual's personality based on their appearance is perhaps seen as inherently undesirable, but this in no way implies that it is not essential to attempt to comprehend this area. The evidence that people seem to be making personality judgements based on minimal information despite the discouragement from society implies that this is an area of cardinal importance in social perception. In face-to-face interactions, appearance is the most prominent information available to others and it can significantly influence the perceivers' behaviour (Todorov et al., 2005; Zebrowitz, 1996).

Researchers have explored the validity of personality impressions from faces using unstandardized images by examining the accuracy of the Big-Five personality traits from facial images available on social media such as Facebook (Back et al., 2010; Ivcevic & Ambady, 2012). These studies have reported that except for neuroticism, four of the Big-Five personality traits can be identified from faces, specifically with high accuracy for extraversion personality traits. Several studies on personality inferences based on zero acquaintance suggest that accuracy is often high for extraversion personality traits (Borkenau et al., 2009; Hall et al., 2008). Observers can make accurate trait judgements from faces within a span of 50ms for traits such as extraversion (e.g., Borkenau et al., 2009) and trustworthiness (e.g., Todorov, Pakrashi, & Oosterhof., 2009).

Using standardized photographs, judgements of personality traits such as extraversion, openness and emotional stability can be perceived accurately based on physical appearance. However, this was not the same for agreeableness and conscientiousness (Naumann et al., 2009). Apart from the Big-Five traits, several research studies have evidenced that judgements of personality trait inferences are made from facial appearance for a varied range of traits including socio-sexuality (Boothroyd et al., 2008), attractiveness (Penton-Voak et al., 1999), intelligence (Zebrowitz et al., 2002), dominance (Quist et al., 2011), trustworthiness (Tognetti et al., 2013), political affiliation (Little et al., 2007; Rule & Ambady, 2010), mental and physical health (Kramer & Ward, 2010; Scott et al., 2013).

Furthermore, work by Penton-Voak et al., (2006) aimed to identify Big-Five personality judgements from faces using composite facial stimuli. The findings of this study suggested that individuals who scored high on the agreeableness self-report personality inventory were also able to make accurate judgements of agreeableness composite faces. This was also found to be similar for extraversion personality traits. Similarly, research conducted by Little and Perrett (2007), suggested that extraversion, conscientiousness, and agreeableness personality traits can be accurately identified from composite images of individuals who self-reported as scoring high or low on the Big-Five personality traits.

Work by Satchell et al., (2019) used targets' self-selected photographs where target photos were obtained from an online database 'Selfies for Science', and along with these photographs, the volunteers also completed a 10-item Big-Five personality inventory. This study followed a standard procedure where a target image was presented along with a five-point rating scale (strongly agree-strongly disagree) and these included statements describing personality traits (e.g., Agreeableness – "do you think this person is often friendly-unfriendly"). The results of this study suggested that accuracy is higher for traits such as openness, conscientiousness, extraversion and neuroticism. However, there is mixed evidence for trait judgement accuracy for agreeableness personality traits (e.g., Little & Perrett, 2007; Penton-Voak, et al., 2006).

What is the relationship between first impressions and personality? A 2D model of face evaluation was developed by Oosterhof and Todorov (2008), using principal components analysis to reduce a large number of trait ratings of face photographs into two underlying dimensions that corresponded closely to judgements of trustworthiness and dominance. Trustworthiness is a trait that is defined as an individual's intentions that are driven by emotional expression. Dominance is defined as a trait derived from an individuals' cues of masculinity, facial maturity and physical strength/weakness. Furthermore, Oosterhof and Todorov (2008) argue that these two traits represent evaluations of threat (e.g., a person with a dominant, untrustworthy looking face can carry out harmful actions which can be a potential threat). However, research also suggests that the trustworthiness trait cannot be accurately judged from facial photographs (Bonnefon, Hopfensitz, & De Neys, 2013; Efferson & Vogt, 2013). In these studies, 'trustworthiness' was measured objectively through targets' behaviour in economic trust games, cheating behaviour or comparing photographs of criminals and non-criminals (Bonnefon et al., 2013; Rule et al., 2013).

According to Sutherland et al., (2015), judgements of openness, extraversion, emotional stability, and agreeableness were mainly linked to facial first impressions of approachability, whereas conscientiousness was linked to dominance and approachability. Research by Willis and Todorov (2006) has shown that trait impressions such as trustworthiness, competence, attractiveness, likeability, and aggressiveness are made within a span of 100ms exposure to a persons' face. Increasing exposure time from 100ms to 500ms made participants judgements more negative, with a decrease in response times and an increase in confidence of judgements. Using explicit methodologies, researchers have investigated face trait judgements associated with certain behavioural aspects, typically by pairing facial stimuli with brief descriptions of behaviour (Todorov & Uleman, 2002, 2004). Researchers have demonstrated that accuracy for extraversion personality traits are extremely high compared to other big-five traits and typically these judgements are achieved within a span of 50ms (Borkenau et al., 2009; Hall et al., 2008; Kenny, 1994).

In summary, the findings reviewed in this section show that faces act as a window to provide information about different types of personality traits. Given that personality trait judgements are inferred accurately from faces, what are the mechanisms involved in this process? We have discussed major theoretical frameworks that underpin face recognition and trait judgements in the following section.

2.3 What is the overlap between other face processing mechanisms and the process of personality trait judgement?

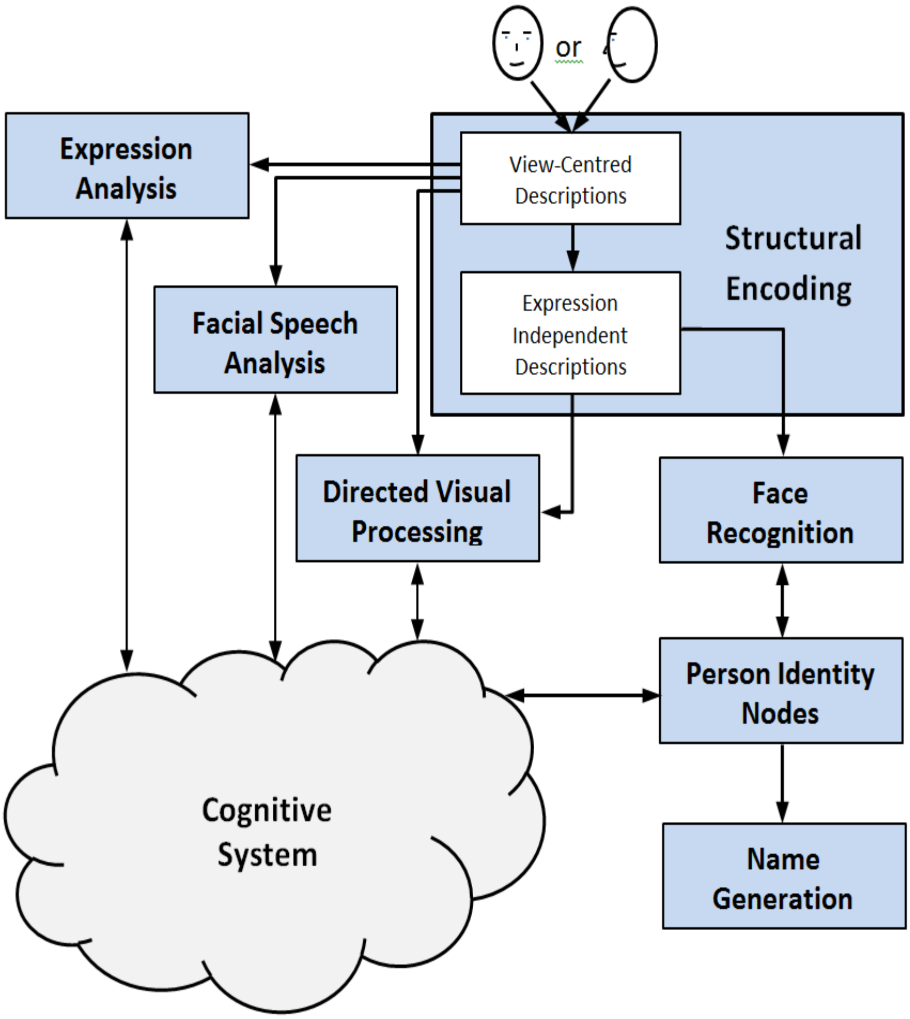
As reviewed so far, considering that cues to personality traits appear to be signalled from faces, in this section, we have outlined (a) a key theory of general face processing/recognition ability, (b) theories of trait judgements that have aimed to explain face recognition and individual differences.

2.3.1 Functional Model of Face Processing

The *functional model* of face recognition developed by Bruce and Young (1986) aimed at explaining the perceptual and cognitive processes involved in face recognition (See Figure 2.1). This model proposed that recognition is a process that includes several sub-processes operating independently and involving multiple functional components referred to as codes. They identified seven different types of information we can derive from processing faces, such as pictorial codes, expression codes, facial speech codes, visually derived semantic codes, structural codes, identity-specific semantic codes, and name codes.

Structural, identity specific semantic, and name codes are predominantly involved in the recognition process of familiar faces. This model suggests that at the initial stage of face processing view-centred descriptions of the facial stimulus are extracted; and by using this information, a range of perceptual judgements are made that are independent of a person's identity. This information aids with judgements regarding age, sex, emotions, and personality traits merely from the information a face provides.

Figure 2.1: pictorial representation of the functional model using a box-and-arrow format.



After viewing a face, in order for the recognition process to occur, a set of processes need to be completed. The structural encoding process produces view centred descriptions including abstract descriptions of local and global facial features and expression independent descriptions. View centred descriptions provide information about the analysis of facial expressions and facial speech. Expression independent descriptions provide information for the *face recognition units (FRU)*. If the perceived information is matched with the stored representation of the face, this can then be inferred that the perception is of a familiar face and the *person identity nodes* associated with that face is then activated.

When face perception occurs, the degree of resemblance between the stored description of a face and the input provided by structural encoding provides the strength of the recognition unit's signal to the cognitive system. The recognition unit's signal to the cognitive system is dependent on the information that is received from the stored description and the information provided by structural encoding. The FRU can further evaluate the identity-specific semantic codes that are held in proportion to the associative memory and are termed 'person identity' nodes. There exists a person identity node for each person we encounter, and these contain identity specific semantic codes which then allows the observer to successfully identify the person encountered.

Name codes are activated only through the person identity nodes. The FRU will be activated when the perceiver views any angle of the target face, but the FRU will not respond to the target's voice or name. On the contrary, the person identity node can be accessed via the targets face, voice, or name. This is the point at which person recognition occurs rather than face recognition. This process then allows the observer to retrieve identity-specific semantic information about the specific target, for example, information about the target's hobbies and occupation. Lastly, the relevant information about the target's name is activated through the name codes, such that the target's name can be accessed independently of their biographical information.

As such, several researchers have predominantly used this model to explain the cognitive mechanisms underpinning face processing. Based on this model, once a trait has been recognized, an identity is formed and therefore connected with previous memorability or understanding of that trait based on the observer's experience. This process triggers automatic retrieval of person knowledge (Gobbini & Haxby, 2007; Todorov et al., 2007; Todorov & Uleman, 2003). However, the functional model has suggested that there is possibly an interlink between the encoding of facial identity and trait impressions, and researchers have also debated on whether there exists a dissociation between the two and that these abilities can be processed independently (Todorov & Duchaine, 2008).

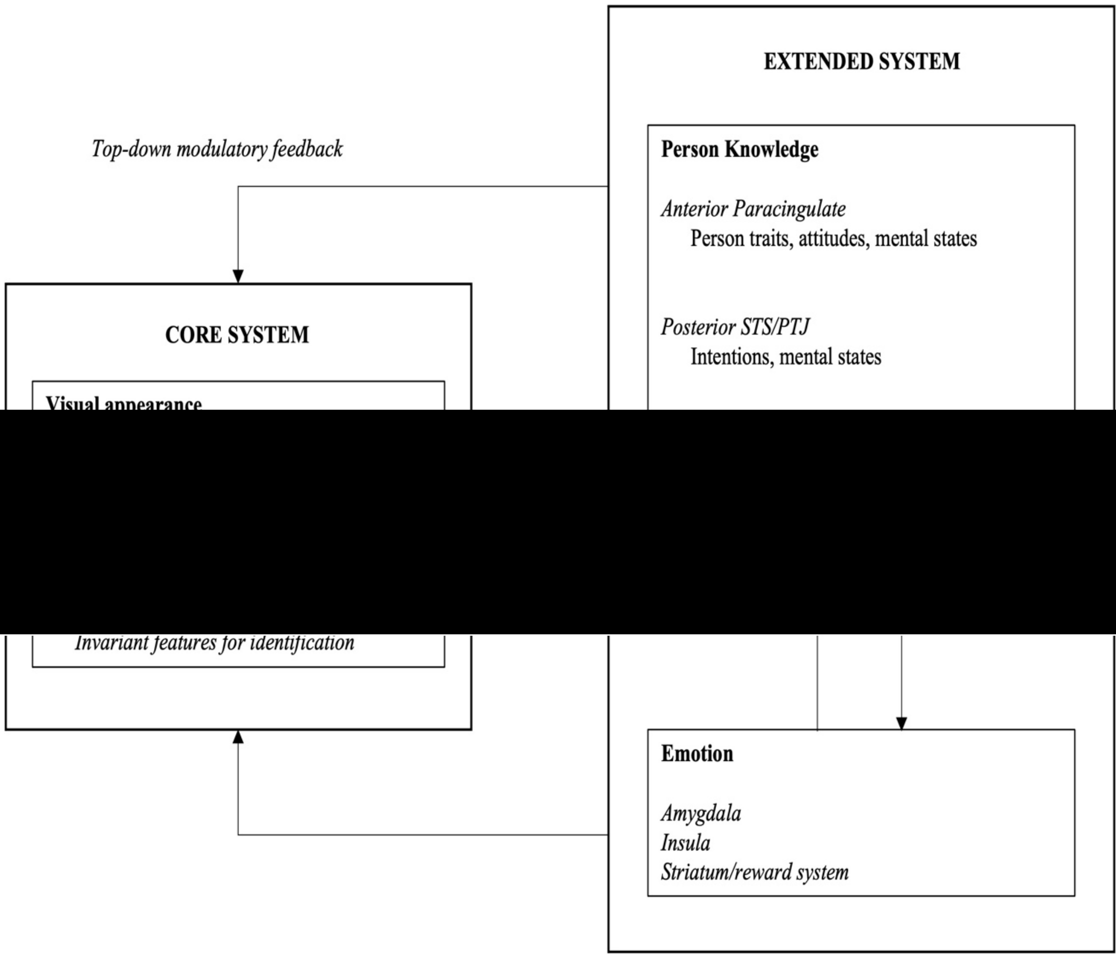
Similarly, another topic that has prompted much debate in face perception literature involves the independence of identity and emotion processing mechanisms from faces, as hypothesised in Bruce and Young's functional model. Studies using this functional model have largely suggested that face identity and emotion recognition from faces are processed independently although the initial process of recognition occurs using a common route (Calder & Young, 2005; Lander & Butcher, 2015; Todorov & Duchaine, 2008). Previously it has been reported that the ability to identify emotions from faces is not influenced by face familiarity and vice versa (e.g., Campbell et al., 1996). For example, identity recognition processes were facilitated by familiarity and repetition priming, but not expression recognition (Ellis et al., 1990; Young et al., 1986); where participants of these studies were able to selectively able to attend to either identity or emotion recognition without much influence from the stimulus dimension. Other evidence for the proposed independence of expression and identity is supported by studies measuring event-related potentials. These studies have largely suggested that neural responses to tasks measuring identity and expression were observable at early stages of recognition, but there was no interaction between these neural signals (Bobes et al., 2000; Caharel et al., 2005). Despite the evidence suggesting the independence of face identity and expression mechanisms, researchers have questioned the reliability of such findings (e.g., Bate et al., 2009; Calder & Young, 2005; Campbell & Burke, 2009; Fox & Barton, 2007). As such, a neurological interactive model of face processing is explained below that has also further explained the relationship between face emotion and identity processing.

2.3.2. Distributed neural model of face processing

Neuroimaging studies incorporating functional magnetic resonance imaging (fMRI) methods have offered a unique route to investigate face processing and have suggested that face perception is mediated by distinct neural pathways involving multiple bilateral regions. The neurological model of face processing (Gobbini & Haxby, 2007; Haxby, Hoffman, & Gobbini, 2000) focused on explaining the distributed neural systems mediating familiar face recognition, illuminating that spatially distributed processes involve both visual areas and areas that primarily have cognitive and social functions other than visual perception. This model hypothesized that visual familiarity only plays a partial role in familiar face recognition, and person knowledge and emotional responses also play an equal role for successful recognition of familiar individuals.

According to this model (See figure 2.2), the ‘core’ neural regions consistently reported in face processing involved the activation of three main areas of the brain, such as the occipital face area (OFA), fusiform face area (FFA) and the superior temporal sulcus (STS). The findings led by Haxby et al., (2000) suggest that the OFA is responsible for early visual processes and basic visual appearance of the face (e.g., Pitcher et al., 2011), the FFA is responsible for non-changeable aspects of face processing such as identity and gender (e.g., Kanwisher et al., 1997), and the posterior STS/temporal-parietal junction (TPJ) region is responsible for changeable aspects of faces such as expression and eye gaze direction (e.g., Hoffman & Haxby, 2000). Thus, suggesting a distributed neural system that includes a core system analysing the visual appearance of faces and an extended system involving the extraction of additional information a face can convey (see Haxby et al., 2000).

Figure 2.2: Neurological model of face processing (Gobbini & Haxby, 2007)



Note. A neurological model that shows the distributed set of neural regions that mediate familiar face recognition. The core system is responsible for the encoding of the visual appearance of a familiar face while the extended system extracts further information from a face (Haxby et al., 2000). These structures participate in the retrieval of different aspects of person knowledge (such as biographical information and personality traits) and emotional response.

Firstly, the model presented in figure 2.2 has a branching structure that differentiates the processing of identity and the perception of dynamic aspects of the face that aids social communication. Secondly, this model implies that there is an extended system interacting with the core system. Particularly the neural structures accessing person-specific semantic and biographical information are thought to interact with the FFA regions that further process face identity. These neural regions include the anterior paracingulate cortex, posterior STS/TPJ that are thought to be involved in the retrieval of person traits and behaviour (intentions, attitudes, and mental states) of familiar faces; and the precuneus to be involved in the retrieval of episodic memory. Further, this model has listed three neural structures such as the amygdala, insula, and striatum that represent different emotion, and activation in these regions are modulated by face familiarity (e.g., Gobbini et al., 2004).

Gobbini and Haxby (2007) conducted two fMRI studies investigating the neural regions responsible for face recognition. The findings showed activation in the face responsive regions of the fusiform gyrus when processing both familiar and unfamiliar faces. Furthermore, this model also investigated the neural regions responsive to the 'theory of mind' framework, where previous research has evidenced the activation of the anterior paracingulate cortex, posterior STS and the precuneus (Frith & Frith, 1999). Using an implicit task, that does not require retrieval of semantic information about the faces viewed, Gobbini and Haxby (2007) suggest that these regions are responsible for spontaneous retrieval of person knowledge. Another key component of the neurological model emphasises the involvement of emotion processing from faces and the activation of the amygdala during emotion perception (e.g., Canli et al., 2002; Gobbini et al., 2004; Leibenluft et al., 2004). Other studies using atypical samples have also evidenced the activation of the amygdala when rating untrustworthiness from faces (Adolphs et al., 1998; Todorov et al., 2007; Winston et al., 2002). As such, suggesting the importance of expression perception in the retrieval of person knowledge.

Research investigating the dissociation of emotion and visual recognition using amnesia patients have shown that implicit retrieval of person identity was available from faces as opposed to explicit memory based on previous positive or negative encounters (Tranel & Damasio, 1993). Other neuroimaging studies have suggested that the response to facial stimuli is possibly modulated based on the type of personality traits associated with the face, independent of explicit memory for those individuals (e.g., Todorov et al., 2007). Similar findings were reported for individuals with prosopagnosia (See Chapter 3, pg. 46), a condition exhibiting an inability to recognize faces (Bate et al., 2017), where acquired prosopagnosia patients were unable to explicitly recollect information regarding familiar faces, nevertheless, they were able to recognize the identity of a face implicitly (Damasio et al., 1982). The functional model (Bruce & Young, 1986) highlights the sequential order in which face recognition and retrieval of person knowledge takes place during face processing operations. Empirical evidence using individuals with prosopagnosia indicate that the activation of emotional responses is possibly mediated by separate pathways that are independent of processes that require explicit recognition of visual appearance and retrieval of person knowledge (e.g., Todorov & Duchaine, 2008).

Although Gobbini and Haxby's (2007) model appears to provide a neurological basis to the functional model, it is important to note that there are some potential differences in its assumptions. Firstly, Gobbini and Haxby's (2007) distributed model of face processing posits an interactive system, as opposed to Bruce and Young's (1986) functionally disparate system. For example, Gobbini and Haxby's (2007) model suggests a more general system that is responsible for processing all changeable aspects of a face (e.g., expression and eye gaze), whereas the functional model posits independent systems for each of these processes (e.g., expression and identity). Secondly, this neurological model views face processing mechanisms as an interactive process that integrates information from neural regions that process physical configurations of the face with regions that also extract the meaning of such configurations. For example, the STS processes the arrangement of facial features in order to extract the expressions displayed on the face. The extended system further extracts information from the emotion system to process the actual meaning of the expression displayed from faces. Therefore, the functional roles related to specific cognitive processes are not reduced to single separate processes as in the Bruce and Young (1986) model; rather these cognitive processes involve a combination of activities in various neural regions that all contribute to a specific function. For example, these neural regions can also be involved in more than one cognitive process by interacting with other systems within the model; activation in the intraparietal regions are known to be responsible for the perception of eye gaze direction but also direct spatial attention according to other non-visual cues.

Spontaneous retrieval of semantic information and information regarding personality traits are strongly associated with perceptual processes of facial visual appearance. Additionally, emotional responses to familiar faces are also considered to be a crucial component for successful face recognition. Information regarding these processes is also essential for appropriate social interactions. As mentioned earlier, individuals form first impressions within a span of 100-ms exposure to a face (e.g., Willis & Todorov, 2006). Once a face is seen, person impressions are linked to person identity and faces of familiar individuals can trigger spontaneous retrieval of person knowledge (e.g., Todorov et al., 2007). Although the processes underlying identity and trait judgements are closely linked, researchers have argued that these processes are also dissociable (Todorov & Duchaine, 2008). Making spontaneous trait judgements is a task functionally different compared to tasks measuring familiar face identity recognition. The different mechanisms for trait judgements and face identity have been explained by studies using fMRI methodology. These studies have reported activation in neural regions such as the inferotemporal cortex for person identity perception (e.g., Kanwisher et al., 1997; McCarthy et al., 1997), and the amygdala for the perception of trustworthiness (e.g., Engell et al., 2007; Todorov, Baron & Oosterhof, 2008; Winston et al., 2002). Furthermore, work by Todorov et al (2007) have reported the activation of the anterior paracingulate cortex in trait perception (supported by the neurological model); and have suggested that computational mechanisms linking specific perceptual features to personality traits could activate different neural responses. For example, the same facial stimuli can trigger different neural regions that can simultaneously process other information that can be inferred from faces.

Given a combination of studies investigating trait judgements, face memory and emotions have suggested that these abilities are possibly processed independently or are represented by dissociable neural mechanisms (e.g., Engell & Haxby, 2007; Gobbini & Haxby, 2007; Haxby et al., 2000), the current thesis seeks to investigate whether implicit personality trait judgements can be predicted by other face processing mechanisms (See Chapter 3). However, given that the functional model focuses on the mechanisms underpinning face processing for familiar or unfamiliar faces, it does not provide an account about how accurate personality judgements can occur; the neurological model provides evidence for familiar face recognition and does not largely account for unfamiliar face recognition including trait judgements. As such, a review of studies based on the lens model is presented in the next section, which has specifically aimed at explaining theoretical frameworks involving trait judgements.

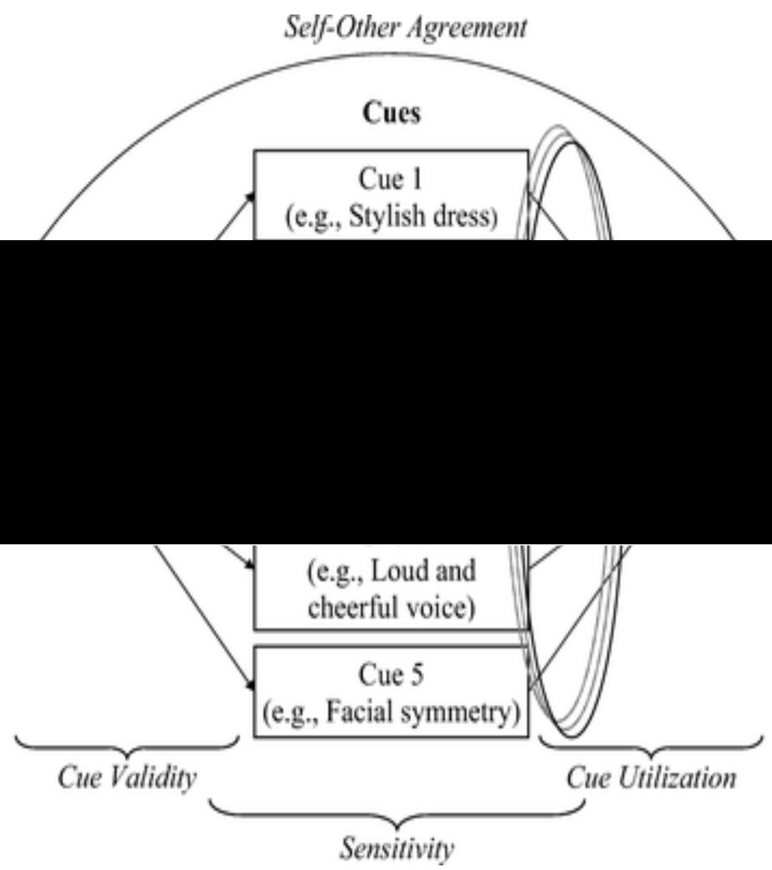
2.3.3 The lens model (Brunswik, 1956)

According to Brunswik's lens model (1956), observers look to cues in the environment (the lens) to formulate impressions of a target's underlying disposition. Observers make accurate judgements if they use cues that are valid indicators of the target's underlying personality. This model suggests that both static cues (e.g., clothing style) and dynamic cues (e.g., facial expression, posture) offer important information about ones' personality (Naumann et al., 2009). This model provides a general framework to account for the relationship between self-ratings of personality and personality judgements by strangers (See Figure 2.3). This model suggests that observers use a set of perceivable attitudes or cues available in a given situation (e.g., stylish dress, loud voice) to infer the personality trait of targets. *Cue validity* is the strength of association between perceivable cues and the target's personality trait. *Cue utilization* is the degree to which perceivers' personality judgements are related to perceivable cues. For example, targets' clothing style (e.g., Stylish) and loud voice in the absence of apparels (such as glasses) might be associated with targets' view of themselves (i.e., 'I am an extraverted person') and the observers' judgements of extraversion personality trait (i.e., the target individual is extraverted). Additionally, the degree to which the observer uses the perceivable cues across different targets (*consistency*), as well as the degree to which the observer is sensitive to validity differences between cues (*sensitivity*) can be obtained.

Research by Borkenau and Liebler (1992) investigated trait inferences at zero acquaintance of targets self-ratings and stranger ratings. In this study, targets were videotaped as they entered a room and sat behind a desk to read a standard text. The targets completed a self-report personality inventory. Researchers then presented the observers with one of four stimuli: a video with sound, a video without sound, audio-only and a still extracted from the video; the strangers were then requested to rate the physical attributes and personality traits of the targets. The results of the study revealed that when video with sound was presented, the observers were able to judge four of the Big Five traits. With the static video, extraversion and conscientiousness personality judgements were more accurate. These results suggest that physical appearance does provide some information, but accuracy increases when information related to verbal and non-verbal cues are available to the observer. The Brunswik lens model provides a general framework for explaining correlations between self-ratings of personality and personality judgements by strangers. This framework assumes that perceivers use a set of attributes or cues available in a given situation to infer the personality traits of targets.

Previous research has indicated that observers use static and dynamic cues related to an individuals' physical appearance to form various personality judgements (Albright et al., 1988; Ambady et al., 2000; Kenny et al., 1992). Using the lens model, research by Naumann et al., (2009) aimed to identify whether specific static and dynamic cues are related to targets' actual personalities (cue validity) and observers' judgement (cue utility). The results of this study imply that personality is manifested through both static and expressive channels of appearance, and observers use this information to form accurate judgements for a variety of traits (e.g., extraversion, emotional stability, conscientiousness). Furthermore, work by Sutherland et al., (2015) explored perceptions of Big-Five judgements using ambient images, specifically focusing on cue utilization stages of the Brunswik model. The findings have

Figure 2.3: Brunswik's Lens Model (1956)

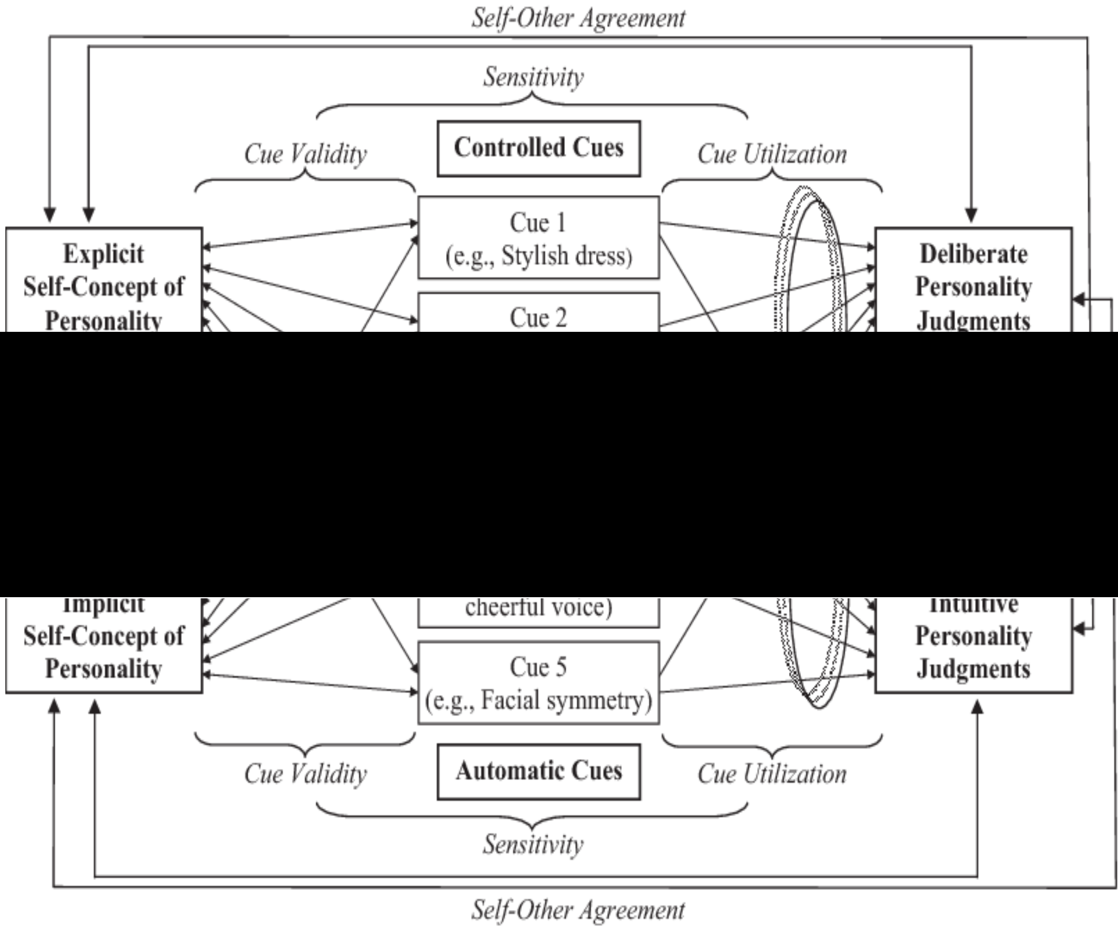


---

demonstrated that perceivers form first impressions based on cues resembling broad facial features representing emotion expression from neutral images; thus, suggesting a relationship between emotion perception and trait judgements.

However, Brunswik's lens model (1956) has not distinguished between explicit and implicit attitudes of personality. For example, the observer might recognize the targets' personality trait to be extraverted based on the static and dynamic cues available to the perceiver; however, this could also be associated with the observers' self-concept of extraversion personality trait. There is mixed evidence for self-perception of personality trait judgements affecting the judgements of the observer. To further explore this model, Hirachmüller et al., (2013) constructed the dual-lens model based on Brunswik's lens model (1956). This model provides a theoretical framework for personality judgements on a self-other agreement at zero acquaintance, for single perceiver level and aggregated perceiver level (See Figure 2.4). The dual-lens model differentiates between explicit and implicit self-concepts of personality, controlled and automatic cues, and deliberate and intuitive personality judgements. According to the Dual-lens model, personality judgements based on zero acquaintance converged with both targets' explicit and implicit self-concept of extraversion personality traits. However, this model fails to explain implicit face-trait judgements that occur in the absence of other cues from static neutral images.

Figure 2.4: Dual Lens model (Hirachmüller et al., 2013)

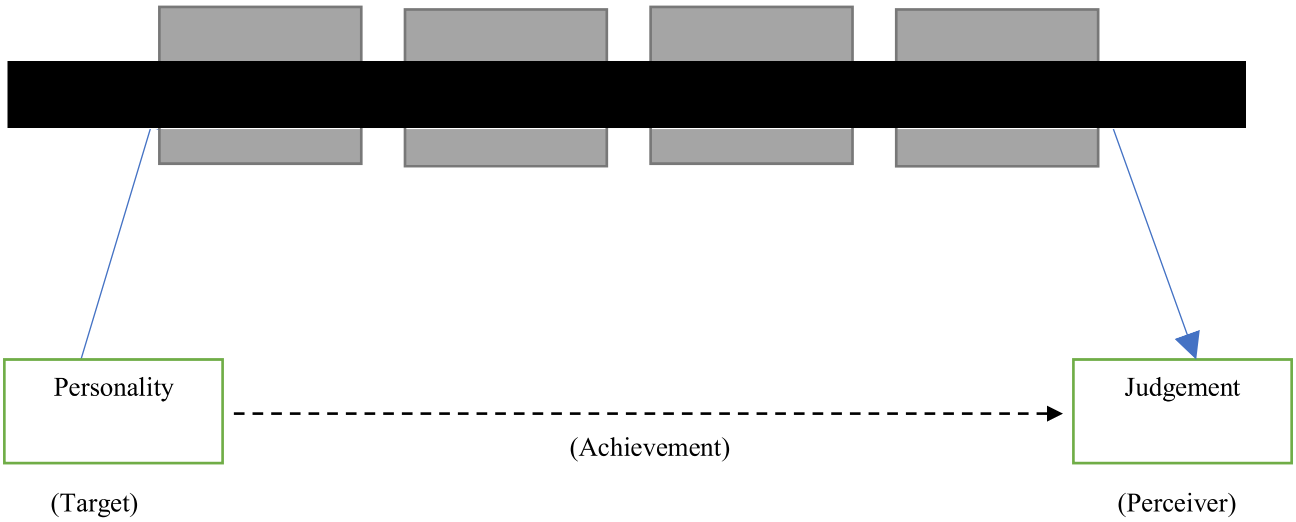


Furthermore, another model was developed based on the perceptual constancy of the Brunswik lens model. In the lens model, there are two processes identified as cue validity and cue utilization. The realistic accuracy model (Funder, 2012) included two more stages that are necessary to achieve trait judgement accuracy. The following section explains the realistic accuracy model.

2.3.4 Realistic Accuracy Model

The Realistic Accuracy Model (RAM; Funder, 1995, 1999) was primarily developed based on the concept of 'self-other agreement' that was grounded in theories such as personality theory, attribution theory, and self-concept theory that aimed to address ''whether we appear to others as we appear to ourselves'' (Funder, 1980). This model aimed to explain the theoretical underpinnings of trait judgement *accuracy* and *when* such judgements are accurate. Regarding *when* accurate personality judgements take place, researchers have identified four moderators related to varying levels of accuracy such as the good judge, good target, good trait and good information (Allport, 1937; Funder, 1987). The RAM was formulated based on these four moderators of accuracy, further focusing on *how* accurate judgements can be made rather than error research (Funder, 1987). This model interlinks the processes of trait judgement of an individual with the observer's ability to make correct judgements of that trait. According to the RAM, to enable accurate personality judgements, the process involved takes place through four stages such as *relevance, availability, detection* and *utilization* of *behavioural cues* (See Figure 2.5).

Figure 2.5: Conceptual diagram of Funder's Realistic Accuracy Model (RAM; 1995, 1999)



Relevance: the first stage of this model indicates that relevant behavioural cues associated with personality traits must be available from the target. For example, to assess a target's level of creativity, the target must portray their creativity levels by conveying innovative thoughts or ideas (Letzring et al., 2020). For this primary stage to be achieved, targets must exhibit behavioural patterns relevant and consistent with their traits. Further, it has been suggested that targets tend to be accurately judged for traits such as extraversion, emotional stability, and self-confidence (e.g., Human & Biesanz, 2013). As such, when targets clearly communicate relevant behavioural cues, they become good targets and therefore increases judgement accuracy which supports the first stage of RAM.

Availability: the second stage of RAM indicates that behavioural cues should be available in the external environment. In this stage, there is an interaction between the target and the observer. For example, studies observing trait judgements from photographs of individuals on social media (e.g., Facebook) suggest that potentially useful information about cues to personality traits are available from an individual's social profile from the words used, picture content, number of friends etc (Gosling et al., 2011; Hall et al., 2014; Wall et al., 2016).

Detection: the third stage of RAM involves detecting relevant and available cues to personality. This stage is influenced mainly by the observer. The observer must be able to detect the cues available from the target.

Utilisation: the final stage of RAM specifies that the observer must appropriately utilize the cues to make an accurate judgement. Research studies have suggested that the observer's trait characteristics would influence the accuracy of the target's trait judgement (e.g., Christiansen et al., 2005). It is essential that the observer contains knowledge about personality and how it is revealed in the target's behaviour.

As a result of interpersonal and cognitive processes, accurate personality judgements are possible only when all four stages of RAM are completed. As such, the target must display relevant cues which are then available to the observer, followed by the observer detecting these behavioural cues and utilising the cues correctly to make accurate personality judgements. Failure at any of the four stages will result in inaccurate judgements (Funder, 2012; Letzring, Wells & Funder., 2006).

A number of predictions are generated based on the above models. The one particular interest to this thesis is that, if emotion processing plays a key role in person perception, there would be a correlation between emotion perception and trait judgements. Despite the extant research available on how individuals can process and extract various cues available from faces, the relationship between face identity and expression perception is still widely debated based on whether these abilities are represented within shared or independent systems. As such, using cognitive tasks, we have explored the relationship between face memory and emotion expression perception. Another question this thesis seeks to ask is that how does unfamiliar face processing explain the relationship between implicit trait judgements, face emotion, and face memory? Additionally if emotion perception appears to be an extension of trait judgment mechanisms, face-processing abilities may be linked to social cognition where individuals who might be poor at emotion perception such as autism and alexithymia might perform worse on trait judgement tasks. As such, a review of studies linking these abilities is presented in Chapter 3.

2.4 Could trait judgement findings be contaminated by demand characteristics?

Empirical evidence based on personality trait judgements are dominated by the use of verbal self-reports of personality. Typically, participants are asked to associate personality traits to faces explicitly via experimental instruction (Asendorpf, Banse, & Mucke, 2002). For example, Hassin and Trope (2000) demonstrated that individuals make strong judgements of personality traits based on physiognomic information using methods such as, a set of photographs (two images of male stimuli on the screen) and explicitly asking questions regarding their career (e.g., "which of the two men above is a psychologist?"). The results of this study suggest that the use of physiognomic information is greater when verbal information is ambiguous compared to unambiguous; and participants had high confidence in their judgements, resulting in low accuracy scores.

A large number of existing studies in the broader literature have concluded that some personality inferences can be made explicitly and accurately from faces. As has been previously reported in the literature, research using facial composites has shown that personality can be accurately inferred from faces generated from the average face of high and low scorers on the Big-Five personality traits (Little & Perrett, 2007), and internal facial features are predominantly important for these judgments (Kramer & Ward, 2010). In order to investigate the validity of face perceptions using the big-five measures, a highly controlled approach must be considered, given that it allows subtle differences to be isolated between the facial stimuli scoring high or low on personality dimensions. Moreover, it leaves open to question how observers make personality judgements from facial photographs available on social media, with naturalistic, highly varying facial images (Jenkins et al., 2011).

However, researchers have criticised the use of *explicit* measures which are also termed direct measures (Fazio & Olson, 2003), as these methods can easily be manipulated by participants (Greenwald, McGhee, & Schwartz, 1998). Specifically, the use of explicit methodologies increases the probability of socially desirable responses and faking tendencies. Further, work by Borkenau and Ostendorf (1992) has demonstrated that individuals tend to show socially desirable responses, and this is considered to be a major limitation in the measurement of the Big-Five. It is interesting to note that first impressions of either personality (e.g., Big-Five) or social traits (e.g., attractiveness, likeability, competence, trustworthiness) are highly correlated constructs, as personality impressions are usually built based on social perceptions (Junior et al., 2018). In everyday intuition, the personality of a person is assessed along several dimensions, such as whether an individual is being (non-)open-minded, (dis-) organized, too much/little focused on oneself, etc. (Zhang et al., 2016). Nonetheless, support for the validity of these first impressions is inconclusive. Thus, raising the question of how we form them so readily.

Since explicit measurements are subject to various limitations it might therefore be desirable to search for an approach that side-steps such issues – namely, testing for trait judgements made automatically and implicitly (Fazio & Olson, 2003). Implicit measures are inferred as automatic (spontaneous) and intuitive responses (Wilson, Lindsey, & Schooler, 2000) and are consequently expected to be more robust compared to explicit methodologies. In addition, evidence that demonstrates that trait judgments are made both automatically and unconsciously has obvious implications for how individuals in day-to-day interactions with strangers may unfold. In a different domain, work on the unconscious bias (e.g., racial prejudice) has demonstrated that despite the explicit report by a participant of no overt prejudice, an automatic implicit one remains. The key implicit measurement tool relating to this literature is the implicit association test (IAT; Greenwald et al., 1998) – and this is discussed in greater deal in the next chapter. The current work sought to utilise an established paradigm (the IAT) used to measure automatic implicit judgement as a tool to establish whether such judgements are also present with respect to judgements of personality from faces.

In summary, there is a considerable amount of literature reviewed in this chapter that indicates various judgments of personality can indeed occur from present faces, under explicit judgements - where observers are presented with unfamiliar faces and explicitly questioned about the personality trait portrayed by the target faces (e.g., Penton-Voak., 2006). But it remains unclear whether judgements of personality traits are partial to deliberative conditions, or whether this process is part of automatic implicit associations. Based on the reviews presented above, the next chapter outlines other possible mechanisms that explain trait judgements and factors that could aid trait judgements from facial structure.

Chapter III

Literature Review Part – II

Implicit trait judgements and their association with other cognitive factors

3.1 Introduction

As mentioned in the previous chapter, trait judgements can be inferred from faces and several studies measuring trait inferences have predominantly used explicit methodologies. Here, in the current chapter, we focus on *implicit* trait judgements from faces and other factors associated with trait judgements. As such, we sought to unpack the potential mechanisms that underpin automatic trait judgements from faces, by identifying several key candidates for overlap (e.g., face recognition and face emotion processing). In the forthcoming sections, these major strands will be outlined further.

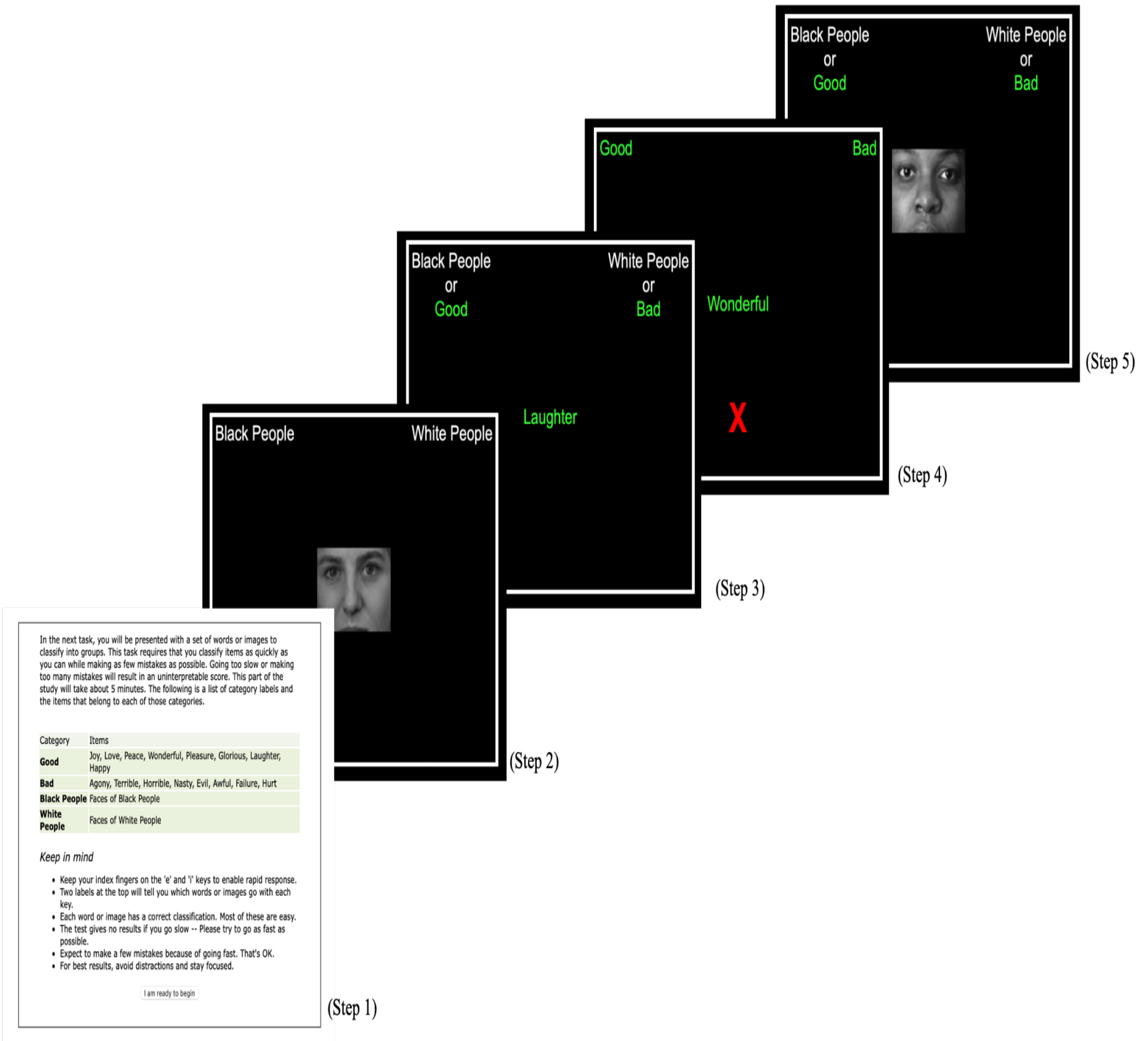
3.1.1 Implicit trait inferences from facial structure

The use of terminology between explicit and implicit attitudes are yet to be distinguished clearly and are found to be inconsistent in the literature. Explicit attitudes are characterized by information processing using conscious, controlled, and reflective methods, whereas implicit associations are characterized by processes involving automatic, unconscious, and intuitive methods (Bosson, Swann & Pennebaker, 2000; Greenwald & Banaji, 1995; Wilson, Lindsay & Schooler, 2000). According to Greenwald and Banaji (1995), *implicit attitudes* are defined as "introspectively unidentified (or inaccurately identified) traces of past experience that mediate favourable or unfavourable feeling, thought, or action toward social objects". The idea of implicit cognition is formed based on some traces of previous experiences that may affect judgements, although the perceiver does not necessarily have to remember the information from past experiences that might not be accessible to self-report (Greenwald, 1990; 1995). Social behaviour originates from an automatic implicit or unconscious manner (Fazio & Olson, 2003; Fiske, 1998; Greenwald & Banaji, 1995; Schneider, 1973).

According to Bruner and Tagiuri's (1954) implicit personality theory, there is a possibility that perceivers presume inferential relationships among characteristic attributes of people. In order to measure individual differences in implicit cognition and identify a wide range of socially substantial associative structures, Greenwald, McGhee, and Schwartz (1998) developed *the Implicit Association Task (IAT)*. The IAT is aimed at measuring implicit attitudes by evaluating fundamental automatic associations. This concept is similar to cognitive priming, by measuring the effect in which exposure to a stimulus influences a subsequent response to a later stimulus without conscious associations; in other words, measuring affect and attitudes (Blair & Banaji, 1996; Fazio & Olson, 2003; Perdue et al., 1990). The IAT is used to assess the strength of associations between a target concept and an attribute dimension using latency measures, i.e., how quickly participants make associations of the dual concept presented. For example, two target concepts appear in a choice task (e.g., flower vs insect names), followed by the attribute in a second task (e.g., pleasant vs unpleasant words). When associations are made for highly associated categories (e.g., flower + pleasant) using the same keyboard response matched with the categories, performance is quicker when compared to the less associated categories (e.g., insect + pleasant; Greenwald, McGhee & Schwartz, 1998).

Throughout the task, target or attribution presented are assigned to keys presented either on the left or right category. It is important to note that attribute discriminations remain on the same presentation side throughout the task. Greenwald, McGhee, and Schwartz (1998) using the IAT methodology, created three experiments (See Figure 3.1 for an example of the race IAT). The initial procedure of the task is to introduce the target concept and distinguish, for example, images of Black Americans

Figure 3.1: Illustration of the Race IAT adapted from Greenwald, McGhee & Schwartz (1998)



---

and European Americans (Step 1: Initial target-concept discrimination). Following this, participants make discriminations of attributions such as good or bad words (Step 2: Associated attribute discrimination). After the target and attribute discriminations, the first two steps are superimposed. In the next step, target and attribute discriminations are presented alternatively within the same block (e.g., African American faces + good, European American faces + bad; Step 3: Initial combined task). In the next step, participants learn the reversal of response for target discrimination, i.e., Black people were presented on the left category in step 1 and now

Black people will be presented on the right category and White people will be presented on the left category (Step 4: Reversed target-concept discrimination). The final step involves pairing attribute discrimination with reversed target discrimination (Black people + Bad, White people + Good; Step 5: Reversed combined task). If participants were faster and more accurate with pairing Black people + good, this would mean that African American faces and good words are highly associated.

It is important to note that the use of single-word presentation results in effective stimulation of attitudes and behaviours that trigger automatic trait judgements (Uleman, 1987; Winter & Uleman, 1984). A major advantage of the IAT is that this methodology can be used to measure implicit self-concept and stereotypes where it reveals attitudes and other automatic associations for individuals who prefer not to express such attitudes. The IAT is expected to reveal conflicting evaluations of participants using explicit self-report measures (e.g., Asendorpf, Banse & Mucke, 2002).

3.1.2 Are automatic trait judgements accurately inferred from faces?

Using a modified version of the IAT, Jones, Ward and Tree (2019) conducted a study on spontaneous trait associations of personality traits such as extroversion and agreeableness. They created a novel version of the IAT (see figure 3.2). High extraversion and high agreeableness composite faces were called Jane, low extraversion and low agreeableness composites were called Mary. The findings of the study revealed that extraversion IAT ($IATD = 0.29$, $p < 0.001$, $d = 0.76$) and agreeableness IAT ($IATD = 0.30$, $p < 0.001$, $d = 0.74$) personality traits can be spontaneously and accurately judged from faces. The IAT D is a form of effect size measure that compares the reaction time latency across congruent and incongruent

Figure 3.2: composite facial stimuli from Jones et al., (2019).

Note: Top row for high extraversion (left), low extraversion (right); bottom row for high agreeableness (left) and low agreeableness (right) composites.

conditions. Implicit bias is marked for when participants take longer to make responses in the incongruent conditions over congruent conditions. The calculations of IAT D are explained in detail in Chapter 4 (pg.83).

In order to eliminate naming confounds - whether certain names are associated with faces (for example, ‘Jane’ can be perceived as a more friendly and outgoing label compared to ‘Mary’), they switched the labels and conducted the same IAT mentioned above. Here high extraverted, agreeable composites were called Mary and low trait composites were called Jane. Previous studies have evidenced that names are associated with facial attractiveness (Garwood et al., 1980) and social traits such as competence (Young, et al., 1993). However, the findings of Jones, Ward and Tree (2019) did not find any such associations, therefore ruling out that particular name labels were influencing accurate and spontaneous attributions of personality from faces.

In another experiment Jones, Tree and Ward (2019) assessed the extent to which accuracy of spontaneous associations of personality was related to general and particular cues. To postulate whether there are specific cues contained within the composite images used in their study (e.g., high agreeableness composite image can exhibit visual cues pertaining to traits such as warmth and empathy), they matched extroversion composite images with agreeableness trait words and similarly agreeableness composite images with extraversion trait words. As such, the findings of this study demonstrated that accuracy for extraversion and agreeableness traits depends on varying levels of information available from facial stimuli. Their research implied that there exists a general halo effect for extraversion trait composites (e.g., Dion, Berscheid, & Walster, 1972; Kramer & Ward, 2010), whereas agreeableness trait composites reveal visual cues pertaining to agreeableness. Further, Jones et al (2019) have suggested that the visual cues associated with personality traits can be related to trait-specific judgements and overall social desirability, and this process could occur implicitly. It is apparent from their work that personality traits such as extroversion and agreeableness can be implicitly and accurately judged from faces using the IAT. But what key processes drive this implicit ability to judge personality from faces? The next segment will be reviewing the plausible candidates that might drive implicit trait judgements.

3.2 Understanding the underlying mechanisms that enable automatic implicit personality judgements from faces – an individual differences approach

In the previous sections we established that judgements of personality from faces are indeed both possible and can be implicit and automatic – it remains unclear though how these judgements are achieved. To foreshadow the forthcoming section, we will discuss several possible underpinning processes that might be candidate loci.

3.2.1 Personality judgements from faces implicated processes involved in more general face recognition.

The faces we come across throughout our lives creates various impressions, where some faces are better remembered and while others are forgotten. Research on visual memory suggests that observers have a remarkable memory for specific details of images (Brady et al., 2008; Vogt & Magnussen, 2007). The Cambridge Face Memory Test (CFMT) is a measure commonly used in testing memory for newly encoded faces (Richler, Cheung & Gauthier., 2011; Wilmer et al., 2010) and to identify face recognition deficits in adults (Avidan, Tanzer, & Behrmann, 2011; Bate et al., 2008, 2009; Bowles et al., 2009; Crookes & McKone, 2009; Rivolta et al., 2010). It was developed based on two early face recognition measures such as the Benton Facial Recognition Test (Benton et al., 1983) and the Recognition Memory Test for Faces (Warrington, 1984). Considering the shortcomings and the strengths of these tools, CFMT was developed as an effective standardized measure for face recognition (Duchaine & Nakayama., 2006a). The CFMT has established high reliability (Bowles et al., 2009; Wilmer et al., 2010b) and validity (Bowles et al., 2009; Dennett et al., 2012; Wilmer et al., 2010a; Wilmer et al., 2010b). Importantly for the purposes of this thesis, given that the CFMT measure was developed to explore facial memory deficits across ages, and as such makes it an ideal tool to explore individual differences in personality judgements from faces – enabling us to determine whether variation on face recognition memory may be linked to variation in individual ability at face-based personality judgements. Similar to memory for identifying objects and places (Parikh et al., 2012), there is some evidence of an association between facial traits and facial memory.

Facial memory and trait judgements: Previous studies have implied that face shape, familiarity and subjective ratings of facial memory can affect face recognition abilities (Bartlett et al., 1984; Deffenbacher, et al., 2000; Vokey & Read, 1992). Studies exploring the association between facial memory and trait judgements have linked facial attractiveness (Lin et al., 2019; Wiese et al., 2014), trustworthiness and dominance (Oosterhof & Todorov., 2008; Rule et al., 2012) with facial memory. Similarly, Bainbridge, Isola, and Oliva (2013) conducted a study on the memorability of face photographs and demonstrated that some facial images can be better remembered or forgotten compared to other images. For example, a face that is perceived to be kind, trustworthy and atypical is often remembered better (Bainbridge et al., 2013).

Additionally, various other studies exploring individual differences in trait judgements and facial memory have suggested a relationship between facial memory and extraversion trait judgements (Lander & Poyarekar, 2015; Li et al., 2010; Satchell et al., 2019), and facial memory and social anxiety (Davis et al., 2011; Megreya & Bindermann., 2013). Furthermore, it has also been suggested that there is a negative association between facial memory and neuroticism personality traits (Bothwell et al., 1987; Brigham et al., 1983; Li et al., 2010; Megreya & Bindemann, 2013; Mueller et al., 1979; Nowicki et al., 1979). There is also some evidence suggesting that individuals who score high on extraversion and emotional stability personality traits tend to be more accurate at face recognition abilities compared to individuals scoring high on introversion and neuroticism traits (Li et al., 2010). These findings are somehow inconclusive, considering other studies have failed to report such associations between extraversion and facial memory (e.g., Thompson & Mueller., 1984). However, neuroticism traits have been consistently reported to have a negative impact on face recognition abilities (e.g., Bothwell et al., 1987; Bringham et al., 1983; Li et al., 2010; Megreya & Bindemann, 2013). Taken together, these studies therefore appear to demonstrate an association between certain personality traits and facial memory. It is important to note that these studies have predominantly used explicit methodologies to make personality judgements from facial images.

In sum, the literature exploring the relationship between memory for faces and personality is inconclusive since research in this area has provided mostly mixed reviews. However, if the ability to identify personality from faces is related to facial memory, we might expect individuals with poor facial recognition abilities (developmental prosopagnosia) to also do poorly on face trait judgement tasks. At this point, it is worth considering cases with lifelong face recognition difficulties – the case of developmental prosopagnosia.

3.2.1.2 What is Developmental Prosopagnosia?

Understanding the structure and development of the healthy face processing system has been helped by studying individuals who present with difficulties in processing faces – a condition known as prosopagnosia (Bate et al., 2014; Duchaine & Nakayama, 2006; Todorov & Duchaine, 2008). While some of these impairments are limited to facial identity recognition, they can often exhibit deficits in other aspects of face perception. For example, interpretation of eye gaze direction. These difficulties can occur due to a variety of conditions, and they are presented in acquired, neuropsychiatric and developmental conditions. Developmental Prosopagnosia (DP) refers to a specific form of visual agnosia which is marked by severe face recognition deficits in the absence of brain damage, abnormal vision, or other cognitive impairments (Bate & Tree, 2017; Duchaine et al., 2007; Russell, Duchaine & Nakayama., 2009). This condition is characterized by an inability to recognize familiar faces which cannot be attributed to reduced vision or vigilance (Behrmann & Avidan, 2005; Jones & Tranel, 2001). In addition to face identity recognition impairments, deficits may also be present in face identity perception, where impairments are present in the early stages of visual processing (Chatterjee & Nakayama, 2012; Duchaine et al., 2007; Palermo et al., 2011; Yovel & Duchaine, 2006). However, in some cases, DPs are also reported to have normal face perception abilities and impaired face identity recognition (e.g., Behrmann et al., 2005; Dalrymple et al., 2014; McKone et al., 2011). Thus, it remains unclear whether face perception and face identity are dissociable among DPs.

The dual processing model of recognition memory suggested that individuals can identify faces through familiarity and recollection (Atkinson & Juola, 1973, 1974; Jacoby, 1991; Mandler, 1980; Yonelinas, 1994). Moreover, in most cases, this perceptual impairment is also present with regard to familiar faces in photographs and, in some cases, even to the person's own face in a mirror (Pietz & Ebinger, 2003). This particular neuropsychological deficit is usually found in individuals with lesions in the cortical region localized on the right hemisphere or bilaterally in the region below the fissura calcarina at the border between the temporal and occipital lobes (Damasio,

Damasio & Van Hoesen, 1982). Impairments in face recognition abilities related to prosopagnosia can be measured using the following instruments: forced-choice tests (e.g., Duchaine & Nakayama, 2006; Rivolta et al., 2012), familiarity judgements (e.g., Grueter et al., 2007; Kress & Daum, 2003) and recall tests for semantic memory (e.g., Grueter et al., 2007). Research on super-recognizers also indicated that individuals can not only be worse than average at face recognition (as in DP) but can also be better than average at face recognition abilities (Russell, Duchaine & Nakayama., 2009).

Further, it has been implied that DPs in some cases may represent a low-functioning version of normal face recognition rather than qualitatively different performance in their face recognition abilities. Although the absence of neurological injury or illness is not the only exclusion criteria for classifying DP, several DP researchers also exclude socio-emotional developmental conditions specifically autism spectrum disorders. Individuals with autism (see 3.2.4) tend to exhibit face processing difficulties; however, these difficulties are reported based on their inability to possess sustained attention throughout life, and thus exhibiting difficulties in face processing. Evidence exploring the relationship between DP and autism have suggested that these two groups that predominantly exhibit difficulties in face processing and social dysfunction respectively, raises the possibility that these conditions co-occur in several cases (Minio-Paluello et al., 2020; Schultz, 2005). As such, it has been suggested that DP should be viewed as a disorder with face recognition difficulties independent of socio-emotional difficulties such as autism (e.g., Bate & Tree, 2017; Duchaine et al., 2009).

DP and trait judgements: The purpose of one of the studies within the current thesis (See Chapter 5) was to use the IAT to determine whether DP candidates, despite exhibiting inabilities in face identity and object recognitions (e.g., Rossion et al., 2003), could elicit intact implicit trait judgements from composite facial stimuli. As indicated earlier, previous literature suggests people form first impressions from faces immediately after exposure (e.g., Bar, Maital, & Linz, 2006; Willis & Todorov, 2006). In regard to the face processing models (e.g., Bruce & Young, 1986), once a trait has been recognized, an identity is formed and therefore connected with previous memorability or understanding of that trait based on the observer's experience. This process triggers automatic retrieval of person knowledge (Gobbini & Haxby, 2007; Todorov et al., 2007; Todorov & Uleman, 2003). The face processing model has suggested that there is an interlink between the encoding of facial identity and emotion expression. However, researchers have also stated that there exists a dissociation between the two at the cognitive level (Todorov & Duchaine, 2008). Similarly, they have also suggested that this categorization does not explain trait judgements (Todorov & Duchaine, 2008). Furthermore, individuals with prosopagnosia, who typically exhibit difficulties with face identity, show normal trait judgements from faces (Todorov & Duchaine, 2008).

To our knowledge, there has been only one study that has been conducted using IAT measures on Prosopagnosia. Using a single case study, Knutson, DeTucci and Grafman (2011) studied whether an individual with acquired prosopagnosia was able to show social IAT effects by categorising race, gender, political views, or celebrity IATs. The results of this study revealed that the acquired Prosopagnosic participant was able to make covert recognition for race and celebrity (based on likability) IATs. Given that overt recognition for some social aspects is possible in individuals with prosopagnosia, it may be that DPs could also make accurate face-based trait judgments. However, additional data is required to explore these associations further.

Making rapid judgements of face identity from unfamiliar faces is a task functionally different compared to tasks using familiar faces. Hence, it is possible that the mechanisms used for trait judgements and person identity recognition could be distinctive. In order to better understand the relationship between face identity and trait judgements, Todorov and Duchaine (2008) conducted a study exploring trustworthiness judgements using individuals with Developmental Prosopagnosia. The DP participants of this study were asked to rate trustworthiness judgements for three sets of unfamiliar faces. The results of this study revealed that DP's who exhibit severe impairments with face identity were able to make normal judgements of trustworthiness. The plausibility of such findings have been supported by studies using functional neuroimaging methodologies, and have revealed that brain regions such as the inferotemporal cortex are pivotal in the perception of identity from faces (Kanwisher, McDermott, & Chun, 1997; Wada & Yamamoto, 2001) and the *amygdala* plays a critical part in the perception of trustworthiness from faces (Adolphs, Tranel, & Damasio, 1998; Engell, Haxby, & Todorov, 2007; Todorov, Baron, & Oosterhof, 2008; Winston et al., 2002). Individuals with bilateral amygdala damage report untrustworthy faces as trustworthy (Adolphs, Tranel, & Damasio, 1998). Todorov and Duchaine (2008) also compared DPs against bilateral amygdala patients and found that DPs performances are similar to control participants in judgements of trustworthiness. This finding indicates that DPs can possess normal face-trait judgement abilities. Additionally, they have also suggested that neural mechanisms for face identity and trait judgements could be computed differently. As such, it is possible that face identity and face-based trait judgements potentially use independent mechanisms, thus enabling DP candidates to possess normal implicit trait judgement abilities.

Emotion perception in DP: Emotional expressions often signal the behavioural intent of the individual displaying emotion (Fridlund, 1994). Preliminary evidence has suggested that holistic processing is not necessary to form trait judgements. Todorov et al., (2007) used facial parts as stimuli to identify trait judgements of trustworthiness. Incomplete facial information is sufficient for trait judgements. Researchers have suggested that trustworthiness trait judgements can be reliably made in the absence of emotional cues (Todorov, 2008). Identity and emotion recognition have also been shown to be unrelated in DP (Bentin et al., 1999; Duchaine, Parker, & Nakayama, 2003; Duchaine et al., 2007; Hymphreys, Avidan, & Behrmann, 2007). This in turn could suggest that individuals who tend to show emotional recognition deficits should also show deficits in trait judgement. However, DPs also show normal emotion recognition abilities (Bate & Cook, 2012; Bentin et al., 2007; Damasio, Tranel & Damasio, 1990; Duchaine, Parker, & Nakayama., 2003; Duchaine et al., 2007; Fisher, Towler & Eimer, 2017; Humphreys, Avidan, & Behrmann, 2007; Palermo et al., 2011; Tranel, Damasio, & Damasio, 1998), and therefore it is possible that perception of emotion expressions are independent of trait judgements. It is of note that, although some DP cases support the independence of face identity and expression perception abilities (e.g., Bate & Cook, 2012); researchers have also demonstrated that in some cases, DPs also experience difficulties in classifying emotions (e.g., Biotti & Cook, 2016; Duchaine et al., 2006, 2009; Lee et al., 2010). Thus, it remains unclear whether these processes are dissociable among DPs.

Face identity and emotion perception: According to Calder and Young's (2005) theory, certain preliminarily processes of face processing are shared mutually by face identity and face emotion perception. Researchers have demonstrated a moderate association between facial identity and emotion recognition (Franklin &

Adams, 2010; Palermo et al., 2013). The relationship between the ability to recognize facial emotions and facial identity is explained by the functional model of face processing (See Chapter 2, Bruce & Young, 1986); where the independence of these two processes have been proposed. Individual differences in face identity recognition have also been associated with the strength of holistic coding, which represents the information obtained from faces into a global representation (Engfors et al., 2017; Wang et al., 2012). However, it is important to note that individuals who exhibit deficits in face identity recognition do not necessarily also show deficits in expression perception (e.g., in the case of DP – see Duchaine et al., 2003; Humphreys et al., 2007; Palermo et al., 2011). Furthermore, researchers have demonstrated that face identity and face emotion expression abilities utilise independent mechanisms (e.g., Fox, Oruç, & Barton, 2008; Fox & Barton, 2007; Fox et al., 2009, 2011; Winston et al., 2004). Hence, these two processes appear to be largely independent of each other, although these perceptual processes can be recognised using some elements of a common route. However, there are contradictory findings to the proposed independence of pathways as explained in Chapter 2 (Pg. 21).

In sum, the previous sections have discussed individual differences in face recognition and literature available on trait judgements and facial memory – and some evidence-based on key populations that indicate the possible likelihood that identity recognition processes may be largely separate from those involving trait judgements. Such populations also indicate that identity and emotion recognition processes are also largely independent systems. The next section has more closely considered the possible links between implicit trait judgements and emotion perception.

3.2.3. Is the ability to judge traits from faces linked to wider face emotion processing?

In addition to the possibility of a link between broader face recognition abilities and face trait judgement – a different candidate might be broader emotional processing abilities. That is, perhaps the signal of a trait like extraversion from the face might be signalled by subtle expressive cues (micro-expressions) that drive particular responses. The facial expression of emotion provides information about an individual's mood and intentions (Darwin & Prodger, 1998). Information about the facial expression of emotion is conveyed through facial muscle movements which in turn provides the ability to accurately perceive, recognize, and understand individual differences in social interactions (Darwin & Prodger, 1998; Ekman, 1972; Plutchik, 1980).

Work by Palermo et al., (2013) developed tools assessing individual differences in expression perception abilities that are widely used in studies investigating face expression processing in the typical, nonclinical populations. The face emotion matching task developed by Palermo et al., (2013) requires participants to identify the odd emotion from a face that is simultaneously presented along with two other images portraying different expressions (See Chapter 4 pg. 82, for detailed methodology). This task is ideal to measure individual differences in expression perception and its association with implicit trait judgements, which is also one of the primary goals of this thesis. Social psychologists over the years have acknowledged the relationship of individual differences on trait inferences and first impressions. In a process called 'temporal extension', Secord (1958) has postulated that observers base some trait inferences on the external facial features which are the static cues available from the face (e.g., hair, skin colour, bone structure). The observers can apply the temporal extension not only to external facial features but also to the dynamic changes in muscle configuration to identify emotional expressions. Theories of embodied cognition (Gallese, 2007; Niedenthal, 2007) have stated that emotion perception in others is tied to emotional representations of the self. As explained in Chapter 2 (Section 19), neurological interactive models have also suggested that trait judgements often appear to be associated with emotion perception abilities (e.g., Gobbini & Haxby, 2007; Haxby et al., 2000; Todorov et al., 2008).

Emotion perception and trait judgements: A key set of basic facial expressions of emotion developed by Ekman (1993), included anger, disgust, sadness, fear and happiness – and these provided an ideal set of stimuli to explore the relationship between emotion expression and personality trait inference. The availability of a standard set of facial expressions of emotions (Ekman & Friesen, 1976) has enabled the development of procedures in which perceptual, memory, attention and cognitive processes involved in facial affect can be assessed. Researchers have argued that facial expressions of emotions covey information relating to interpersonal functioning (e.g., Knutson, 1996; Secord, 1958). Work by Knutson (1996) investigated whether facial expressions of anger, disgust, fear, sadness, and happiness affected interpersonal trait inferences such as dominance and affiliation. The participants of this study identified high dominance and affiliation from the facial expression of happiness; high dominance and low affiliation from facial expressions of anger and disgust; and low dominance from facial expressions of fear and sadness. The findings of this study have revealed that facial expressions of emotion convey information about the target's internal state and interpersonal information associated with trait inferences. Therefore, *personality judgements appear to be an extension of the mechanism involved in processing the emotionality of facial expressions.*

Furthermore, work by Palermo et al (2018) aimed to identify why individuals vary in their ability to recognize facial expressions. The findings of this study suggested that individuals with stronger adaptive coding of facial expressions show better expression recognition abilities. They also demonstrated that participants who self-reported with high anxiety were poorer at recognizing facial expressions (Davis et al., 2011; Demenescu., 2010). Could this mean that individuals with high neuroticism traits are poor at face recognition? In the current thesis, we have also aimed at exploring whether implicit judgements of neuroticism are related to facial emotion expression in Chapter 7.

The evidence considered here indicates that there may well be an overlap between functional processes linked to emotion processing and particular trait judgements in the general population – however, two key dimensions linked to poor emotion processing have been identified that are relevant for consideration. On the one hand, populations with higher levels of autism (even sub-clinically) have been reported to be poor at emotion processing, so might such individuals also do poorly on trait judgements (and thus suggest a link between the two)? On the other hand, populations with higher levels of alexithymia have also been reported to be poor at emotion processing, and thus a link here might also suggest an overlap between emotion/trait processing from faces. We will consider each of these populations separately below.

3.2.4. Could individuals who struggle with wider social interaction be impaired at face-based trait judgements? The case of autism.

Autism is defined as a condition that exhibits deficits in social interaction and communication development in the presence of repetitive behaviours and limited imagination (American Psychiatric Association, 2013). Several social impairments in autism such as eye contact, attention span, emotional responses and facial recognition are derived from the information processed from faces (Dawson et al., 2002; Dawson, Webb & McPartland, 2005; Webb, Faja & Dawson., 2011). Face processing abilities have been postulated to be critical in the development of social relationships and the theory of mind (e.g., Baron-Cohen,1995; Perrett et al., 1990). To receive a positive diagnosis in terms of clinical aspects of autism, it demands an individual meet the specified criteria (American Psychiatric Association, 1994, 2013).

Evidence for a continuous, dimensional approach to autistic traits in the general population has led to the development of the Autism-Spectrum Quotient (AQ; Baron-Cohen et al., 2001; Constantino & Todd, 2003). Baron-Cohen et al., (2001) developed a critically relevant tool known as the AQ measure, which is a self-administered scale that is used to identify the degree of autistic tendency in adults with normal intelligence. This 50-item questionnaire is designed to assess autistic traits in the general population. The AQ was designed to assess five different areas of functioning such as social skill, attention switching, attention to detail, communication, and imagination. Individuals with High AQ are known to typically perform better in areas relating to echoic memory, short-term memory, and associative memory skills (Bennetto, Pennington, & Rogers, 1996; Hermelin & O'Connor, 1970; Lincoln et al., 1992; Minshew & Goldstein, 1993, 1998; Rumsey & Hamburger, 1988). Normal and healthy adult populations generally process the complex set of details available from a face, and recognize the emotional state and social contexts, and moreover often remember the individual's face later. This mechanism of processing specific facial information involves a region along the superior temporal sulcus which detects facial movements associated with eye gaze, speech, emotional expression, and intention (Allison, Puce & McCarthy, 2000; Puce et al., 1998; Winston et al., 2002).

Autism and emotion perception: Researchers have established that individuals scoring high on the AQ scale tend to perform poorly on tasks relating to emotion perception (e.g., Ashwin et al., 2006; Humphreys et al., 2007; Lewis, Lefevre, & Young, 2016; Poljac, Poljac, & Wagemans, 2013). On the contrary, researchers have also reported no such associations between autism-like traits and expression perception (e.g., Adolphs et al., 2001; Castelli, 2005; Halliday et al., 2014; Palermo et al., 2018). Although, individuals with autism exhibit impairment in emotion recognition and show reduced empathy, these poor inferences of facial expression perception are mainly predicted by a highly co-occurring condition termed alexithymia (See section 3.2.5) that is also often seen in individuals with autism (Bird & Cook, 2013; Cook et al., 2013; Shah et al., 2016). However, in the current thesis, we aim to explore the association between autism-like traits and emotion perception across the general population.

Autism and face identity: The fusiform face area which is a region in the ventral occipital cortex was found to be responsible for face detection, categorization, and identity recognition (George et al., 1999; Grill-Spector et al., 2000; Grill-Spector, Knouf & Kanwisher, 2004; Hoffman & Haxby, 2000; Kanwisher, McDermott & Chun, 1997; Winston et al., 2004). Evidence suggests that most autistic individuals have an impairment in these brain regions which are linked to performance on measures of memory for facial identity (Dalton et al., 2005; Grelotti, Gauthier & Schultz, 2002; Grelotti et al., 2005; Hubl et al., 2003; Pierce, Haist, Sedaghat, & Courchesne, 2004; Pierce et al., 2001; Piggot et al., 2004; Schultz et al., 2000). These findings propose that facial recognition memory is impaired in autistic individuals although visual perception for faces may be intact (Robel et al., 2004). This finding could be supported by adding that high AQ individuals lack face recognition skills due to insufficient attention to faces throughout development, with an inability to address faces as emotionally salient (Grelotti, Gauthier & Schultz, 2002; Grelotti et al., 2005; Klin et al., 2002, 2005; Schultz, Romanski & Tsatsanis, 2000). Overall, studies on facial memory and autism have largely suggested that autistic individuals tend to perform poorly on face identity recognition tasks (Davies et al., 2017; Rhodes et al., 2013; Riby et al., 2009; Sasson et al., 2013; Webb, Neuhaus, & faja, 2017; Weigelt, Koldewyn, & Kanwisher, 2012) - but not in all cases, since other studies have found no such deficits (e.g., Deruelle et al., 2004; Ozonoff et al., 1990).

Furthermore, recent research by Minio-Paluello et al., (2020) has suggested that impairments in face identity recognition in autism phenotype are associated with co-occurring prosopagnosia conditions. On the contrary, work by Lewis, Shakeshaft and Plomin (2018) have demonstrated a negative association between face memory and AQ traits, specifically for social interactions difficulties. Their study also revealed that face memory deficits reported among individuals with high AQ was independent of object memory recognition, thus suggesting that this ability is not reflective of a broader memory deficit.

Autism and trait judgements: It is well known that individuals with autistic traits exhibit difficulties with social situations. Furthermore, researchers have also demonstrated that individuals with high autistic traits show reduced adaptive coding for face identity, and also processing emotional expressions from faces (e.g., Dennett et al., 2012; Lewis, Lefevre, & Young, 2016; Sucksmith et al., 2011). Previous research studies have stated that high AQ scores are associated with self-perception high neuroticism, low extraversion, and low agreeableness personality traits (Austin, 2005; Murphy et al., 2000; Piven et al., 1997). While studies have reported an association for individuals with autism-like traits and facial memory and emotions, few studies have considered face-trait judgements among individuals with autism. Researchers have suggested that individuals with autism spectrum disorders (ASD) show normal trait judgements for dominance and trustworthiness (Caufield et al., 2014; Ewing et al., 2015; Hooper et al., 2019; Latimier et al., 2019; Mathersul et al., 2013; White et al., 2006). On the contrary, work by Adolphs et al., (2001) has reported that individuals with ASD tend to rate untrustworthy faces to be highly trustworthy. However, in the current thesis, it is of interest to assess the associations between autism-like traits and face-trait inferences.

3.2.5 Could individuals who have issues with interpreting their own feelings have problems with trait judgements from faces? The case of alexithymia.

The term alexithymia was coined by Nemiah and Sifneos (1970) to describe the characteristic aspects of psychosomatic and psychiatric illnesses. Alexithymia refers to an *individual's inability to verbally describe or identify his or her own feelings* (Nemiah, Freyberger, & Sifneos, 1976; Taylor, Bagby & Parker, 1991). For example, individuals with alexithymia might be aware that they are experiencing an emotion but are unaware of whether the emotion they are experiencing is sadness, happiness or anger etc. (Nemiah, Freyberger, & Sifneos, 1976). Furthermore, researchers have suggested that this inability to identify emotions is a product of developmental dysfunction based on the neural regions responsible for idiosyncratic connectivity of emotions and affect recognition (Bird et al., 2010; Ihme et al., 2013). The most commonly used standardized tool to measure alexithymia is the Toronto Alexithymia Scale (TAS-20, Bagby, Parker & Taylor, 1994). The TAS20 measures three main facets of Alexithymia: difficulty identifying feelings, difficulty communicating or describing emotions to others, externally oriented style of thinking. These characteristics are thought to reflect deficits in the ability to cognitively process and regulate emotions (Bagby & Taylor, 1997; Müller et al., 2014; Parker, Taylor & Bagby, 1993).

Several research studies have established that individuals showing characteristic traits of alexithymia (e.g., individuals who score high on the TAS20), tend to be less accurate and exhibit difficulties in recognizing facial emotional expressions (Calder, Lawrence & Young, 2001; Lane et al., 1996; Parker, Prkachin & Prkachin, 2005). Studies have reported that high alexithymic individuals perform worse on recognizing all six basic emotions in tasks measuring emotion matching (Lane et al., 1996, 2000; Montebarocci et al., 2011; Parker, Taylor & Bagby, 1993; Prkachin, Casey & Prkachin, 2009; Swart, Kortekaas, & Aleman, 2009) and emotion labelling (Jessimer & Markham, 1997; Jongen et al., 2014; Mann et al., 1994; Montebarocci et al., 2011; Swart, Kortekaas, & Aleman, 2009). In addition, individuals with alexithymia specifically tend to show extreme deficits in recognizing emotions such as anger and fear (e.g., Ihme et al., 2014; Prkachin, Casey & Prkachin, 2009). Furthermore, apart from the inability to recognize one's own feelings or emotions, individuals with alexithymia are also impaired in emotion recognition abilities for other individuals (Cook et al., 2013; Prkachin et al., 2009). Contradictory to these results, literature also suggests that individuals with characteristic traits of alexithymia would be better at recognizing emotions from faces if the presentation time in computer tasks increased to enable effective recognition to occur. In other words, tasks that included a longer latency period or no time limit showed that there was better accuracy in recognizing emotions from faces. (e.g., Ihme et al., 2014;

McDonald & Prkachin., 1990; Pandey & Mandel., 1997; Parker, Prachkin, & Prachkin., 2005; Swart, Kortekaas & Aleman., 2009).

Autism and alexithymia: As discussed in section 3.2.4 in this Chapter, it is suggested from previous literature that individuals with autism appear to exhibit impairment in emotion recognition and show reduced empathy. These poor inferences of facial expression perception are mainly predicted by co-occurring alexithymia in individuals with autism (Bird & Cook, 2013; Bird et al., 2010; Cook et al., 2013; Shah et al., 2016). In the general population, the incidence of Alexithymia is thought to be about 10 % (e.g., Linden et al., 1995), and several studies have suggested varying degrees of alexithymia in about 50% of individuals with autism (e.g., Berthoz, & Hill., 2005; Lombardo et al., 2007). Therefore, alexithymia appears to be prevalent in individuals with autism traits in comparison to the general population and appears to play a role in emotion perception difficulties exhibited by autistic individuals (e.g., Bird & Cook., 2013). Furthermore, emotion perception seems to be altered on a basic perceptual level in individuals with autism and alexithymia, however, additional research in this area is required to understand these mechanisms.

Alexithymia and face trait judgements: It is well-established that people make inferences of ones' emotions and personality characteristics from faces (Said, Haxby & Todorov, 2011; Todorov et al., 2008, 2015; Willis & Todorov, 2006). Based on the emotion overgeneralisation hypothesis, it has been suggested that observers constantly tend to make associations between internal facial features and emotional expression (e.g., Said et al., 2011). For example, individuals with the facial feature of lower eyebrows, are usually associated with anger and they may also cause an individual to be perceived as highly dominant (e.g., Montepare & Dobish., 2003; Said et al., 2011; Zebrowitz & Montepare, 2008). Emotion neutral models that portray emotions such as happiness or anger are usually perceived to be associated with personality traits such as trustworthiness and aggressiveness respectively (Engell, Todorov & Haxby, 2010; Oosterhof & Todorov, 2008). Similarly, other populations with impaired emotion processing have also demonstrated atypical judgements of trustworthiness and dominance (Sprengelmeyer et al., 2015). Work by Brewer et al., (2015) aimed at identifying trait judgement abilities among individuals with alexithymia. Using inter-rater consistency for traits such as trustworthiness, aggressiveness, intelligence and attractiveness, their results suggested that alexithymics exhibit low interrater consistency for trustworthiness, aggressiveness and intelligence traits and consistent ratings for attractiveness from unfamiliar faces; and hence reveal atypical judgements for trait judgements compared to control participants. However, they have also suggested that there are similar levels of association between emotion perception and trait judgements among individuals with and without alexithymia (Brewer et al., 2015). Furthermore, Brewer et al., (2015) have implied that it is possible in the face-processing system that emotion detection could take place before personality trait inferences, and individuals with alexithymia could possess selective impairment at detecting emotions – which would imply some similar knock-on consequence for trait judgments. As such, current work in this thesis has also aimed at exploring whether the performance of implicit face-based trait judgements can be predicted by alexithymia traits presented across general populations.

3.3 Investigating automatic implicit personality judgements from faces – an individual differences approach.

In the modern age of online interaction and social media, individuals readily make first impressions from facial photographs (e.g., Naumann et al., 2009; Vazire & Gosling, 2004). With this, there has been an increase in psychological studies using first impressions (Borkenau et al., 2009; Carrè et al., 2009; Gosling et al., 2011). As such, several studies have demonstrated that participants are able to infer extraversion and agreeableness trait judgements at zero acquaintance within short periods of time (e.g., Kenny et al., 1992; Watson, 1989).

In sum, the previous literature reviewed has covered a number of key studies that have explored the key types of traits participants can judge from faces and determined that such judgements can be both automatic and implicit. What is less well understood is how such judgements are made – that is what underlying cognitive processes may well be linked to face based trait judgements? In the later sections, we considered at least two major possibilities, (a) that trait judgements share some overlap with the processes underpinning face recognition more generally or (b) that trait judgements share some overlap with processes underpinning aspects of emotion processing more generally. A third possibility might be that no overlap occurs, and that the mechanisms that underpin individuals' ability to make face-based trait judgements imply separate cognitive processes entirely. This work seeks to explore this theme through the lens of individual differences. In the earlier review, it is clear that performance within the general population varies substantially with respect to both (a) and (b) above – such that in some cases individuals may perform very poorly indeed. We can also assume that there will be some similar variability in individuals' performance on face-based trait judgement. As a consequence, we can ask – how might the distributions on these dimensions overlap? That is, do people who might perform particularly very well/very poorly on (a) or (b) also reliably perform in a similar manner for face-based trait judgements?

3.4 Study aims and hypotheses

Based on the review presented above, the current thesis aims to investigate whether implicit personality trait judgements are available from composite faces, and if so, what other factors can predict such ability? Based on the extensive review presented, we have considered face identity, emotion recognition, autism and alexithymia traits as predictors of trait judgements.

Given that it has been suggested that trait judgements often appear to be an extension of expression perception abilities, we hypothesise that there will be a correlation between implicit trait judgements and emotion perception. Furthermore, individuals with autism and alexithymia who predominantly exhibit emotion perception difficulties may also perform poorly on implicit trait judgements.

Previously it has been suggested that trait judgment mechanisms are independent of face identity recognition. On the contrary, several empirical studies have demonstrated an association between trait judgements and face memory. Although face identity and expression recognition have been suggested to utilise some shared/independent mechanisms; here we hypothesise that trait judgement mechanisms may be related to face identity recognition. Potentially, if face identity is related to trait judgements, how might individuals with face identity deficits perform on implicit trait judgement tasks? As such we have explored whether developmental Prosopagnosics will be able to perform equivalent to non-clinical populations on extraversion trait judgement tasks given previous research has also demonstrated that in some DP cases, trait judgement mechanisms are unrelated to face identity mechanisms (e.g., Todorov & Duchaine, 2008).

The experimental hypothesis is that there will be a relationship between face-based implicit trait judgements and other cognitive factors such as face memory, emotion perception, autism traits and alexithymia traits. The null hypothesis is that there will be no relationship between implicit trait judgements and other cognitive factors; which would then answer the research question – are trait judgements independently processed within the face recognition system?

To test these hypotheses, firstly the implicit association task (IAT; Greenwald et al., 1998) was employed to measure implicit personality judgements. The IAT is one of the most prominent measures utilised to assess implicit cognition by measuring the strength of associations between a target concept (in this case composite faces conveying personality) and an attribute (words describing personality) using latency measures. As such, the IAT is a highly valid and reliable tool that is used to measure unconscious and automatic social cognitions and is considered as a key implicit measurement tool in this thesis. We have specifically focused on three traits from the five-factor model (McCrae & Costa, 1989), positively regarded traits such as extraversion and agreeableness given these two traits have been repeatedly shown to be cued using implicit (Jones et al., 2019) and explicit (e.g., Jones et al., 2012; Kramer & Ward, 2012; Little & Perrett, 2007; Penton-Voak et al., 2006) methods; and negatively regarded traits such as neuroticism for a contrast of trait judgments.

Secondly, using a well-known standardized measure such as the Cambridge Face Memory Task (CFMT; Duchaine & Nakayama, 2006), face identity recognition abilities were measured. This test is commonly used in testing memory for newly encoded faces, and largely accounts for individual differences in face identity recognition; given this tool is also one of the main diagnostic measures used to establish face recognition deficits (e.g., Bate et al., 2019), as such considered an ideal tool to measure associations between face memory and trait judgements. Further, it has also been suggested that face memory determines our success in identity recognition in everyday life as opposed to face perception abilities (Bowles et al., 2009; Duchaine & Nakayama, 2006).

Thirdly, Emotion perception ability was measured using an Emotional Expression Matching Task (ET; Palermo, et al., 2013) which allow us to separately measure perceptual discrimination of categories of facial expression. This measure is widely used to measure individual differences in facial expression perception (e.g., Palermo et al., 2018) and as such, is an ideal tool to establish the relationship between emotion perception and trait judgements.

As mentioned earlier autism traits and alexithymia traits were associated with poor emotion recognition abilities. As such, autism traits were measured using the autism screening questionnaire (AQ; Baron-Cohen et al., 2001), a measure highly used to measure autism traits across the general population (e.g., Ruzich et al., 2015). Alexithymia traits were measured using the Toronto Alexithymia Scale (TAS), a 20-item measure used to measure alexithymia traits across the general population. As such these measures are ideal tools used to establish individual differences.

Using these measures mentioned above (see chapter 4 for methodology), we predict that i) there will be a positive relationship between trait judgements and expression perception abilities; ii) there will be a negative relationship between trait judgements and autism/alexithymia; iii) there will be a positive association between face memory and trait judgements. Further, we predict iv) a positive association between face memory and face emotion perceptions. We also predict that v) there will be a positive association between autism and alexithymia traits; vi) negative association between autism/ alexithymia traits and emotion perception, face memory. We also predict that vii) self-perception of neuroticism will be unrelated to implicit neuroticism trait judgements.

While these measures have been used to test different aspects of face recognition and personality judgements, currently no studies have established the relationship between implicit trait judgements and other face recognition abilities using these measures. Individually each of these measures has been proved to have high validity and reliability. These measures are described in detail in the general methodology chapter.

Chapter IV
General Methods

4.1 Introduction

This Chapter summarises the general methods employed in the experiments contained within this thesis. The differences in the methodology outlined within this section and that of the experimental chapters are explained in the experimental chapters.

4.2 Participants

For the purposes of this thesis, we have recruited participants across ages, other-ethnicity, and developmental prosopagnosia groups. As such, a power analysis was conducted Using G* power (Faul et al., 2007) based on previous findings (Jones et al, 2019) with a minimum n = 94 on younger adults in each study outlined in the experimental chapters, where α = 0.05, β = 0.80 and expected a conventionally medium effect size >.3.

The younger adult population (Age range 18-35) were recruited using Swansea university's participant pool for psychology course credits, where the students came into Swansea University labs to complete the experiments; and were also recruited through Prolific.ac (online platform), where participants were paid £3 for participation. This process also helped us to measure consistency in data quality for both lab and online data. The older adults were recruited through the Swansea older adult volunteer participant panel (Age range 55+ above). All the older adults came to the Face Research Swansea lab to take part in the study. Only Caucasian participants were included in empirical Chapters 5, 6, 7 and 10, to avoid other-ethnicity effects (Young et al., 2012). In Chapter 9, other-ethnicity (Indian) participants (Age range 18-35) were recruited using study links to explore other-ethnicity effects. No participant was excluded in the study after considering the improved scoring algorithm outlined by

Greenwald et al., (2003). No exclusions were made to the young adult group based on high autism traits, high alexithymia traits, poor face memory and poor face emotion recognition in order to include the variability across the general population to incorporate individual differences.

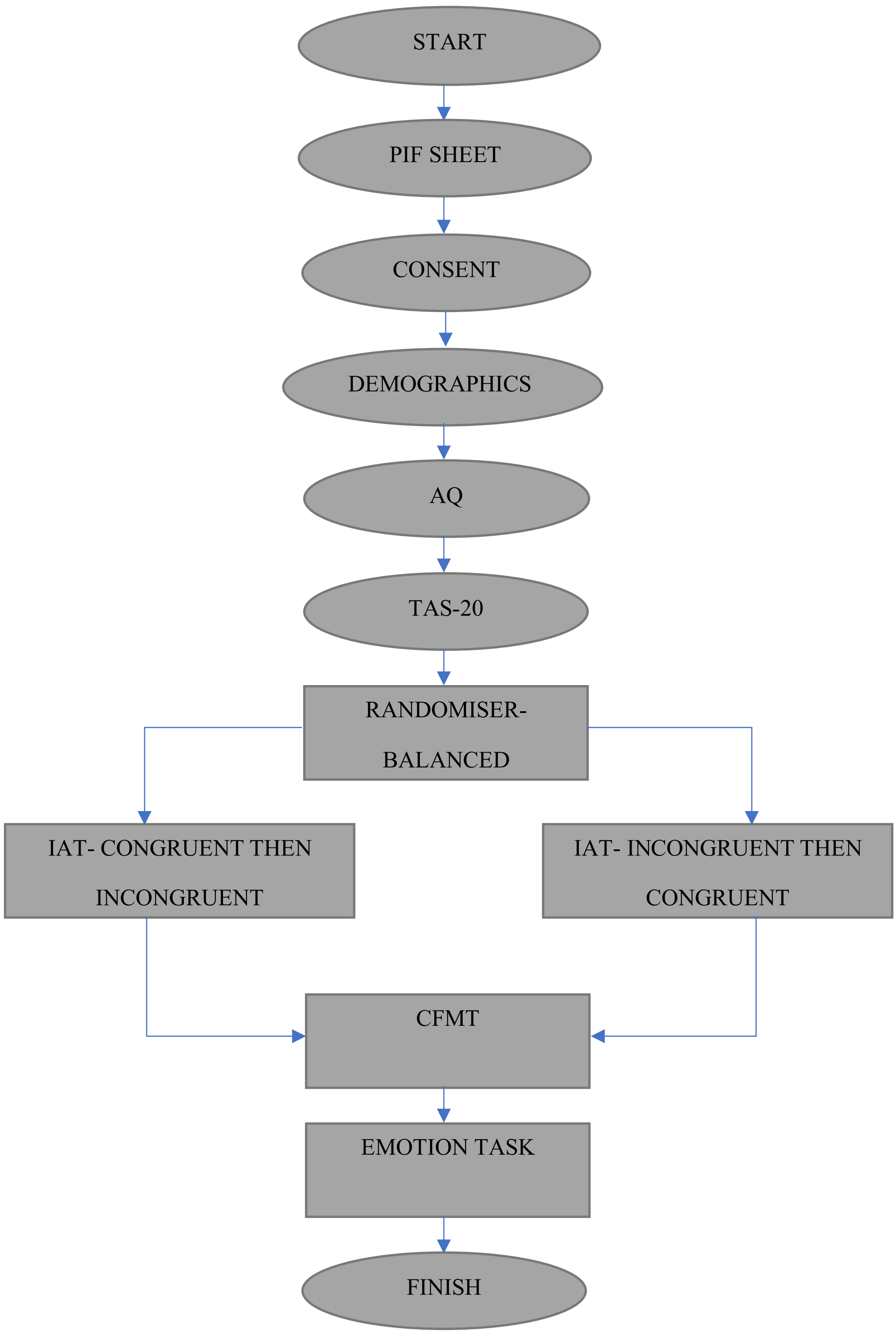
Developmental Prosopagnosia inclusion criteria: Detailed methodology has been explained in Chapter 5 (pg. 104). Participants with Developmental prosopagnosia (DP) were recruited from the Face Research Swansea (FaReS) database. Here we used the Prosopagnosia Index (PI20; Shah et al., 2015), Cambridge Face Memory Test (CFMT; Duchaine & Nakayama, 2006), Cambridge Face Perception Test (CFPT; Duchaine & Nakayama, 2007) and the Famous face test (FFT; Bate et al., 2019): young version (18-34 age group), older version (35+ age group) as a screening measure for identifying individuals with DP. Participants scoring 2 SDs below the mean on CFMT, CFPT, FFT and scoring above 85 on the PI-20 self-report measure were categorized as eligible for the DP group. A web link was sent to the DP group to complete tasks relating to this thesis.

Ethical approval for all experiments was obtained from the Swansea university department of psychology ethics committee. Participants were provided with a participant information sheet and a consent form before taking part in the study. A debrief form was provided once the participants completed the study.

4.3 Experimental Materials

All the tasks were designed using the software Gorilla (Evershed et al., 2018). Gorilla is an online platform that is used to design psychological experiments. For all the questionnaires explained below, participants were unable to progress to the next section until they have filled all the questions. This is to ensure there was no missing

Figure 4.1: Experimental design



Note: The randomizer node automatically distributes a group of participants to begin IAT congruent, followed by the CFMT and emotion tasks; and similarly, another group of participants begin with the IAT incongruent, then CFMT and emotion tasks in a balanced order. PIF = participant information sheet.

data. Participants were instructed to complete the questionnaires as quickly as possible to avoid thinking or pausing for too long to answer. See Figure 4.1 above for the experimental design employed within this thesis.

4.3.1 Demographic information questionnaire

Participants were asked to complete a demographic information questionnaire, providing information regarding their age, ethnicity, gender, and email address. This information was collected to determine the representativeness of participants relating to a target population (such as ethnicity) and to report back with the results of the study based on the participant's consent.

4.3.2 Autism Spectrum Quotient (AQ)

A 50- item AQ scale (Baron-cohen et al., 2001) was used to measure autistic traits. The AQ measure is a self-assessed questionnaire designed to establish the degree to which an adult with normal intelligence has the traits associated with the autistic spectrum. The AQ is a highly reliable and valid measure to distinguish where any given individual is placed on the continuum from autism to normality. This measure includes 5 subscales made up of 10 questions each measuring: *social skill* ($\alpha = .77$); *attention switching* ($\alpha = .67$); *attention to detail* ($\alpha = .63$); *communication* ($\alpha = .65$); and *imagination* ($\alpha = .65$). Participants recorded their responses using 4-point Likert scales ranging from 1 = ‘definitely agree’ to 4 = ‘definitely disagree’.

4.3.3 Toronto Alexithymia Scale (TAS-20)

The TAS 20 (Taylor, Bagby & Parker, 2003) was used as a screening measure to assess Alexithymia traits (cut off score < 61). This 20-item scale has 3 subscales measuring: *difficulty identifying feelings (*α *>.70); difficulty describing feelings (*α *>.70);* and *externally oriented thinking (*α *>.60)*. Participants completed the questionnaire using 5-point Likert scales ranging from 1 = 'strongly disagree' to 5 = 'strongly agree'.

4.3.4 Mini-International Personality item pool (IPIP)

The mini IPIP (Donnellan et al., 2006) measure is a short version of the 50-item international personality item pool five-factor model by Goldberg (1999). The mini IPIP is a 20-item scale (α >.60) measuring traits related to the Big-Five personality (openness, conscientiousness, extraversion, agreeableness, and neuroticism) with 4 items per trait. This self-report measure was used to identify whether there was a relationship between an individual's score on personality traits and the neuroticism IAT. This questionnaire is explained in detail in Chapters 7 and 10.

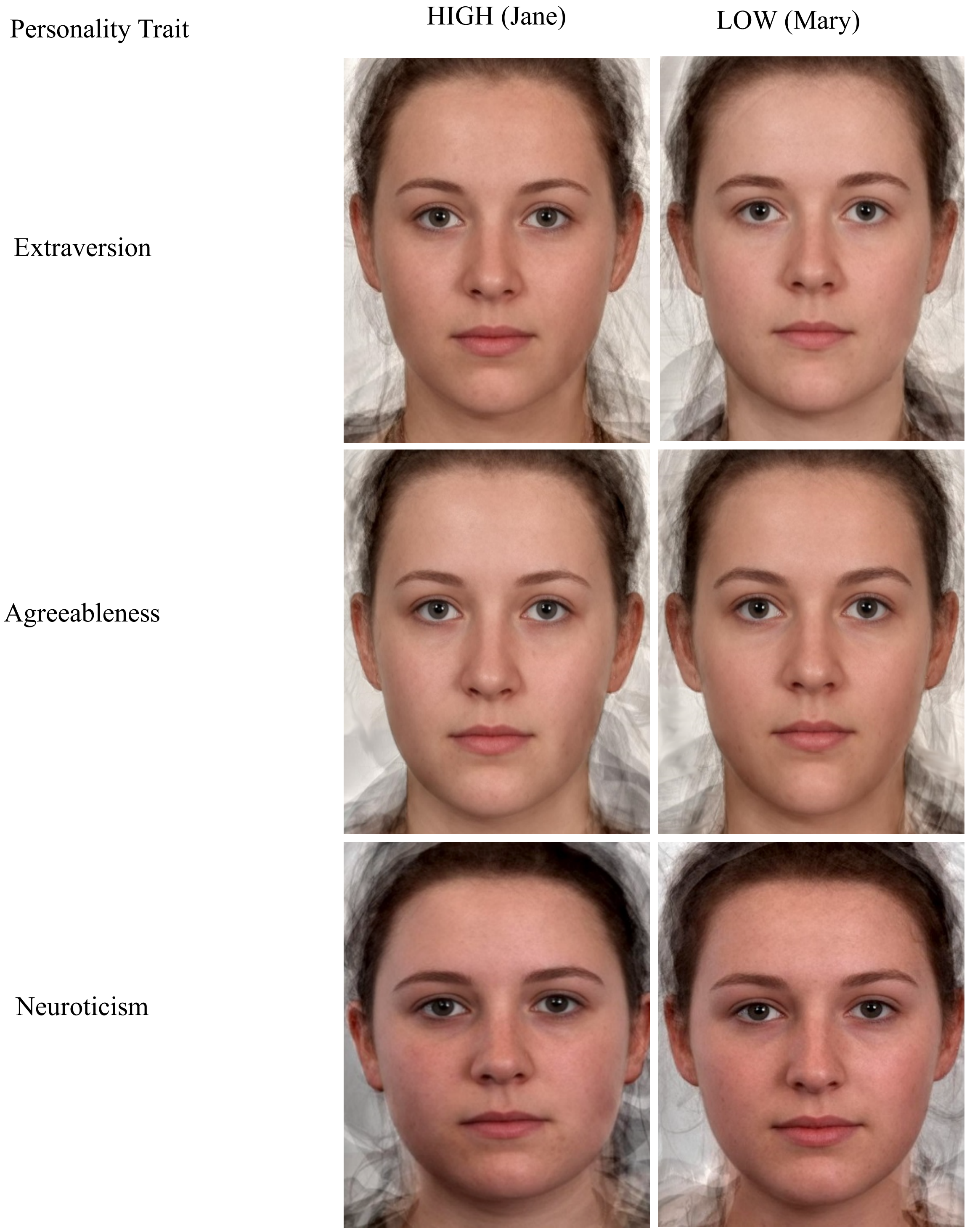
4.3.5 Face Trait Implicit Association Task

As discussed earlier we used the ***Implicit Association Task*** (**IAT**; Greenwald, McGhee & Schwartz, 1998), a well-known measure used in evaluating associations underlying implicit attitudes. In the current thesis, the IAT is used to measure whether accurate implicit personality trait judgements are available from faces (following the approach of Jones et al., 2019). A novel version of the IAT was used in this study with female composite facial stimuli.

Stimuli

Three sets of two facial composites were generated from a sample of 64 Caucasian females (age M = 21.03, SD= 1.94) who completed the 20-item measure of

Figure 4.2: Showing different composite faces used in the IAT.



Note: High-level trait composite faces 'Jane' appear on the left and low-level trait composite faces 'Mary' appear on the right.

mini-IPIP (Donnellan et al., 2006). The images were obtained from previous research by Kramer and Ward (2010) and here we have created novel versions of the composite facial stimuli (See Figure 4.1 for facial composites used in this thesis). The photographs were averaged using the software Abrasoft Fantaface Mixer. Although previous studies have investigated personality traits using both male and female composites, the studies in this thesis only explored implicit trait judgements using female composites. Furthermore, arguably female composites are suggested to contain cues to personality that can be measured more efficiently compared to male composites, as male composites have been reported to contain fewer cues to their actual personality (e.g., Little & Perrett, 2006).

This thesis looked at faces portraying high extroversion, low extroversion; high agreeableness, low agreeableness; high neuroticism and low neuroticism personality traits; as such using the facial stimuli of individuals scoring high and low on these traits. Table 4.1 below includes the words used to describe personality traits in the IATs.

Table 4.1: Words used to describe personality traits in the implicit association task

Personality traits	***High traits***	***Low traits***
Extraversion	*Confident, Sociable, Outgoing, Talkative*	*Shy, Quiet, Reserved, Thoughtful*
Agreeableness	*Kind, Sympathetic, Helpful, Warm*	*Cold, Unsympathetic, Harsh, Unkind*
Neuroticism	*Moody, Vulnerable, Insecure, Worrying*	*Hardy, Relaxed, Secure, Calm*

Procedure

Across all studies, high extroversion, high agreeableness and high neuroticism composites were called 'Jane', the low composite faces were called 'Mary'. The keyboard response included keys pertaining to the image and words. In this task keyboard response 'E' was used for categories on the left, and 'I' was used for the categories on the right. Figure 4.3 shows an example of the IAT task design.

Figure 4.3: IAT extraversion congruent version task design.

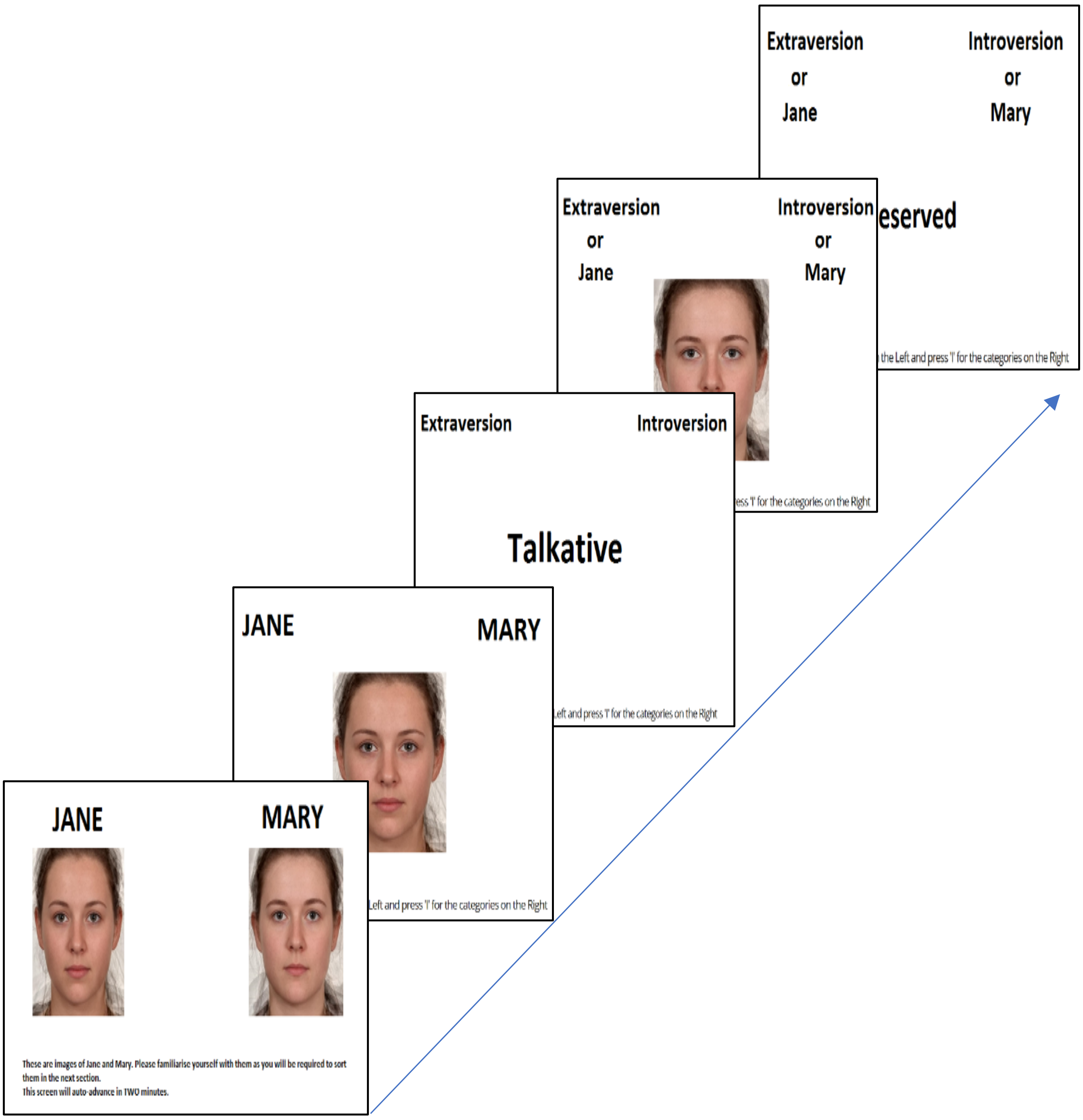


Table 4.2: IAT block design

Block	No. of trials	Function	Item assigned to left key	Items assigned to right key
1	20	Practice	Jane images	Mary images
2	20	Practice	Extraverted words	Introverted words
3	20	Test	Jane images + extraverted words	Mary images + introverted words
4	40	Test	Jane images + extraverted words	Mary images + introverted words
5	20	Practice	Mary images	Jane images
6	20	Test	Mary images + extraverted words	Jane images + introverted words
7	40	Test	Mary images + extraverted words	Jane images + introverted words

Note: This table is an example of the congruent conditions of the IAT. Blocks 5,2,6,7 appear at the start in the incongruent conditions followed by blocks 1,3,4. This is an outline of the extraversion IAT block design. An identical design was used for agreeableness and neuroticism IATs with words and images for these traits.

The task began with a general instruction and familiarization phase where words describing personality traits were presented. The words describing personality traits were obtained from Grumm and Collani (2007). This was followed by a screen presenting the categories of composite faces labelled 'Jane' and 'Mary' for a fixed duration of two minutes. Participants were instructed to familiarize themselves with the faces in order to categorise them in the following blocks. Instructions were given before each block.

Following the familiarization task, a practice block was presented where instructions were given to categorise images of Mary and Jane. For the first 4 blocks, Mary appeared on the right and Jane appeared on the left. The main motivation in this task was to familiarize participants with the images under usual response conditions.

After the first 4 blocks, the position of Mary and Jane switched. Participants completed all 7 blocks of the task (See table 4.2). Blocks in which the high extroversion face was paired with high extroversion words were called *congruent conditions* and in the *incongruent condition,* the high extroversion face was paired with low extroversion words, similarly for agreeableness and neuroticism personality traits. To counterbalance the conditions, half the participants started with the congruent then incongruent version and the other half vice versa. A **randomiser node** was included in the experimental design that automatically allocates participants to begin the IAT the congruent or incongruent version in a balanced order.

When participants made an error in their response, a red cross appeared on the screen below the stimulus presented. After this, participants were allowed to correct the response by entering the correct keyboard response. Based on the scoring algorithm (Greenwald, Nosek & Banaji, 2003), any participant scoring below 300ms or over 10000ms for 10% of the trials were removed. A fixation point for 200ms was presented between each trial and reaction times were measured. Using the improved scoring algorithm, the reaction times were converted into D scores. The IAT D is a form of effect size measure that compares the reaction time latency across congruent and incongruent conditions where bias is marked for longer latency responses in incongruent conditions over congruent conditions. For the analysis procedure see section 4.4.

4.3.6 The Cambridge Face Memory Task - upright version

As discussed earlier, we sought to determine whether individual variation on a face recognition memory test is related to a variation on our implicit face trait tasks. In this case, a well-established face recognition paradigm called the Cambridge Face Memory Task was used.

The *Cambridge Face Memory Task* (CFMT; Duchaine & Nakayama, 2006) is commonly used in testing memory for newly encoded faces and to explore individual differences in face recognition memory in adults.

Stimuli

Images were obtained from the original study by Duchaine and Nakayama (2006). The images used in this task were cropped so that details about facial features such as hair and facial blemishes were not available. Six target faces and forty-six distractor images were included in the task. See figure 4.4 (image A) for the 6 target faces. A target image was presented with two distractor images. The procedure for the task is explained below in detail.

Procedure

The CFMT task presentation is made up of four stages: stage 1- Practice task, stage 2 - Introduction/same images, stage 3- novel images, stage 4 - novel images with noise. Table 2 shows the block design of the CFMT.

Practice task

The practice task began with general instructions where participants were asked to memorize a series of faces. Each image was presented 3 seconds apart. They were instructed to record their answer by using keyboard response 1 for the first image; 2 for the second image; and 3 for the third image. Following these instructions images of Bart Simpson was presented in three angles (left profile, frontal view and right profile) to memorize. A forced-choice test was provided asking the participants to pick which face they just viewed along with the two other cartoon distractor images, using keyboard responses 1, 2 or 3. In total, there were 3 trials in the practice block.

Introduction/same images:

Following the practice block, the actual test blocks began with instructions similar to that of the practice block. 6 sets of target images were presented with three poses (left profile, frontal view, and right profile). Figure 4.4 (image B) shows an example of the target image in frontal and right profile views. Each target face was presented in three poses for 3 seconds each. After target images were presented, participants undertook the recall trials. This block involved distractor images identical to the target images. Following this procedure, the next 5 sets of target images were presented.

Novel images:

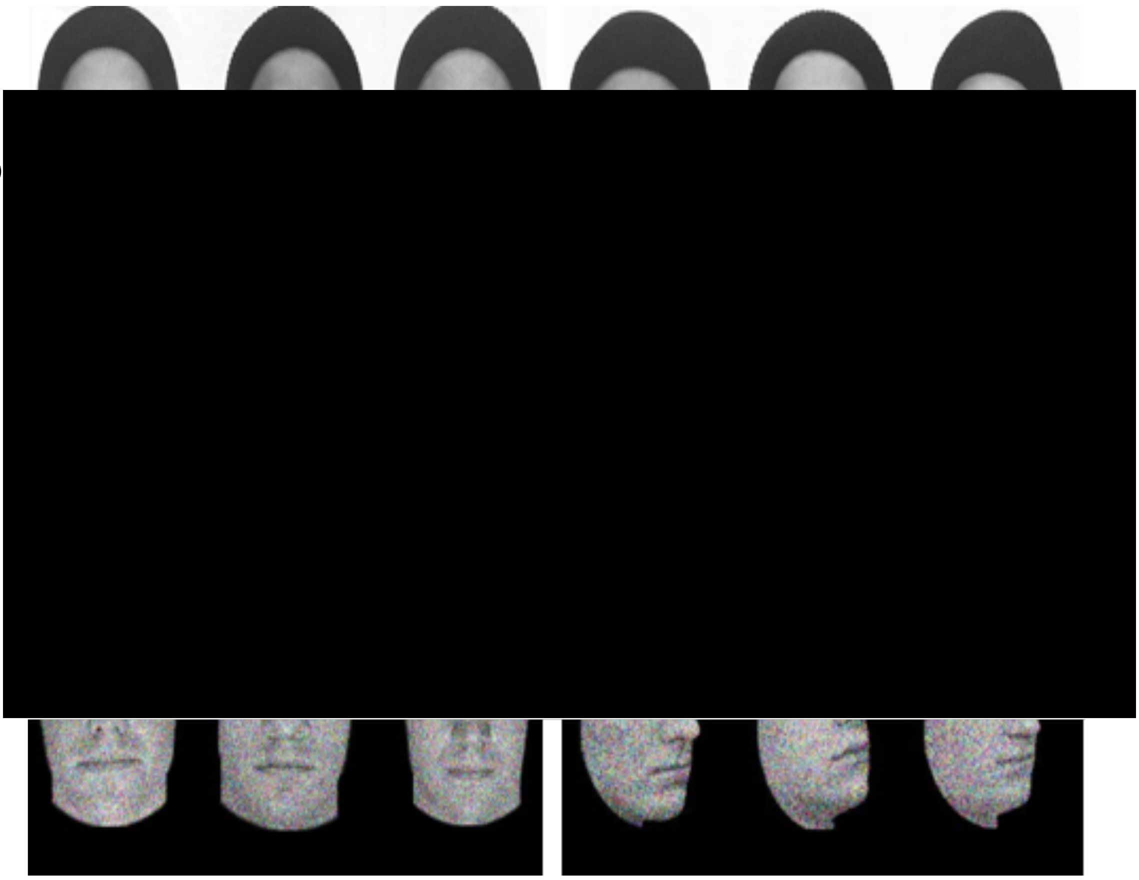
This block began with reviewing the 6 target images in frontal view for 20 seconds on one screen. After reviewing the images, following the same procedure participants were presented with 30 forced-choice trials (6 target faces x 5 presentations). Each target image was presented with distractor images similar to Stage 2.

Figure 4.4: Cambridge Face Memory Test (Duchaine & Nakayama, 2006)

(A)

(B)

(C)



Note: Image A represents the six target images. Image B shows an example of block 2 where the target face has to be selected from the distracters. Image C shows the novel noise images from which the target face has to be identified.

Table 4.3: CFMT block design

Block	Function	No of trials
1	Practice	3
2	Introduction/same images	18
3	Novel images	30
4	Novel images with noise	24

Novel images with noise:

Participants reviewed the 6 target faces in frontal view for 20 seconds before responding in this block. This block involved 24 test items (6 target faces x 4 presentations). The target and distractor images in this block consisted of Gaussian noise (see figure 4.4 image C for example). Systematic analysis using normal participants on face recognition tasks revealed that noise forces amplified the dependence of the special mechanisms that facial recognition normally depends on (McKone, Martini, & Nakayama, 2001). After completing these 4 blocks, accuracy for stages 2, 3 and 4 was calculated. A total score was generated from these 3 blocks. A maximum score of 72 can be achieved in the CFMT.

4.3.7 Emotion Matching Task (100 Item Matching Task)

As discussed earlier, we sought to determine whether individual variation on face emotion processing may be linked to a variation on our implicit face trait tasks. In this case, we used a well-established emotion recognition paradigm (Palermo et al., 2013).

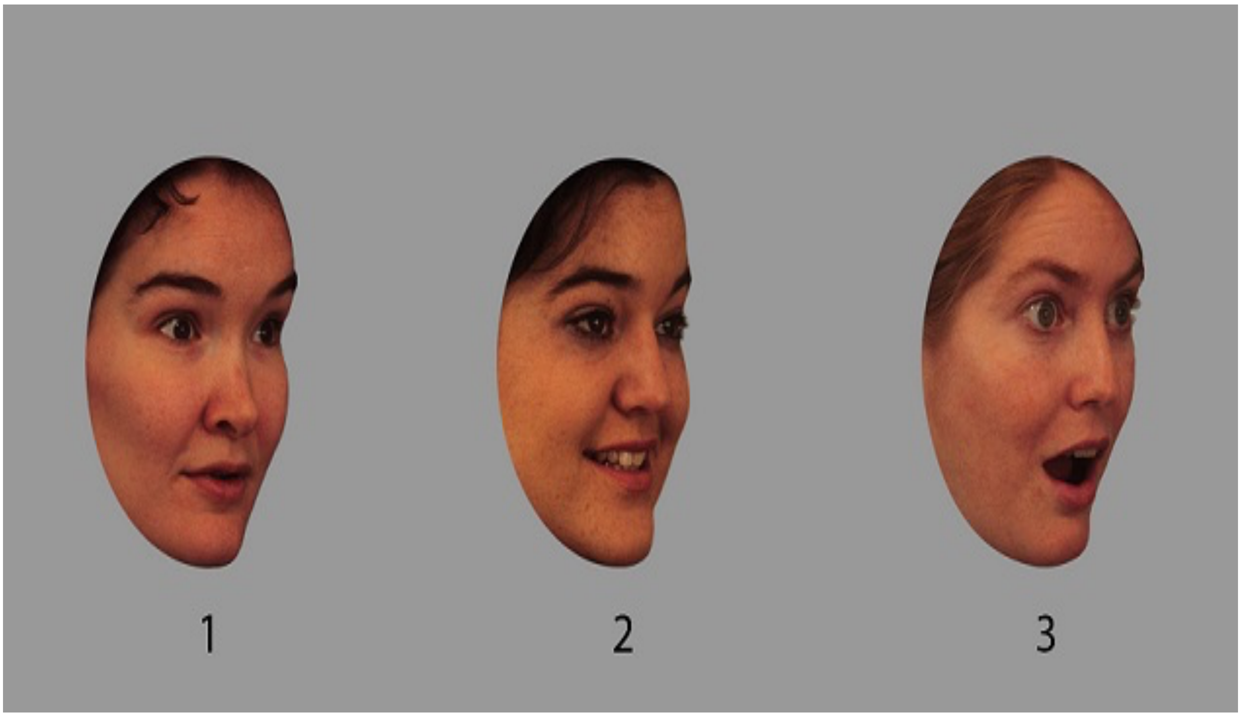
Emotion Matching Task (Palermo et al., 2013) was designed to identify whether individual differences in facial expression perception in non-clinical populations can be made (Cronbach's alpha = .77). We used the *100-item emotion matching task* described in Palermo et al., (2013).

Stimuli

Stimuli were obtained from the original study by Palermo et al (2013). The images used in this study were selected from Karolinska Directed Emotional Faces Database (KDEF; Lundqvist, Flykt & Öhman, 1998) which comprised of full-colour images of Caucasian males and females portraying six basic emotions (fear, anger, disgust, happy, surprise and sad) in either front profile, left profile or right profile angles. These full-face images were enclosed in an elliptical grey oval with hair excluded (See figure 4.5).

Participants were presented with 5 blocks of 20 trials each. Within each trial, there were three images depicting facial expressions. Each target face appeared in a triad with two other distractor faces. The faces portrayed two similar emotions and one different emotion that is commonly confused with the other emotion. The images used emotions such as fear, anger, disgust, happy, surprise and sad. The images were paired with emotions that are commonly confused for example happiness and surprise (See figure 4.5 for an example).

Figure 4.5: Emotion matching task



Note: Showing an example of the task in right profile angle with faces portraying happiness and surprise emotion - the correct 'odd one out' response here would be 3.

Procedure

Participants were presented with a general task description. The task required the participants to choose the 'odd one out' of emotions from the images by using keyboard response 1, 2 or 3 keys. Each trial was presented for 4500ms after which the images disappeared and there was an additional window of 7000ms to enter a response. If the response was not entered within this time frame, the response was recorded as 'timeout'. After completing each block, participants were allowed to take a short break before moving on to the next block. Accuracy for each block was calculated.

4.4. Analysis procedure

All the questionnaires and tasks described above were analysed using python software using the following steps.

AQ scoring: AQ is comprised of 50 questions with 10 questions per subscale. Item numbers 1, 2, 4, 5, 6, 7, 9, 12, 13, 16, 18, 19, 20, 21, 22, 23, 26, 33, 35, 39, 41, 42, 43, 45, 46 scored 1 point if the responses were "definitely agree" or "slightly agree". Responses "definitely disagree" or "slightly disagree" scored 1 point on the following items: 3, 8, 10, 11, 14, 15, 17, 24, 25, 27, 28, 29, 30, 31, 32, 34, 36, 37, 38, 40, 44, 47, 48, 49, 50. Participants scoring a total score above 32 was considered as individuals with high AQ. The sub-scales for the AQ were also included for all participants.

TAS scoring: The TAS20 has a straightforward scoring method. Item numbers 4, 5, 10, 18, 19 are reverse scored (i.e., response 1 is scored 5, 2 = 4, 3 = 3, 4 = 2, 5 = 1). Individuals with a total score above 61 were classified as individuals with high alexithymia, a score below 51 was low alexithymia. Sub-scales were also calculated based on the scoring key.

CFMT and Emotion Task: Excluding the practice task, total correct responses were calculated for the test blocks in both CFMT (maximum score – 72) and emotion matching task (maximum score – 100).

IAT: The IAT measures the extent to which implicit automatic associations can be made. The IAT effect is based on reaction times obtained from four trials which consist of four test blocks comparing the congruent and incongruent blocks. Using the improved scoring algorithm (Greenwald, Nosek & Banaji, 2003), latencies from these four blocks were converted to D scores.

Table 4.4: IAT D score calculation based on the improved IAT scoring algorithm (Greenwald et al., 2003)

Step	Improved Algorithm
1	Use data from B3, B4, B6, & B7
2	Eliminate trials with latencies > 10,000ms; eliminate subjects for whom more than 10% of trials have latency less than 300ms
3	Use all trials
4	No extreme-value treatment (beyond Step 2)
5	Compute mean of correct latencies for each block
6	Compute one pooled SD for all trials in B3 & B6; another for B4 & B7
7	Replace each error latency with block mean (computed in Step 5) + 600 ms
8	No transformation
9	Average the resulting values for each of the four blocks
10	Compute two differences: B6 - B3 and B7 - B4
11	Divide each difference by its associated pooled trials SD from Step 6
12	Average the two quotients from Step 11

See table 4.4 for the IAT scoring algorithm. The IAT D is a form of effect size measure similar to that of Cohens *d* (Cohen, 1977), that compares the reaction time latency across congruent and incongruent conditions where bias is marked for longer latency responses in incongruent conditions over congruent conditions. Calculating the difference between means and dividing by standard deviation is similar to that of Cohen's *d* effect size calculation. Whereas, for the IAT D, the standard deviation is computed from the scores of both congruent and incongruent conditions (pooled standard deviation). To reiterate from earlier, when participants make errors on any given trial, they were required to make a correct response instead of replacing each error latency with block mean as described in step 7 from the scoring algorithm described in table 4.4, the additional time taken to correct the response was added to the initial reaction time as error latency i.e. error trials were included in the analysis by including latencies between stimulus presentation and correct response which is a built-in error penalty (Back et al., 2009; Jones et al., 2019) The typical finding reported for the IAT is that individuals tend to be quicker and respond faster in congruent conditions compared to incongruent conditions. As such, reaction times can be utilised to measure the strength of association between the presented stimuli and implicit attitudes of the participant. Hence, accuracy is measured based on whether there is a bias towards congruent over the incongruent face-word association.

4.5 Statistical analysis

The results section for each of the empirical Chapters reports both Bayesian and frequentist statistical methods. We have mainly reported both statistical methods for 'one sample t-tests' for the IAT in order to calculate the ability to detect an association in the IAT by calculating bias significantly greater than zero in a one-sample *t*-test. Data was analysed using independent *t*-tests, bivariate correlations and multiple linear regressions (using the enter method) for all the measures used within our studies. The main aims of this thesis was to identify whether trait judgements can be predicted by cognitive factors such as autism traits, alexithymia traits, face memory and emotion perception abilities. As such, the multiple linear regression was the most appropriate statistical analysis to estimate the strength of the relationship between the dependent variable (personality traits), and the predictor variables (autism traits, alexithymia traits, face memory and emotion recognition). This enables us to calculate the amount of variance in the dependent variable that can be explained by variation in each of the predictor variables. It also shows the relative importance of each predictor variable to the dependent variable (Petchko et al., 2018). Bonferroni's correction was applied to correlational analysis with multiple comparisons that involved more than five comparisons (Curtin, & Schulz,1998). All the statistical analysis was carried out using JASP and SPSS (IBM Corp). Given that Bayesian analysis is not understood widely and is not a common approach for standard statistical approach employed in the field of Psychology, we have provided some additional information regarding the Bayesian analysis used in this thesis.

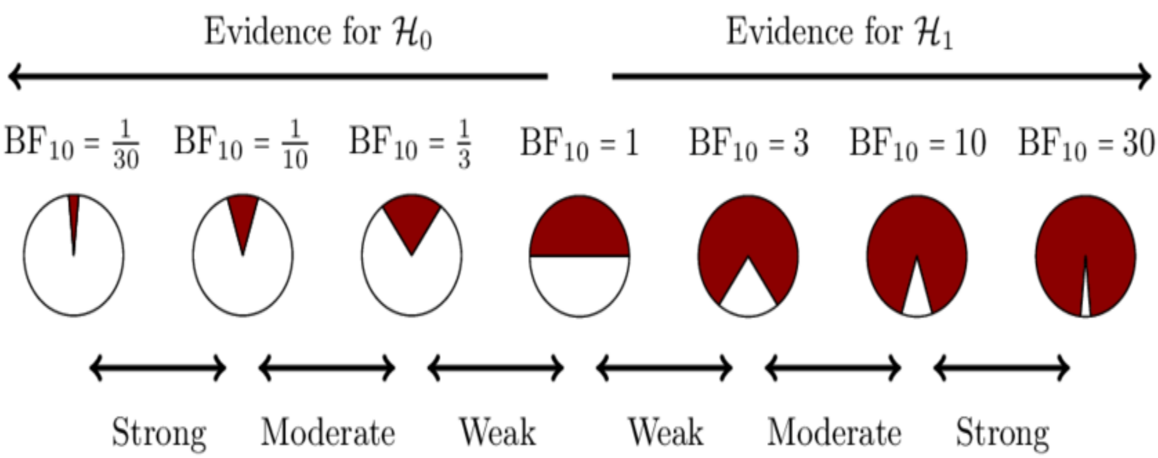
Bayesian analysis: Bayesian analysis is reported as a Bayes Factor (BF) that reports the chances of the alternative hypothesis being reported likely over the null hypothesis (e.g., $BF_{10} = 3$ represents that alternative hypothesis is thrice more likely as the null). Table 4.5 shows the Bayes factor interpretation used to infer whether the evidence from data points is favouring either the null or alterative hypothesis (e.g., Dienes, 2014; Lee & Wagenmaker, 2014). We have mainly included Bayesian effect size distributions where there is a power issue, one-sample t-tests, independent t-tests, and Bayesian correlations for null-hypothesis testing (Dienes, 2014; Doorn et al., 2019; Keysers, Gazzola, & Wagenmakers, 2020; Schönbrodt, & Wagenmakers, 2017;

Quintana & Williams, 2018). For a graphical representation of the Bayes factor see Figure 4.6. When the BF deviates from 1 (indicating equal support favouring alternative or null hypothesis), more support would favour alternative or null hypothesis. In the figure below, BF is represented in probability wheels where the ratio represented in white is in support of the null hypothesis H_0, and the ratio represented in red supports the alternative hypothesis H_1.

Table 4.5: Bayes factor inferences

BF_{01} in support of the null hypothesis		BF_{10} in support of the null hypothesis
1 – 1/3	Anecdotal evidence	1-3
1/3 – 1/10	Moderate evidence	3 - 10
1/10 – 1/30	Strong evidence	10 – 30
1/30 – 1/100	Very strong evidence	30 – 100
<1/100	Extreme evidence	>100

Figure 4.6: Graphical representation of Bayes Factors



Outliers: Within the experimental chapters of this thesis, participants who identified as other-ethnicity participants were excluded from Chapters 5, 6, 7 and 10. This was to avoid other-ethnicity effects (e.g., Young et al., 2012). In order to extend our findings to the overall general population, we have not removed any outliers in our studies, and hence considering inclusions for the variability across samples. However, excluding individuals scoring high on measures such as AQ, and TAS20 did not change the findings reported in our empirical chapters, and hence we did not remove any participant from our studies.

4.6 Conclusion

Using the methodologies explained in this chapter, the following empirical chapters explore implicit associations of extraversion, agreeableness and neuroticism personality traits and their relationship with autism, alexithymia, facial memory, and emotion perception among younger adults.

Chapter V

Extraversion trait judgements among young adults and individuals with Developmental Prosopagnosia

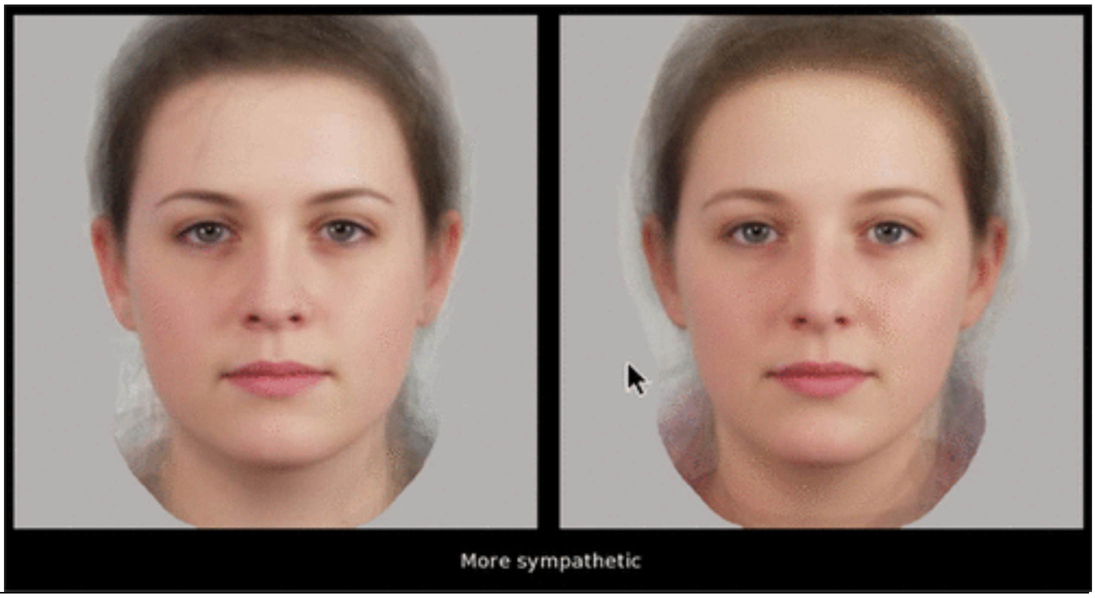
5.1 Introduction

In the earlier chapters, we established that a key test of face-based recognition memory (CFMT) and various proxy tests variability in emotion processing performance (Emotion matching task) will be used to see if either is linked to individual variability on our key test of face-based trait judgement (IAT). This is to determine if there is any overlap between these key processes and the process that must underpin face-based extraversion trait judgement ability – or whether the latter reflects some form of independent process. As such, the current chapter aims to explore whether accurate implicit extraversion personality traits as a factor is related to autism traits, alexithymia traits, facial memory and emotion perception using an individual differences approach.

5.1.1 Can you predict extroversion personality traits implicitly from faces?

Face recognition is a vital skill used in identifying people we interact with in our day-to-day life. A human face reveals many different kinds of information to the observer. Primarily it allows us to identify individuals, but it can also provide information about mood, intention and attentiveness (Baron, 1979; Ellis, 1975, 1981). Research suggests that static features of the face are equally expressive which provides information about sex hormone levels predicting dominance traits in males (Swaddle & Reierson, 2002) and sociosexual orientation (Boothroyd et al., 2007). As we have established earlier, several studies have demonstrated that various other personality trait judgements can also be made from faces (Little & Perrett, 2007; Penton-Voak et al., 2006). Research by Kramer and Ward (2010) indicated that accurate judgements of personality characteristics can be made from faces, for example, judgement of extroversion personality trait, when asked to select from two composite faces (one of

Figure 5.1: Showing discrimination task using composite images by Kramer and Ward (2010)



Note: In this task, participants were explicitly asked to select on the image that appeared more sympathetic.

which are an aggregated group of extroverted people and another from a group of introverted people) where the task involved selecting the face that better matched the discrimination statement (See figure 5.1 above for example). The study concluded that four of the Big Five traits (except conscientiousness) and physical health can be accurately differentiated based on internal facial features.

Using a modified form of the Implicit Association Task (IAT), Jones, Ward and Tree (2019) conducted a study on automatic trait associations using composite facial stimuli for extroversion and agreeableness personality traits. The findings of their study revealed that extraversion and agreeableness personality traits can be automatically and accurately inferred from composite facial stimuli. The use of composite faces has the advantage that non-facial cues and other idiosyncratic characteristics are eliminated, meaning that personality judgements are based upon generalised properties of the presented faces. On this basis, the current study sought to extend this work in a number of keyways. Firstly, using the same IAT paradigm we sought to determine if similar automatic trait judgements can be made from faces for extraversion trait judgements in young adults replicating previous findings. Secondly, we measured the relationship between trait judgements and other cognitive and behavioural factors.

Additionally, given it has already been established that implicit automatic extraversion trait judgements are available from faces in non-clinical populations, the experiments in this chapter also seek to ask the question of whether individuals with face processing deficits perform similarly in their face trait judgements. As such, in the next session, we have considered individuals with Developmental Prosopagnosia.

5.1.2 How do individuals with face processing deficits identify personality from faces?

Testing of individual differences indicates that face recognition abilities can be exceptionally good (super recognizers) or extremely poor in neurologically intact individuals (Developmental Prosopagnosics; Duchaine & Nakayama., 2006; Russell et al., 2009). The composite effect of holistic face processing involves pairing identical top half of faces with the non-identical bottom half and identical top half with the misaligned bottom half (Hole, 1994; Rossion, 2008; Young et al., 1987). Studies have demonstrated that individuals with DP report difficulties in identifying faces when the facial stimuli presented are vertically aligned as compared to when the faces were misaligned (e.g., McKone, 2008). Using holistic face processing approaches, research indicates that individuals with DP show severe impairment in face identity recognition (Bate et al., 2012; Duchaine & Nakayama, 2006; Palermo et al., 2010) and holistic processing of both identity and emotion perception (Palermo et al., 2011). However, researchers have also implied that holistic processing is not necessary to form trait judgements (Kramer & Ward, 2010). Furthermore, Todorov et al., (2007) have suggested that incomplete facial information is sufficient to form trait judgements of trustworthiness. Similarly, another study using DP candidates has suggested that it is plausible for DPs to form trait judgements of trustworthiness and attractiveness similar to neurologically intact individuals (e.g., Rezlescu et al., 2014; Todorov & Duchaine, 2008). Similarly, Knutson et al., (2011) using a single case study has suggested that it is possible for DPs to show social IAT effects.

Moreover, it is well known that there is a strong association between facial identity and emotion recognition (e.g., Gobbini & Haxby, 2007; Palermo et al., 2013). While findings on emotion recognition abilities among DPs are mixed (for contrast see Biotti & Cook, 2016; Lee et al., 2010), a large number of studies have suggested that identity recognition and emotion perception abilities are unrelated in DPs (Duchaine, Parker, & Nakayama, 2003; Hymphreys, Avidan, & Behrmann, 2007). Given that majority of the findings suggest these two cognitive abilities are likely dissociable; similarly, it is also plausible that trait judgements are dissociable among DPs similar to emotional expression abilities.

Taken together, in the current Chapter we undertook two behavioural studies measuring implicit personality judgements of extraversion. These studies will be the first to explore two key areas Experiment 1a) replicating the results of Jones et al., (2019) and whether other cognitive and behavioural factors such as autism traits, alexithymia traits, facial memory and emotion perception can predict performance on our extraversion IAT task; Experiment 1b) Can individuals at the limits of face processing ability (i.e., those with impairments) infer personality from facial features, and thus can their performance illuminate the mechanisms that underpin such ability?

5.2 Experiment 1a: Extraversion personality trait judgements in young adults

This study aimed to explore whether implicit associations of extraversion personality traits can be made from faces and their relationships with other cognitive and behavioural factors such as facial memory, emotion perception, autism traits and alexithymia traits.

5.2.1 Method:

This study followed the experimental structure outlined in the general methods section (see Chapter 4, pg. 69). Questionnaires measuring autism quotient (AQ) and alexithymia traits (TAS-20) were presented. Those were followed by a novel version of the extraversion IAT, a standard upright version of the CFMT and an Emotion matching task with a time limit. We used facial composite images of Caucasian young women (age M = 21.03, SD = 1.94) portraying neutral emotion who possessed high and low scores on extraversion personality traits. Using a within-group research design, participants (n = 118, age M = 23.50, SD = 4.79; 68 females, 50 male) were recruited using prolific.ac and Swansea University participant pool. Participants were compensated £3 or course credits, respectively, for their participation. Participants who signed up to take part in our study through the participant pool came to the Face research lab Swansea to take part in the study. This process also helped us to measure consistency in data quality for both lab and online data. Of the 118 participants, 7 scored high on the AQ scale (AQ score of $\geq$ 32) and 27 participants scored high on the TAS-20 scale (TAS-20 score of $\geq$ 61). To control for a possible other-ethnicity effect, this study only included Caucasian young adult population (age range 18-35).

See table 5.2.1 for descriptive statistics. No exclusions were made to the young adult group based on high autism traits, high alexithymia traits, poor face memory and poor face emotion recognition to include the variability across the general population to incorporate individual differences. However, excluding participants did not change the findings reported below (refer to Appendix A, pg. 303 for analysis excluding individuals scoring high on AQ and TAS scales; 2SDs below the mean for CFMT and Emotion task). All participants had normal or corrected-to-normal vision, reported no history of neurological or psychiatric disorders, and provided signed consent prior to participation.

Table 5.2.1: Descriptive statistics for performances of young adults on extraversion IAT and other cognitive factors (N = 118)

	Mean	**Std. Deviation**	**Minimum**	**Maximum**
Age	23.50	4.79	18	35
IAT D score	.125	.353	-.787	.971
AQ	19.09	8.46	4	45
TAS20	50.27	12.45	24	89
CFMT	53.18	9.50	34	72
Emotion task	67.86	7.42	42	86

Note: IAT D – extraversion implicit personality, other cognitive factors: AQ – Autism traits, TAS20- alexithymia traits, CFMT – face memory, Emotion task – emotion perception.

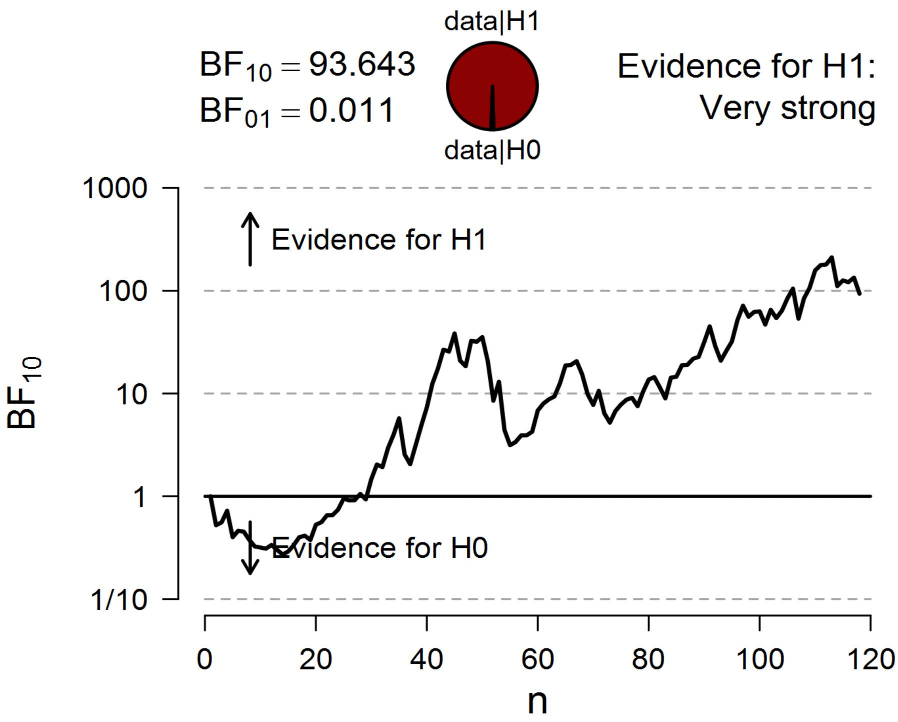
5.2.2 Results and Discussion:

5.2.2.1 Are young adults able to form accurate implicit judgements of extraversion personality traits?

The reaction time data obtained from the extraversion IAT was converted into IAT D scores using python codes following the scoring algorithm (Greenwald, Nosek & Banaji, 2003) detailed in the general methods section in Chapter 4 (pg. 71). It was ensured that there were approximately equal number of participants in both conditions, congruent then incongruent ($N = 56$, $M = .177$, $SD = .358$); incongruent then congruent ($N = 62$, $M = .078$, $SD = .345$).

A one-sample t-test against chance (zero) was conducted to identify whether there was a significant relationship between faces and personality trait words. The results revealed that the young adults were able to make accurate implicit personality trait judgements from faces, Extraversion $IAT\ D = 0.13$ ($SD = .35$), 95% CI [.06, .19] $t\ (117) = 3.85$, $p <. 001$, $d = .354$. Participants were faster and more accurate on trials where highly extraverted faces were paired with highly extraverted words, and on trials where highly introverted faces were paired with highly introverted words. These results are consistent with previous literature that extraversion personality can be judged accurately and implicitly from facial structure (Jones et al., 2019; Kramer & Ward, 2010). Furthermore, a Bayesian alternative was also considered for the IAT scores. A Bayesian one-sample t-test revealed that these results strongly evidence the alternative hypothesis with $BF_{10} = 93.64$, this also supports the results of the frequentist method. Figure 5.2.1 shows the sequential analysis of the Bayesian approach.

Figure 5.2.1: Bayesian sequential analysis for young adults extraversion IAT



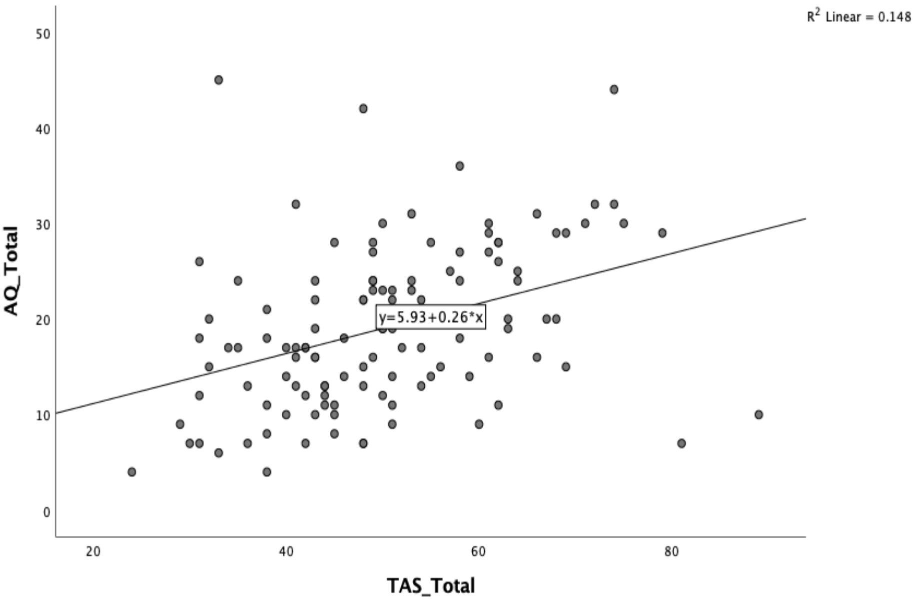
Note. The trend line represents the degree of evidence in favour of the alternate hypothesis (above the line for alternative hypothesis H1 and below the line for null hypothesis H0).

5.2.2.2 Correlational analysis between measures

A two-tailed Spearman's correlation was conducted to explore the relationship between implicit extraversion trait judgements (Extraversion IAT), autism traits (AQ and subscales), alexithymia traits (TAS20 and subscales), facial memory (CFMT) and emotion perception (Emotion matching task).

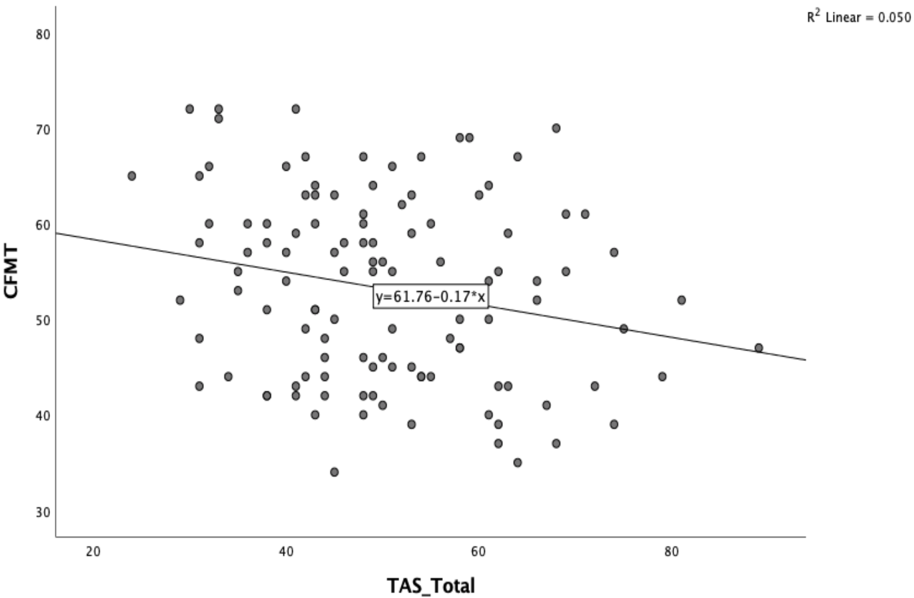
The results of Spearman's rho indicated a positive association between AQ and TAS scales (*rs* (117) = .439, $p < .001$), where high autism traits were associated with high alexithymia traits (See figure 5.2.2), and these findings are also supported by previous work (e.g., Bird & Cook, 2013; Cook, Brewer & Shah, 2013); a significant negative correlation between TAS and CFMT (*rs* (117) = -.205, $p = .026$), where low alexithymia traits were associated with high accuracy for facial memory (See figure 5.2.3); similarly, there were negative associations between TAS20 subscale – externally oriented thinking and CFMT (*rs* (117) = -.212, *p* = .021), and difficulty identifying feelings and CFMT (*rs* (117) = -.188, *p* = .042), where high scores indicating difficulties in externally oriented thinking and identifying feelings were associated with poor facial memory recognition. However, after applying Bonferroni's corrections and considering Bayesian correlations, these associations were non-significant. There was a significant positive association between the CFMT and Emotion tasks (*rs* (117) = .338, *p* < .001), where high accuracy for facial memory was associated with high accuracy for emotion perception (e.g., Franklin & Adams, 2010; Palermo et al., 2013; see figure 5.2.4). All other correlations were non-significant after applying Bonferroni's corrections and Bayesian correlations. Recent studies suggest that there is no evident relationship between most Big-Five personality traits and facial memory, however, there is evidence implying that there is a weak relationship between facial memory and extraversion personality trait in specific (Satchell et al., 2019). Contrary to this, the current study does not show any associations between implicit extraversion trait judgements and facial memory.

Figure 5.2.2: Correlation plots for autism traits vs alexithymia traits among young adults



Note: Scatterplot for total scores on the AQ- autism and TAS20 - alexithymia scales.

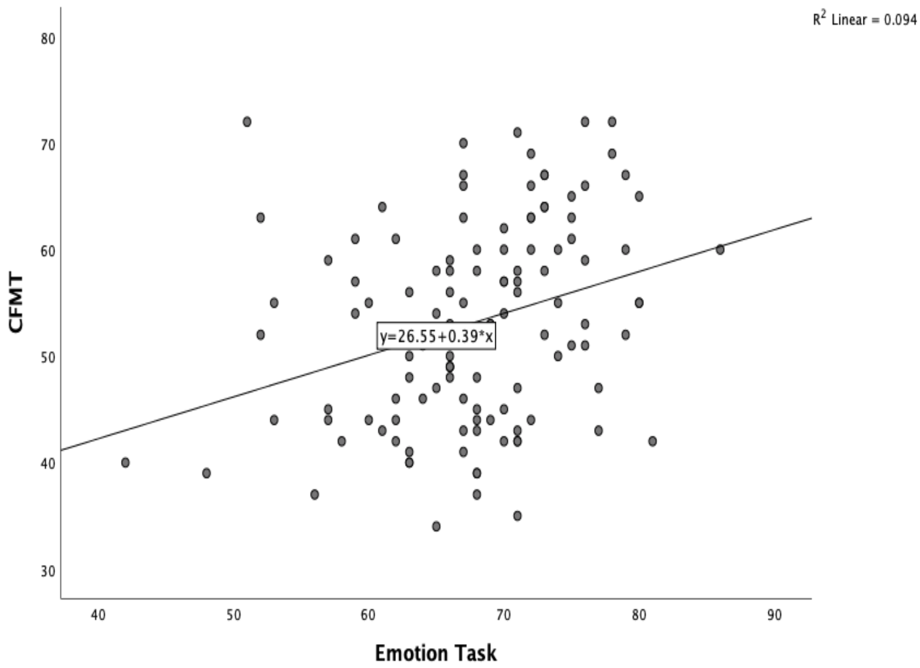
Figure 5.2 3: Correlation plots for alexithymia traits vs facial memory among young adults



Note: Scatterplot for total scores on TAS-alexithymia and CFMT- face memory

---

Figure 5.2.4: Correlation plots for facial memory vs emotion perception among young adults



Note: Scatterplot for total correct responses on CFMT- face memory, Emotion task – emotion perception

5.2.2.3 Regression analysis

A multiple linear regression analysis (using the enter method) was conducted to explore whether extraversion personality judgements was significantly predicted by autism quotient, alexithymia quotient, facial memory, or emotion perception. Tests for Multicollinearity were conducted by calculating the Variance of Inflation Factor (VIF) in SPSS. A rule was employed where VIF values < 10, were acceptable measures of Multicollinearity (Gordon, 2015; O'Brien, 2007). Given that for all variables VIF factors were < 2, as such all variables were included in the regression model.

Results of the linear regression indicated that there was no significant effect between IAT and AQ, TAS, CFMT and Emotion task (F (4, 113) = 2.272, p = .066, R^2 = .074). In sum, the regression analysis appears to indicate that the ability to identify

Table 5.2.2: Multiple Linear regression Analysis for young adults Extraversion IAT

	t	p	β	F	df	p
Model				2.272	4,113	0.066
AQ	-0.417	0.677	-0.041			
TAS20	-1.700	0.092	-0.170			
CFMT	-1.581	0.117	-0.153			
Emotion task	-1.594	0.114	-0.153			

Note: AQ – Autism traits, TAS20- alexithymia traits, CFMT – face memory, Emotion task – emotion perception.

personality from faces is independent of other factors such as autism traits, alexithymia traits, facial memory, and perception of facial expression (See table 5.2.2 above).

5.2.3 Summary of results of experiment 1a.

1) The findings of Experiment 1a replicated the findings of Jones et al (2019) where young adults were able to make accurate judgements of extraversion personality traits from faces. This ability was unrelated to other behavioural and cognitive factors such as autism traits, alexithymia traits, facial memory and emotion perception.

2) Correlational analysis between measures revealed certainly expected correlations in line with previous work such as the associations between autism and alexithymia traits (Cook et al., 2013); facial memory and emotion perception (e.g., Palermo et al., 2013). Some of the correlational effects reported are small and therefore additional data is required to support such findings. Similarly, additional data is required to support the non-significant associations after applying Bonferroni corrections.

5.3 Experiment 1b: Extraversion personality trait judgements among individuals with Developmental Prosopagnosia

Based on the findings of Experiment 1a, we further explored whether individuals at the limits of face recognition abilities were able to perform similar to the non-clinical young adult group (from experiment 1a) on the extraversion personality trait judgements. Given that the extraversion personality trait IAT was the most robust measure, here we used the same to identify how individuals with Developmental Prosopagnosia identify personality from faces and its relationship with autism traits, alexithymia traits, facial memory, and emotion perception.

5.3.1 Method

5.3.1.1 Background for screening individuals with Developmental Prosopagnosia

Inclusion criteria: All participants with prosopagnosia in this thesis suffer from developmental prosopagnosia (DP). None of the participants reported having any history of head injury or brain damage. Additionally, the participants also reported that they were not diagnosed with autism and dementia. While there is no single standardized diagnostic tool to measure prosopagnosia, tests measuring face perception (Cambridge Face Perception Test, CFPT), unfamiliar face recognition (Cambridge face memory test, CFMT), familiar face recognition (Famous Face Test, FFT) are largely classified as diagnostic tools for identifying DP. Additionally, the self-report Prosopagnosia Index-20 (PI20) measure was included; several studies have suggested that self-rating of DP should be supplemented by objective measures of face recognition mentioned above. Together these tests offer a theoretically driven assessment battery. Each of these measures is described in detail below.

The CFMT (Duchaine & Nakayama, 2005) remains to be one of the most widely used measures employed by prosopagnosia researchers (for detailed methodology see Chapter 4, section 4.3.6, pg. 79).

Cambridge face perception test (upright version; Duchaine et al., 2007): The CFPT is a standardised tool that measures face perception abilities. In each trial, participants are shown a target face along with 6 comparison images that appear similar in varying degrees to the target image. Participants arrange six facial images according to their similarity to the target image. On each trial, a ¾ view of the target image is presented above in frontal views in a random order. Participants had one minute to sort each set. The upright version of the task contained 8 trials. For each trial, the final matched order is scored by summing the deviations from the correct order (e.g., if a face is five places away from its proper place, it contributes 5 to the score). A score of 0 represents perfect performance, while the maximum possible score is 144. However, it should be noted that DP diagnosis is not completely reliant on the CFPT, however, performance on this task highlights the nature of the respective DP participants. For example, in some cases DP individuals typically performing poorly on the CFMT might score within the normal range in the CFPT; these cases can be considered as individuals suffering from face memory difficulties but not the perception of faces, as in the case of associative DP (e.g., DeRenzi et al., 1991; Fox et al., 2008; McNeil et al., 1993). However, in the current thesis participants possessing both memory and perceptual problems are included as DP cases.

Famous faces test (Bobak et al., 2017; Duchaine et al., 2007): The FFT is a measure widely used to gauge recognition memory deficits (e.g., Bate et al., 2014; Duchaine & Nakayama, 2005; Eimer et al., 2012). Two versions of the FFT was employed based on the participant's age range: one for adults 35 years and above, and another for younger adults (age range 18 – 34). Both versions of the FFT contained 60 images of celebrities each. These images were presented in a sequential randomised order without any time limit. A correct identification was scored by the participants ability to provide information about the celebrity's name or identifying biographical information about that person. If a participant was unable to identify a face, they were subsequently told who that person was after recording their response and asked if they have had previous exposure to that individual. Any celebrities that were unknown to each participant by name or biographical information were removed from the overall score and the percentage correct was adjusted accordingly.

Prosopagnosia Index (PI20; Shah et al., 2015): The PI20 is a highly valid 20 item self-report questionnaire designed to assess Prosopagnosic traits. Using a five-point Likert scale (strongly agree to strongly disagree), participants indicate the extent to which they agree or disagree on statements describing face recognition experiences. Fifteen statements are scored positively (i.e., strongly agree = 5, strongly disagree = 1), and five statements are reverse scored (i.e., strongly agree = 1, strongly disagree = 5). Total scores are calculated, and the DP classification is made based on the score ranges such as mild (65-74), moderate (75-84) and severe (85-100) impairments. It should be noted that the PI20 is used as a complementary diagnosis instrument rather than replacing the objective measures of face recognition abilities.

The current consensus of DP diagnosis is that an individual should demonstrate substantial impairment where individuals scoring 2 S.D.s below the control mean are categorised as DPs based on their lack of recognition abilities on at least 2 of the objective face tasks described above.

Exclusion Criteria: as explained earlier in the literature review (Pg. 48), an exclusion criteria for DP is to remove participants scoring high on the autism screening questionnaire. Individuals with autism also tend to exhibit face processing difficulties and these difficulties are reported based on their inability to possess sustained attention throughout life, and thus exhibiting difficulties in face processing. Evidence exploring the relationship between DP and autism have suggested that these two groups that predominantly exhibit difficulties in face processing and social dysfunction respectively, raises the possibility that these conditions co-occur in several cases (Minio-Paluello et al., 2020; Schultz, 2005). As such, it has been suggested that DP should be viewed as a disorder with face recognition difficulties independent of socio-emotional difficulties such as autism (e.g., Bate & Tree, 2017; Duchaine et al., 2009). Thus, we have excluded any participant scoring higher than 32 on the autism screening questionnaire (Baron-Cohen et al., 2001) from the current analysis. See table 5.3.1 for descriptive statistics on the neurological testing battery.

Table 5.3.1: Developmental prosopagnosia scores on the neuropsychological testing battery (N=36)

	Mean	**Std. Deviation**	**Minimum**	**Maximum**
Age	53	14.40	18	81
CFMT	33.11	4.86	24	43
CFPT	27.72	4.44	20.67	36.67
FFT	44.73	15.39	15.39	70
PI20	80.44	7.44	61	92
AQ	18	6.97	4	31

Note: CFMT – face memory, CFPT – face perception, FFT- famous face test, PI20 – prosopagnosia index, AQ – Autism traits.

Procedure: A web link was created using Gorilla software for Psychology (Evershed et al., 2018) and sent to participants who consented to take part in the study. We contacted over 100 participants who were diagnosed with Developmental Prosopagnosia from the Face research Swansea group. However, only a total of 51 participants responded to the request to complete face-based tasks employed within this experiment and thus resulting in a varied age range. The weblink contained the autism measure, alexithymia measure, extraversion implicit association task, and emotion matching task. Full details of the DP performance on the neuropsychological battery are provided in the appendix (Appendix B, pg. 303). Also please refer to Appendix C (pg. 305) for extraversion IAT performance of DPs split by age range. It is of note that splitting by age range did not produce an IAT effect given the small sample size.

Out of the 51 participants, 15 participants scored high on the AQ scale (AQ score of ≥ 32) and 14 participants scored high on the TAS-20 scale (TAS-20 score of ≥ 61). Upon further review, participants scoring high on the AQ scale were excluded from the study. After all exclusions, a final sample size of the DP group was thirty-six (26 Female: age range 18 - 81, age M = 53, SD = 14.39). To control for a possible other-ethnicity effect, this study only recruited a Caucasian sample. See Table 5.3.2 for descriptive statistics showing DP group performances on the tasks employed in this study: personality traits (IAT), autism traits (AQ), alexithymia traits (TAS), face memory (CFMT) and emotion perception.

Table 5.3.2: Descriptive Statistics for DP group performance on the extraversion IAT and other cognitive factors (n = 36)

	Mean	**Std. Deviation**	**Minimum**	**Maximum**
Age	53	14.40	18	81
IAT D score	.156	.354	-.538	.886
AQ	18	6.97	4	31
TAS20	44.33	10.56	22	65
CFMT	33.11	4.86	24	43
Emotion task	67.78	9.29	38	82

Note: IAT D – extraversion implicit personality, other cognitive factors AQ – Autism traits, TAS20- alexithymia traits, CFMT – face memory, Emotion task – emotion perception.

This study followed the same experimental procedure and stimuli from Experiment 1a. Although previous studies have demonstrated that DP participants portray emotion perception abilities similar to control subjects (e.g., Palermo et al., 2011), due to the variability in the age range included in our study, we did not include a time limit in the emotion matching task.

100 item Emotion-matching task (*Palermo et al., 2013*): this task involves identifying the odd emotion presented from faces displaying two similar emotions and one dissimilar emotion (e.g., one happy and two surprised faces). In the original task (See Chapter 4 for detailed procedure), a 4500ms timer was included for image presentation after which the image disappears and there is an additional time window of 7000ms to make responses. If the participants are unable to make responses within this time frame, the response is encoded as ''timed out''. Several researchers have demonstrated that older adults take longer to process information and report age-related motor decline compared to younger adults (e.g., Smailes et al., 2019; Zebrowitz et al., 2013). Initially, we conducted a pilot study examining whether older adults are able to complete the task efficiently with the timer but several blocks within the task were timed out for older adults. Hence, for a better quality of results, we have excluded the timer in the emotion matching task for DP participants.

5.3.2 Results and discussion

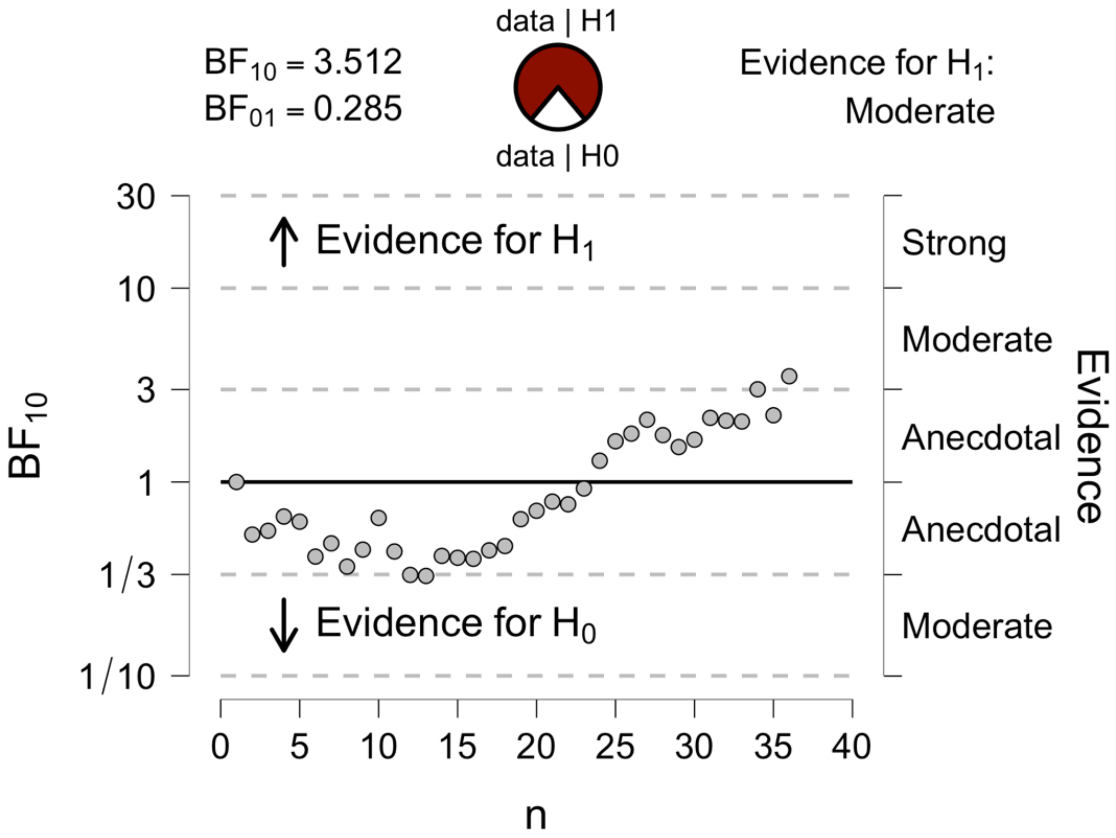
5.3.2.1 How do individuals with developmental prosopagnosia perform on face-based implicit extraversion trait judgements?

The reaction time data obtained from the extraversion IAT was converted into IAT D scores using python codes following the scoring algorithm (Greenwald, Nosek & Banaji, 2003) detailed in the general methods section in Chapter 4. There were equal number of participants in both conditions, congruent then incongruent (N = 18, M = .127, SD = .44); incongruent then congruent (N = 18, M = .185, SD = .257).

A one-sample t-test against zero was conducted to identify whether there was a significant relationship between extraversion composite faces and personality trait words. The results revealed that the DP sample were able to make accurate implicit personality trait judgements from faces, extraversion $IAT\ D$ = .156 (SD = .35), 95% CI [.36, .28] t (35) = 2.635, $p < .05$, d = .439. Participants were faster and more accurate on trials where highly extraverted faces were paired with highly extraverted words, and on trials where highly introverted faces were paired with highly introverted words. A Bayesian approach was also considered given the small sample size. A Bayesian one-sample t-test revealed moderate evidence for the alternative hypothesis with BF_{10}

= 3.51, supporting the results of the frequentist approach. See figure 5.3.1 above for Bayesian sequential analysis.

Figure 5.3.1: Bayesian sequential analysis for Extraversion IAT among DPs



Note. The trend line represents the degree of evidence in favour of the alternative hypothesis (above the line for alternative hypothesis H_1 and below the line for null hypothesis H_0).

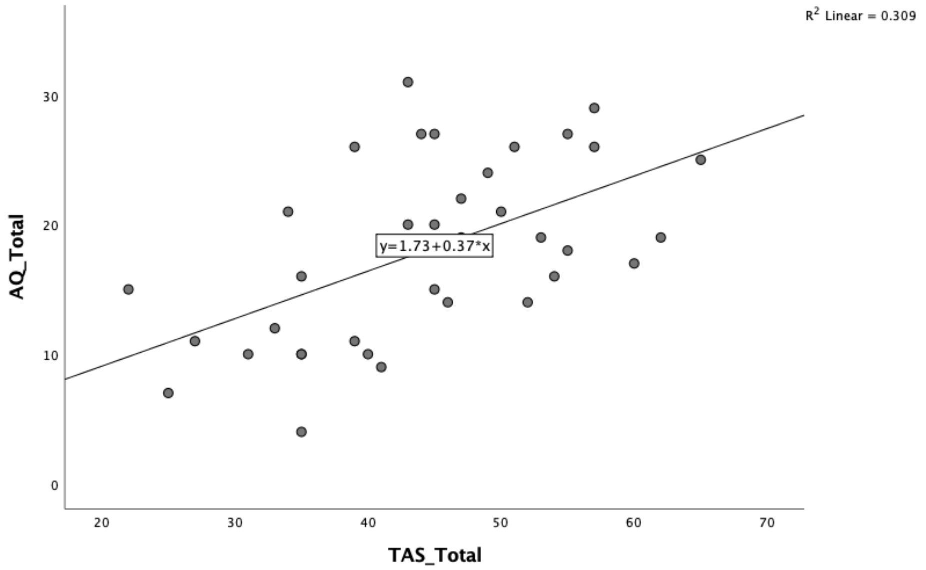
5.3.2.2 Correlational analyses between measures

A two-tailed Spearman's correlation was conducted on the DP sample to explore the associations between age, implicit extraversion trait judgements (IAT), autism traits (AQ and subscales), alexithymia traits (TAS20 and subscales), facial memory (CFMT) and emotion matching task.

The results of Spearman's rho indicated that there was no relationship between DP extraversion IAT performance and other cognitive and behavioural factors, or age and other cognitive and behavioural factors within the DP group. There was a positive association between AQ and TAS scales (r_s (35) = .542, p<.001), where high autism scores were associated with high alexithymia scores (e.g., Bird & Cook, 2013; Cook, Brewer & Shah, 2013; see figure 5.3.2); a significant negative association between AQ subscale - imagination and emotion task (r_s (35) = -.589, p <.001), where low scores on the AQ subscale-imagination was associated with an increase in emotion perception accuracy (See figure 5.3.3).

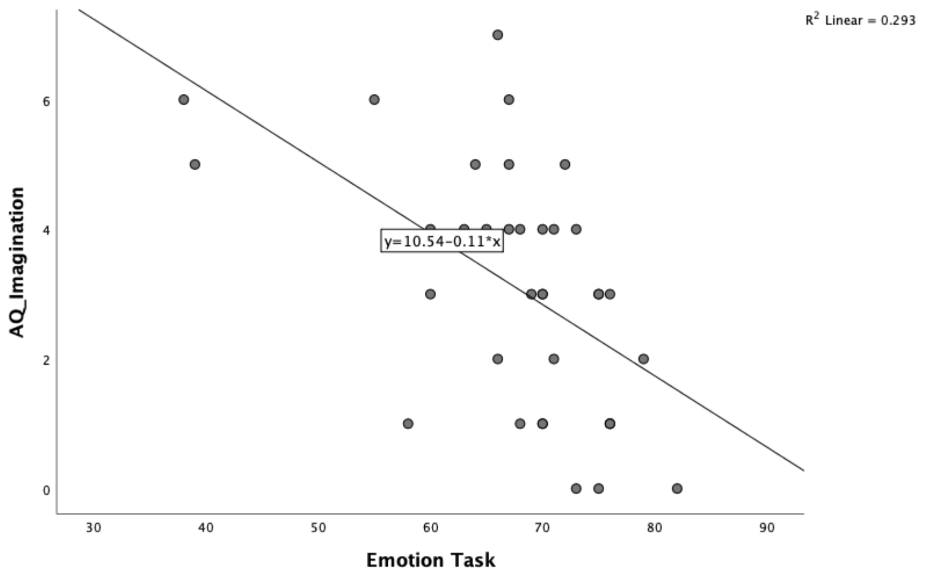
A significant negative association was reported for AQ subscale – attention switch and CFMT (r_s (35) = -.392, p = .018), where difficulties in attention switching tendencies in autism were associated with poor face memory (e.g., Davies et al., 2017; Lewis et al., 2018; Rhodes et al., 2013; Sasson et al., 2013). However, after applying Bonferroni's correction and considering Bayesian correlations these associations were non-significant.

Figure 5.3.2: Correlations between autism and alexithymia traits among DP groups



Note: Scatterplot for total scores on the AQ- autism and TAS20 - alexithymia scales.

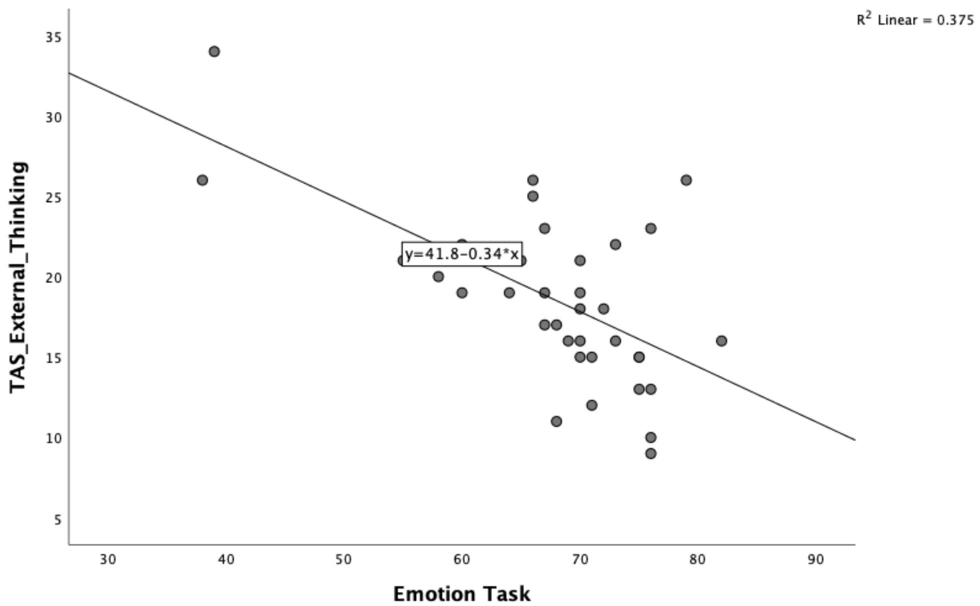
Figure 5.3.3: Correlations between AQ imagination traits and emotion recognition among DPs



Note: Scatterplot for total scores on the AQ- subscale imagination and Emotion task – emotion perception.

Furthermore, there was a significant negative correlation between TAS20 scores and the Emotion Task (*rs* (35) = -.394, *p* = .17), where high alexithymia scores were associated with poor emotion perception. However, after applying Bonferroni's correction this association was non-significant; a significant negative association was reported for TAS20 subscale - externally oriented thinking and emotion perception (*rs* (35) = -.539, *p* <.001), where low scores on the subscale were associated with better accuracy for emotion perception (See figure 5.3.4). Similarly, there was a negative association between TAS subscale - difficulty describing feelings (*rs* (35) = -.352, *p* = .035) and emotion perception. After applying Bonferroni's correction and using Bayesian correlations, this association was non-significant. All other correlations were non-significant.

Figure 5.3.4: Correlations between TAS externally oriented thinking and emotion recognition among DPs



Note: Scatterplot for total scores on the alexithymia subscale- externally oriented thinking and emotion task – emotion perception.

5.3.2.3 Multiple Linear regression analysis

A multiple linear regression analysis (using the enter method) was conducted to identify whether extraversion personality trait judgements were significantly predicted by age, autism quotient, alexithymia quotient, facial memory, face perception and emotion perception. Tests for Multicollinearity were conducted by calculating the Variance of Inflation Factor (VIF) in SPSS. A rule was employed where VIF values < 10, were acceptable measures of Multicollinearity (Gordon, 2015; O'Brien, 2007). Given that for all variables VIF factors were < 2, as such all variables were included in the regression model.

Results of the linear regression indicated that there was no significant relationship between IAT and age, AQ, TAS or the CFMT and Emotion task (F (6, 29) = .445, p = .84, R^2 =.084). Regression analyses thus indicate that the ability to identify personality from faces is independent of other factors such as autism traits, alexithymia traits, facial memory and facial expression perception abilities (See table 5.3.3).

Table 5.3.3: Linear Regression analysis for Extraversion IAT performances of DP

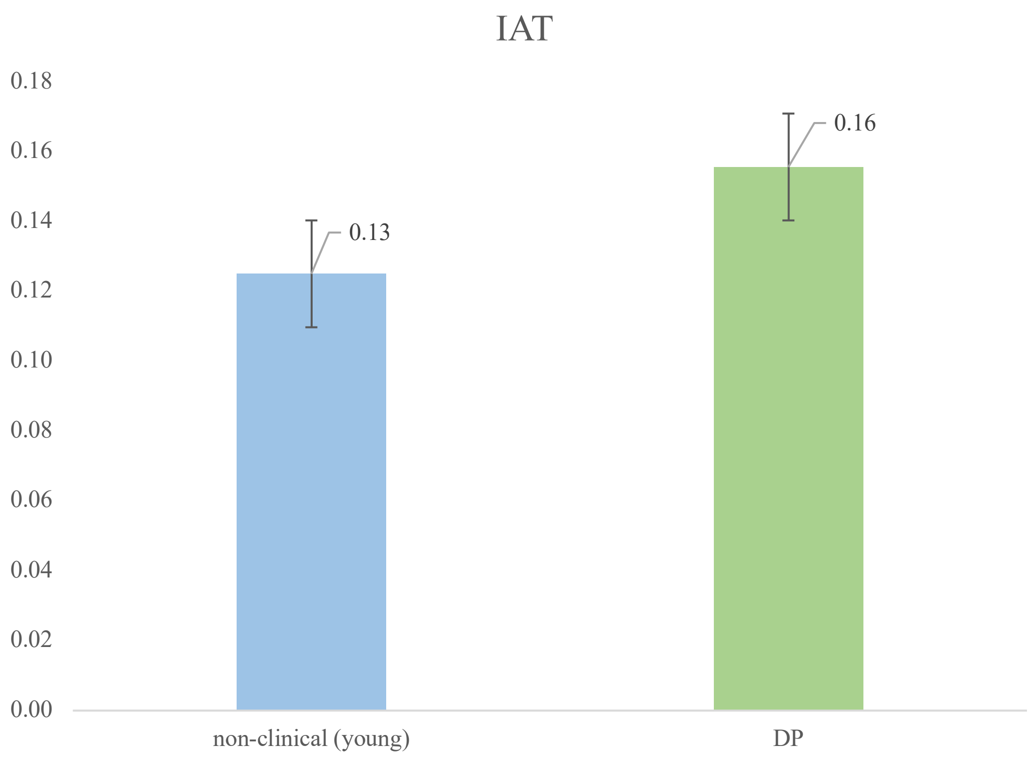
	t	p	β	F	df	p
Model				.445	6,29	.842
Age	.121	.905	.817			
AQ	-.010	.992	.011			
TAS20	.074	.941	.008			
CFMT	1.247	.222	.015			
Emotion task	.009	.993	.008			

Note: AQ – Autism traits, TAS20- alexithymia traits, CFMT – face memory, Emotion task – emotion perception.

5.3.2.4. Group differences between non-clinical young adults and DP samples in Extraversion IAT

A two-tailed independent sample *t*-test was conducted to identify whether individuals with DP differed in their extraversion face-trait judgements in comparison with non-clinical young adults (from Experiment 1a). As such, the findings revealed a non-significant difference between groups (t (152) = .455, p = .65; See figure 5.3.5 for group differences). Although the control group is not age-matched given the varying age range among the DP sample, these results are thus interpreted with caution.

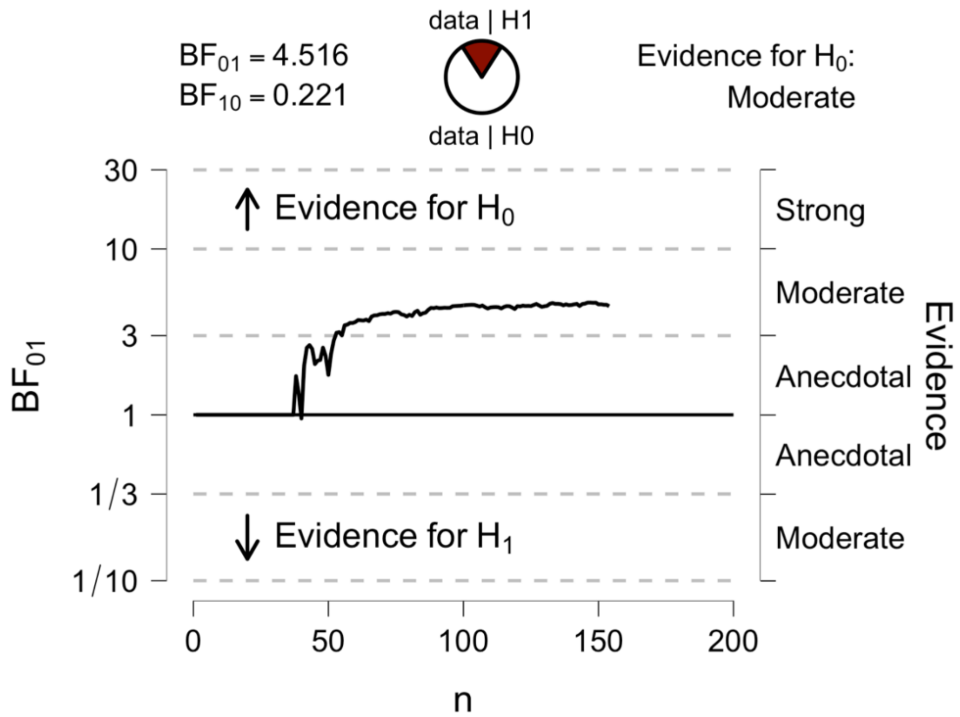
Figure 5.3.5: Extraversion IAT performances between non-clinical young adults and individuals with DP



Furthermore, we also considered a Bayesian approach for null hypothesis testing. The Bayesian independent *t*-test suggested a moderate evidence favouring the null hypothesis (BF_{01} = 4.52), suggesting that these results support the acceptance of the null hypothesis (See figure 5.3.6 for sequential analysis).

Additionally, a multiple linear regression analysis (using enter method) was conducted on age and extraversion IAT performances of the non-clinical young adult sample and the DP sample considering the varied age range included in the DP group. The results revealed that age did not significantly predict the extraversion IAT performances (F (1, 152) = .248, p = .619, R^2 =.002).

Figure 5.3.6: Bayesian sequential analysis for the difference in Extraversion IAT performances between DP and non-clinical samples



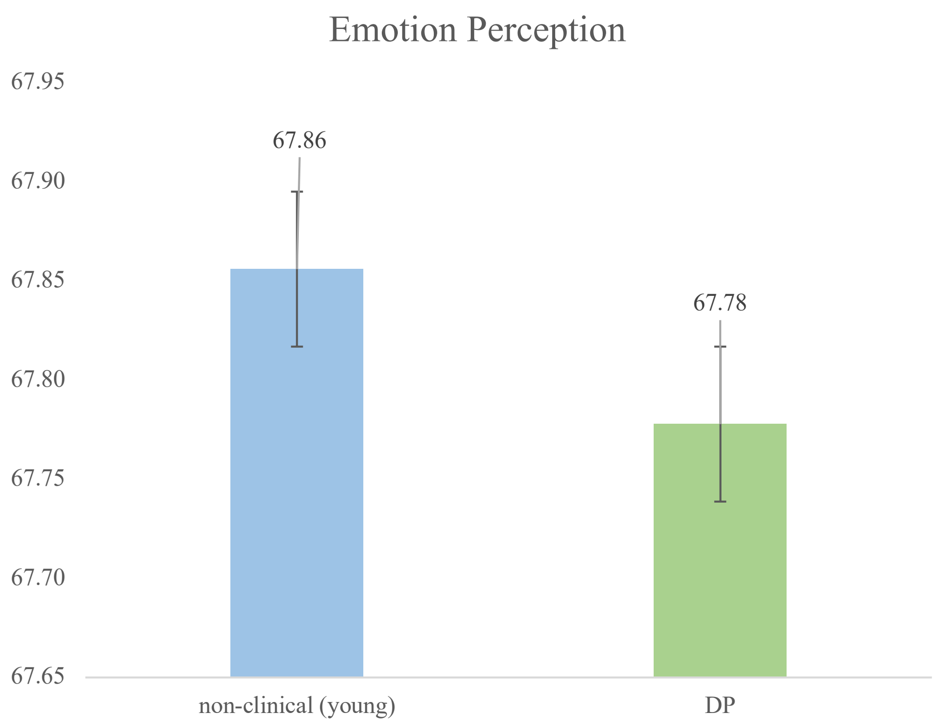
Note. The trend line represents the degree of evidence in favour of the null hypothesis (above the line for null hypothesis H0 and below the line for alternative hypothesis H1).

5.3.2.5 Emotion Perception among DP sample

The findings reported for the performance of DPs in the emotion perception task is consistent with previous literature (Biotti & Cook, 2016; Duchaine, Parker & Nakayama, 2003; Palermo et al, 2011) where individuals with DP are likely able to differentiate emotions from faces (Emotion task $M = 67.78$, $SD = 9.29$). Although there are differences in the methodology as reported in the Methods section (5.3.1) above, however, as a comparison, an independent sample revealed non-significant differences between non-clinical ($M = 67.86$, $SD = 7.42$), and DP groups ($t(152) = -.052$, $p = .959$). Figure 5.3.7 reports the mean differences for non-clinical and DP groups in the emotion matching task.

However, these results must be considered with caution given the methodological limitation of not including a time limit on the emotion task for the DP group. Although there was no time limit included in the emotion matching task for DP groups, the reaction times were measured. The findings of an independent sample *t*-test demonstrated that the DP groups (average latency $M = 4087.35$, $SD = 1207.481$) significantly take longer than non-clinical (average latency $M = 2081.40$, $SD = 410.10$) groups in emotion perception abilities ($t(152) = 15.45$, $p<.001$, $d = 2.94$).

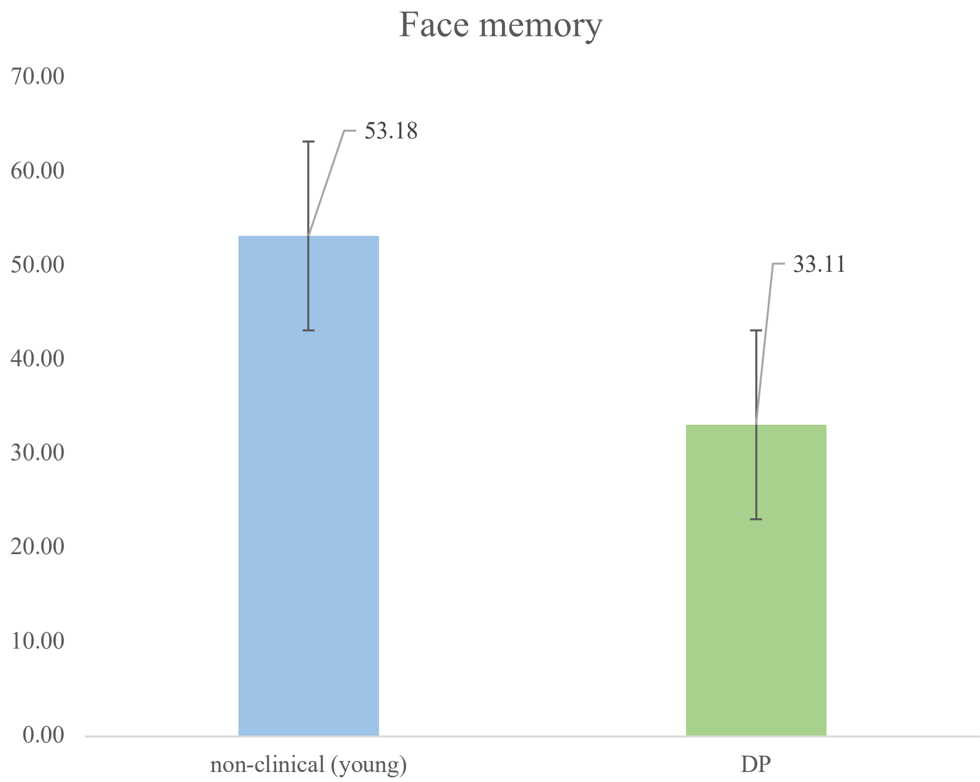
Figure 5.3.7: Group differences between non-clinical young adults and DP groups in emotion matching task



5.3.2.6. Differences in the performances of face memory recognition among DP and non-clinical sample

A two-tailed independent t-test was conducted to report group differences in face identity recognition performances for DP and non-clinical groups. The results revealed that there was a significant group difference (t (152) = 12.18, p < .001, d = 2.32) where the non-clinical group showed superior performance in the face memory task, a finding consistent with previous literature (e.g., Bate et al., 2014; Duchaine & Nakayama., 2006; see figure 5.3.8).

Figure 5.3.8: Face memory performances between non-clinical young adults and DP groups



5.4 Summary of results of experiment 1b.

The main findings of Experiment 1b are:

1) Developmental Prosopagnosic samples in the current study were able to significantly form implicit face-trait associations for extraversion personality traits.
2) Although the developmental Prosopagnosic group showed accuracy equal to non-clinical groups for emotion perception abilities, the DPs also were significantly slower than the non-clinical groups in the emotion matching task.
3) There were significant group differences for face memory performances among non-clinical young adults and developmental Prosopagnosic groups, where superior performance was observed for non-clinical groups.

4) There were significant correlations for autism and alexithymia traits, Autism subscale-imagination and emotion perception, alexithymia subscale-externally oriented thinking and emotion perception. All other correlations were non-significant.

5.5 General Discussion

Extraversion personality judgements among non-clinical young adults

We have established in Experiment 1a that spontaneous associations of extraversion personality traits can be made implicitly using composites facial stimuli. One of the main findings revealed that Caucasian young adults accurately and implicitly associated facial composites of women scoring high and low on *extraversion* personality traits with corresponding trait words. For example, participants paired extroverted facial composite images frequently with words describing extraversion personality traits such as ‘’outgoing’’ and ‘’friendly’’, similarly for introversion. Previous studies have already ruled out naming confounds where the nature of association in the implicit association task was not driven based on name labels such as ‘’Mary’’ or ‘’Jane’’ for extraversion or introversion composite images (Jones, Tree, & Ward., 2019). This finding where extraversion first impressions are accurate accords with previous literature and this finding is also a replication of extraversion personality trait impressions from Jones, Tree, and Ward (2019). This finding reflects a generic association between positive trait words and extraversion trait composite images, and negative trait words with low extraversion composite images. Further, visual cues associated with personality traits can be related to both trait-specific perception and social desirability (extraversion traits). These associations take place at implicit levels of cognition.

What might be driving automatic face trait inferences? Previous studies have associated trait inferences and attractiveness, where extraverted individuals are perceived to be more attractive (Kramer & Ward, 2010). However, this might not be true for other traits such as agreeableness (See Chapter 6). Empirical studies have associated personality judgements and individuals with differences in social perception (Austin, 2005; Collins, Cook, & Bird, 2015; Knuston, 1996). Hence, we further investigated whether this ability to identify extraversion personality traits from faces can be driven by socially disrupted behavioural factors such as autism traits, alexithymia traits and cognitive factors such as facial memory and emotion perception. The correlational analysis revealed that there was no association between implicit personality judgements and other cognitive behavioural factors.

Despite research suggesting that there might be an association between facial memory and extraversion personality trait judgements, here we did not find any such associations (See Satchell et al., 2019). Most likely that this effect has been suggested based on extraversion and attractiveness associations which in turn posits that attractive faces are remembered better. However, this ability was unrelated to personality associations based on the findings presented in this chapter. Similarly, for expression perception, previously it has been suggested that personality judgements are an extension of the mechanism involved in processing the emotionality of facial expressions (Knuston, 1996; Montepare & Dobish, 2003; Todorov et al., 2008, 2015). However, we did not find any such associations between implicit trait judgements and expression perception abilities.

Further, the regression analysis revealed that the ability to form accurate judgements of extraversion personality traits are unrelated and independent of other factors such as facial memory, emotion perception, autism and alexithymia quotient. This could further be interpreted as indicating that the face-processing system uses a unique route that enables personality judgements from faces to be made independent of cognitive processes such as memory or emotion perception. Based on these findings, experiment 1b further explored whether this ability to form extraversion implicit trait inferences were limited to neurologically intact individuals with normal face processing abilities. Thus, we conducted the same study using a developmental Prosopagnosic sample and the findings are discussed below.

Extraversion trait judgements among individuals with Face-recognition deficits

Given that neurologically intact individuals are able to make accurate implicit judgements of extraversion personality traits and this ability appears to be independent of other cognitive and behavioural variables, we then investigated whether individuals at the limits of face processing deficits are also able to accurately make such trait judgements. Individuals at the limits of face processing ability such as the Developmental Prosopagnosia sample were able to form accurate implicit extraversion personality trait judgements. This finding was also supported by the Bayesian approach with moderate evidence favouring the alternative hypothesis. However, this finding is interpreted with some caution given the varied age range and small sample size. Concerning other cognitive and behavioural factors that might affect the ability to make implicit personality judgements, the regression analysis revealed that this ability was not predicted by age, autism traits, alexithymia traits, facial memory or emotion expression recognition.

It is evident from previous literature that DPs exhibit deficits in holistic processing of identity but show normal emotion perception (Palermo et al., 2011; Duchaine et al., 2007). As such the performance of DPs in the emotion perception task is consistent with previous literature (Bentin et al., 2007; Biotti & Cook, 2016; Damasio, Tranel & Damasio, 1990; Duchaine, Parker & Nakayama, 2003; Fisher et al., 2017; Humphreys, Avidan, & Behrmann, 2007; Palermo et al, 2011; Tranel, Damasio, & Damasio, 1998) where individuals with DP are able to differentiate emotions from faces with accuracy similar to neurologically intact individuals in time unconstrained conditions. However, emotion perception abilities among DPs reported in this chapter is interpreted with some caution given the methodological limitation in the emotion matching task where a timer was not included for the presentation of stimuli; thus, the presence of atypicality cannot be completely ignored. In other words, it is likely that the advantage in processing emotions among DPs is only seen after longer exposure to faces. Although we have provided the average response times for DPs in the emotion expression perception tasks, the DP participants completed the emotion matching task in time unconstrained conditions. Previous research has indicated that when response times are not provided, it is possible that the high accuracy in such tasks that appear to indicate a normal performance may be shadowed by the application of successful, but abnormal facial feature matching strategies (Busigny et al., 2014; Duchaine & Nakayama, 2004; Farah, 2004). In support of such claims, researchers measuring reaction times indicated that DPs were significantly slower than controls at perceptual tasks (e.g., Behrmann et al., 2005; Humphreys et al., 2007). This finding is also supported in this thesis where the results of the emotion expression perception tasks indicated that DPs were significantly slower than controls.

Preliminary evidence suggests that holistic processing is not necessary to form trait judgements (Kramer & Ward, 2010). Todorov et al (2007) used facial parts as stimuli to identify trait judgements of trustworthiness. This suggests that incomplete facial information is sufficient for trait judgements. As mentioned earlier in this chapter, individuals with DP have also been reported to perform better than controls on composite face tasks (Avidan et al., 2011; Palermo et al., 2011); individuals with intact face recognition abilities tend to find composite face tasks difficult as they are likely to incorporate holistic face processing, thus processing composite faces as a whole. The DP groups are much less susceptible to difficulties in processing composite faces due to their tendency to process faces based on individual features of the face. However, previously it has been reported that in some DP cases there are normal configural face processing (Susilo et al., 2010) and normal holistic face processing (Duchaine et al., 2007).

Studies have claimed that some individuals with DP are able to make accurate judgements of trustworthiness and attractiveness (Carbon et al., 2010; Rezlescu et al., 2014; Todorov & Duchaine, 2008). Using a single case study, Knutson et al (2001) has reported normal social IAT effects for DPs. Thus, it is possible that mechanisms used for trait judgements are different from mechanisms for representing person identity. The evidence from the extraversion studies (Experiment 1a & 1b) in this chapter revealed no associations between facial memory and personality trait judgements. Hence it is possible for DPs to infer face-trait judgements accurately.

In sum, young adults without face identity deficits are able to form implicit and accurate judgements of extraversion personality traits from faces. Individuals with face identity deficits are likely able to form accurate implicit extraversion trait judgements from faces. In both studies, this ability was not predicted by other cognitive and behavioural factors such as facial memory, emotion perception, autism and alexithymia quotient. As such, we suggest that implicit personality judgements from faces potentially involves functionally independent mechanisms. However, evidence as such suggests with the caveat that findings of DPs reasonably remain inconclusive based on the limitations reported.

5.6. Conclusion

There are potential methodological limitations to the DP sample. 1) varied age range, 2) small sample size. Controlling for age and increase in sample size can increase the reliability of the findings reported. Although where there was no timer included in the emotion matching task, the findings reported for DPs does not exclude the possibility of atypicality. As such, the lack of including timer in the emotion task is also considered as a potential limitation, however, average latency response duration has been reported.

In conclusion, all additional measures of both face-based memory and emotion processing, autism traits and alexithymia traits appear to have no relationship to the variability of performance on the IAT face-based trait judgement tasks. As a consequence, it is evident from Experiments 1a and 1b that implicit judgements of extraversion personality traits from faces are independent of other cognitive and behavioural factors mentioned above.

Chapter VI

Implicit Agreeableness trait judgements from faces

In the previous chapter, we have explored implicit judgements of extraversion personality traits from faces among the young adult population and individuals with developmental prosopagnosia. We have concluded that the young adult sample was able to make implicit face trait judgements for extraversion; the developmental Prosopagnosic also appear to demonstrate such face-trait associations. Further, we have discussed that this ability to identify extraversion personality traits from faces is independent of factors such as autism traits, alexithymia traits, facial memory, and emotion expression perception.

Based on the findings of the previous chapter, the current chapter aimed to identify implicit judgements of another positively regarded trait among the Big-Five such as agreeableness personality traits from faces using the implicit association task (IAT). This was to determine the generalizability of our pattern of findings with the extraversion trait in particular we aimed to establish whether implicit associations of agreeableness personality trait can be predicted by factors such as autistic traits, alexithymia traits, facial memory, or emotion perception.

6.1 Agreeableness personality trait from faces

As reviewed in Chapters 2 and 3, prior research has demonstrated that perceivers form first impressions of targets personality traits and exhibit better accuracy for some traits more than other traits (e.g., extraversion). Predominantly, *explicit* studies using composite images have demonstrated that agreeableness personality traits are inferred accurately from faces (Little & Perrett, 2007; Penton-Voak et al., 2006; Kramer & Ward, 2010; Jones, Kramer & Ward, 2012; Jones et al., 2019; Sutherland et al., 2015). However, studies have also suggested that face trait judgements for agreeableness personality traits are less accurately judged compared to the other big-five personality traits (e.g., Al Moubayed et al., 2014; Gosling, Gaddis, & Vazire, 2007; Satchell et al., 2019; Zebrowitz & Collins, 1997). However, agreeableness traits are suggested to be an essential dimension in interpersonal judgement (Fiske, Cuddy, & Glick, 2006) and the most frequently identified dimension amongst the big-five (Ames & Bianchi, 2008).

Further, research on *implicit* judgements of agreeableness personality traits has demonstrated that observers make accurate face trait associations using IAT (Jones, Ward & Tree, 2019; Grumm & Collani, 2007). Using standard procedures of the IAT, Jones, Ward and Tree (2019), demonstrated an implicit association between agreeableness composite images and corresponding trait words with IAT D = 0.30 (See figure 6.1 below for the agreeableness composite images use in their study).

Figure 6.1: Agreeableness composite images

Note: Showing low agreeableness composite on the left and high agreeableness composite on the right (Jones, Tree & Ward, 2019)

As such, the present chapter aimed to:

1) replicate the agreeableness IAT effect reported by Jones, ward and Tree (2019)
2) establish whether personality judgements can be predicted by autistic traits alexithymia traits, facial memory or emotion perception.

6.2. Methods

This study followed the experimental structure outlined in the general methods section (see Chapter 4, pg. 69). Using G* power (Faul, Erdfelder, Lang, & Buchner, 2007), the appropriate sample size was calculated to establish an association between agreeableness composite images and agreeableness trait words using the IAT to obtain a score significantly greater than zero in a one-sample *t*-test. It was estimated that a sample of n = 94, with $\alpha = 0.05$ and $\beta = 0.80$, effect size $d > .3$ (conventionally medium effect size) was required to provide adequate power to the study. We obtained a sample of $N = 99$ and excluded 10 participants data due to age and other-ethnicity factors with a final sample of $N = 89$. To control for a possible other-ethnicity effect, this study only included Caucasian young adult population (age range 18-35).

Questionnaires measuring autism quotient (AQ) and alexithymia quotient (TAS20) were presented. Those were followed by a novel version of the agreeableness IAT with facial composites, a standard upright version of the CFMT and an Emotion task with the time limit. We used composite images of women scoring high and low agreeableness personality traits. Using a within-group research design, participants ($n = 89$, age $M = 22.32$, $SD = 4.44$; 67 females, 22 males) were recruited using prolific.ac and Swansea University participant pool. Participants were compensated £3 or course credits, respectively, for their participation. Students who registered to

Table 6.1: Descriptive Statistics for young adults agreeableness trait judgements and other cognitive factors (N= 89)

	Mean	Std. Deviation	Minimum	Maximum
Age	22.33	4.44	18	34
IAT D	-.093	0.320	-.802	1.103
AQ	17.494	8.074	2	43
TAS20	47.034	11.399	24	78
CFMT	52.708	9.073	30	69
Emotion task	67.775	8.715	34	81

Note: IAT D – agreeableness implicit personality, other cognitive factors: AQ – Autism traits, TAS20- alexithymia traits, CFMT – face memory, Emotion task – emotion perception.

take part in the study through the participant pool came to the face research lab Swansea to take part in the study. Out of the 89 participants, 7 participants scored high on the AQ scale (AQ score ≥ 32), and 7 participants scored high on the TAS20 scale (TAS20 score ≥ 61). See table 6.1 for participant descriptive statistics. No exclusions were made to the participants based on high autism traits, high alexithymia traits, poor face memory and poor face emotion recognition in order to include the variability across the general population to incorporate individual differences. However, excluding participants did not change the findings presented below (refer to appendix E, pg. 307 for analysis excluding individuals scoring high on AQ and TAS scales; 2SDs below the mean for CFMT and Emotion task). All participants had normal or corrected-to-normal vision, reported no history of neurological or psychiatric disorders, and provided signed consent prior to participation.

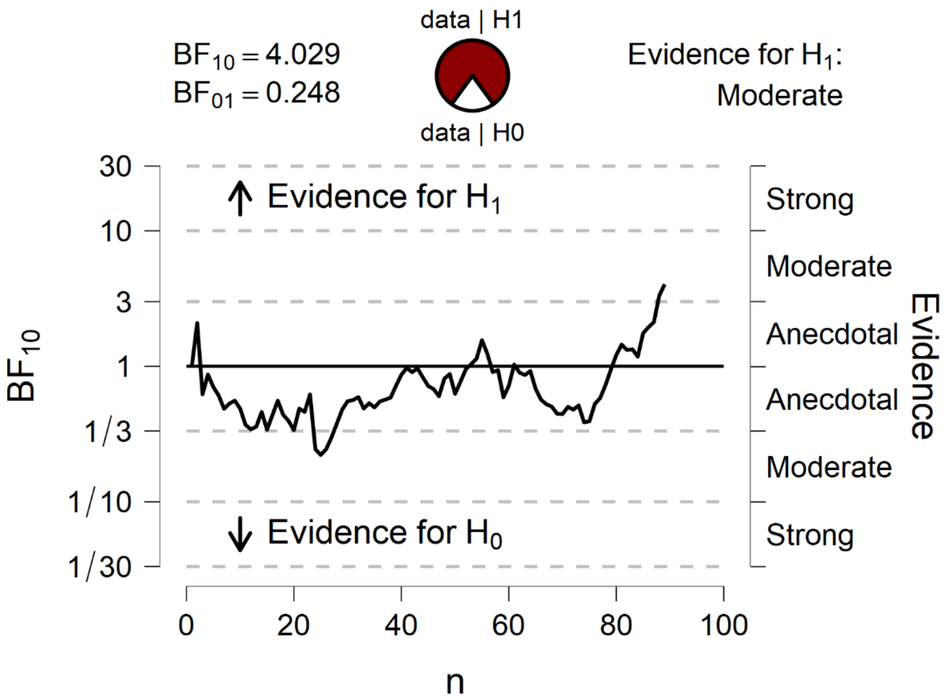
6.3. Results and discussion

6.3.1 Implicit Agreeableness trait judgements

The reaction time data obtained from agreeableness IAT was converted into IAT D scores using python codes based on the improved scoring algorithm (Greenwald, Nosek & Banaji, 2003) detailed in Chapter 4. It was ensured that there were equal number of participants in both conditions - congruent then incongruent (N = 46, M = -.096, SD = .335); incongruent then congruent (N = 43, M = -.090, SD = .306). Initially, an independent sample t-test was conducted against the order of conditions to ensure that the groups were evenly distributed across participants in a randomised balanced order. In order to eliminate the plausibility of entering random keyboard responses, we checked the accuracy of words, and approximately most participants were accurate at identifying words refer to Appendix D (pg. 306) for the descriptive table showing the accuracy of words and images in congruent and incongruent conditions.

A one-sample t-test against zero was conducted to identify whether there was a significant relationship between faces and personality trait words. The results revealed that young adults were making implicit judgements of agreeableness personality trait with $IAT\ D$ = -.093 (SD = .320), 95% CI [-.16, -.03] t (88) = -2.76, p = .007, d = -.29. However, these results imply that observers have associated the composite images to opposite trait categories which have resulted in producing a negatively significant D score. For example, observers were associating low agreeableness images with high agreeableness trait words and similarly associating highly agreeable faces with low agreeableness trait words (i.e., participants

Figure 6.2: Bayesian sequential analysis for agreeableness IAT



Note. The trend line represents the degree of evidence in favour of the alternate hypothesis (above the line for alternative hypothesis H_1 and below the line for null hypothesis H_0).

were quicker in incongruent blocks). A Bayesian analysis was conducted since the sample size did not meet the G* power analysis. A Bayesian one-sample t-test suggested that there was moderate evidence favouring the alternative hypothesis with $BF_{10} = 4.029$. See figure 6.1 for sequential analysis.

One of the possible explanations for significant negative D score is that impressions of agreeableness personality trait from faces have been demonstrated to have low accuracy compared to the other traits of the Big-Five (e.g., Al Moubayed et al., 2014; Gosling, Gaddis, & Vazire, 2007; Satchell et al., 2019; Zebrowitz & Collins, 1997). Studies have also claimed that agreeableness personality traits judgements are not only the least accurate, but also produce unreliable results (e.g., Ames & Bianchi, 2008). Researchers have been concerned about how accuracy can be obtained and interpreted from facial appearance, especially with concerns about image selection and the possibility of confounding cues (Todorov & Porter, 2014). Attractiveness and facial maturity are known to be vital for distinguishing dimensions in person perception (e.g., Rhodes, 2006; Zebrowitz & Montepare 2006). As such, based on the findings of the current study, it is implied for future studies to use composite faces of women who are in a higher age category for young adults.

Making accurate judgements of personality traits is acknowledged to be a very challenging cognitive process. Another possible explanation is that the composite images of this study were very similar looking which could have caused the observers to indicate mismatch. As suggested by previous studies, agreeableness personality can be associated with approachability and conscientiousness (e.g., Little & Perrett, 2007; Sutherland et al., 2013), which in turn suggests that these composite faces could have projected other possible personality traits. However, to acknowledge the power issue in this study, we also suggest that future studies should also consider larger sample size.

6.3.2 Correlations between measures

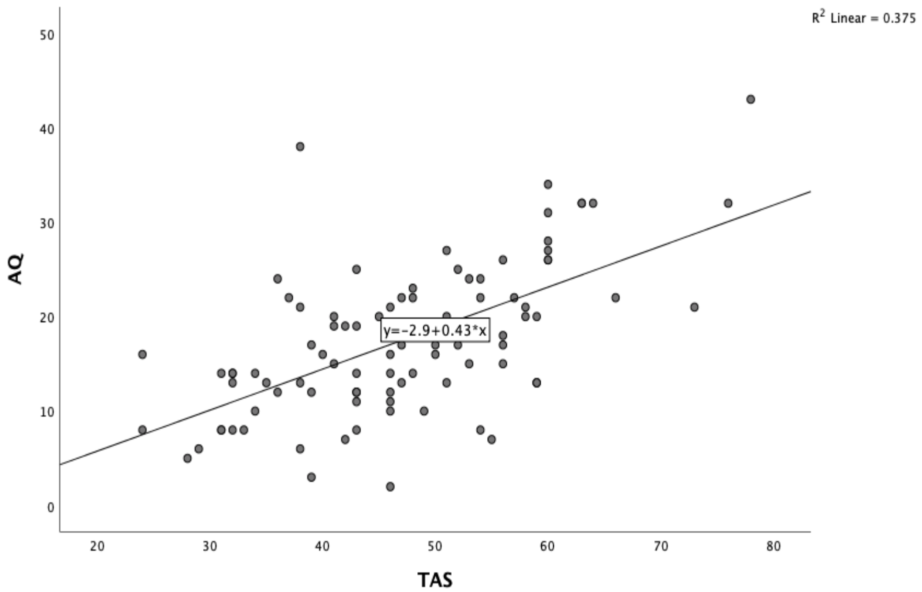
A two-tailed Spearman's correlation was conducted to explore the relationship between implicit agreeableness trait judgements, autism traits, alexithymia traits, facial memory, and emotion perception. Consistent with previous work (e.g., Bird & Cook, 2013; Cook, Brewer & Shah, 2013), the results of Spearman's rho indicated a positive association between AQ and TAS scales (r_s (88) = .589, $p < .001$), where high autism traits were associated with high alexithymia traits (See figure 6.3.1).

Consistent with previous literature (Davies et al., 2017; Lewis et al., 2018; Rhodes et al., 2013; Sasson et al., 2013), a significant negative association was reported for AQ and CFMT scores (*rs* (88) = -.325, *p* = .002), where high autism traits were associated with lower accuracy for facial memory (figure 6.3.2); specifically, for AQ subscales: attention to detail (*rs* (88) = .243, *p* = .022); attention switching (*rs* (88) = -.231, *p* = .029); communication (*rs* (88) = -.355, *p* <.001); imagination (*rs* (88) = -.380, *p* < .001); social skills (*rs* (88) = -.428, *p* < .001). The associations were non-significant for attention to detail and attention switching subscales of AQ and CFMT after applying Bonferroni's correction. There was a negative association between AQ and Emotion task (*rs* (88) = -0.250, *p* = 0.018), where high autism traits were associated with poorer facial expression perception (e.g., Bird & Cook, 2013). However, after applying Bonferroni's correction, this association was non-significant.

Similarly, there was a negative association between TAS-20 and CFMT (*rs* (88) = -.233, *p* = .028), and the TAS20 and emotion tasks (*rs* (88) = -.281, *p* = .008), where low alexithymia scores were associated with high accuracy for facial memory and emotion perception (e.g., Prkachin, Casey & Prkachin, 2009). Specifically, the TAS20 subscale (difficulty describing feelings) (*rs* (88) = -.295, *p* = .005) and face memory. However, after applying Bonferroni's correction, these associations were non-significant. There was also a significant negative correlation between TAS20 subscale - difficulty describing feelings and emotion perception (*rs* (88) = -.357, *p* <.001).

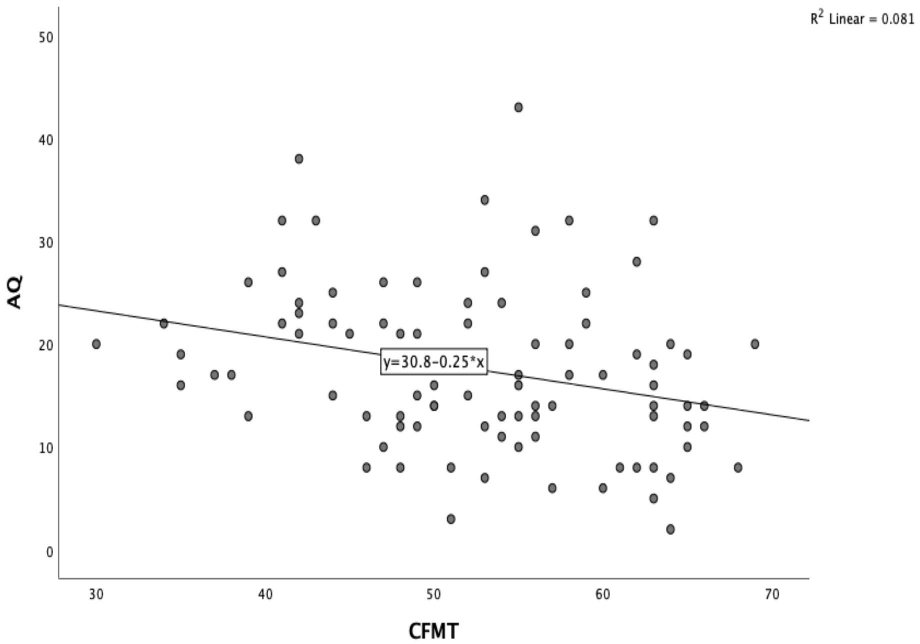
Consistent with previous literature, there was a positive association between CFMT and Emotion task (*rs* (88) = .277, *p* = .009), where high accuracy for facial memory was associated with high accuracy for expression perception abilities (e.g., Palermo et al., 2013; Franklin & Adams., 2010). This association was non-significant after applying Bonferroni's correction. All other correlations were non-significant after applying Bonferroni's correction and considering Bayesian correlations.

Figure 6.3.1: Correlation plots for autism and alexithymia traits



Note: Scatterplot for total scores on the AQ- autism and TAS20 - alexithymia scales.

Figure 6.3.2: Correlation plots for autism traits and facial memory



Note: Scatterplot for total scores on the AQ- autism and CFMT- face memory task.

6.3.3. Multiple Linear regression analysis

A multiple linear regression analysis (using the enter method) was conducted to identify whether this ability to form implicit associations of agreeableness personality trait judgements from faces can be predicted by factors such as autism quotient, alexithymia quotient, facial memory, or emotion perception. Tests for Multicollinearity were conducted by calculating the Variance of Inflation Factor (VIF) in SPSS. A rule was employed where VIF values < 10, were acceptable measures of Multicollinearity (Gordon, 2015; O'Brien, 2007). Given that for all variables VIF factors were < 2, as such all variables were included in the regression model.

Results of the linear regression indicated that there was no significant relationship between IAT performance and any of our four key measures – AQ, TAS, CFMT and Emotion task (F (4, 84) = 0.094, p = 0.98, R^2=.0.004). The regression analyses revealed that the ability to identify agreeableness personality traits implicitly from faces was unrelated to other cognitive and behavioural factors such as autism quotient, alexithymia quotient, face memory, and emotion perception. See table 6.2 below for regression analysis.

Table 6 2: Regression analysis for agreeableness IAT vs other factors

	t	p	b	F	df	p
Model				.094	4,84	.984
AQ	.240	.811	.034			
TAS20	-.321	.749	-.045			
CFMT	.047	.963	.005			
Emotion task	-.533	.596	-.063			

Note: AQ – Autism traits, TAS20- alexithymia traits, CFMT – face memory, Emotion task – emotion perception.

6.4 Summary of findings

The current chapter explored agreeableness face-trait judgements and their association with other cognitive and behavioural factors.

As such the main findings of this chapter are:

1) observers have constantly associated the agreeableness composite images to opposite trait categories which have resulted in producing a negatively significant D score. As such, failing to replicate previous findings reported by Jones et al (2019). However, this ability was unrelated to autism traits, alexithymia traits, face memory and emotion perception.
2) there were significant correlations between autism and alexithymia traits, autism traits and face memory.

6.5 General Discussion

Agreeableness trait judgements from faces

The current chapter investigated whether spontaneous associations of *agreeableness* personality traits can be made implicitly and accurately using composite facial stimuli. Similar to extraversion IAT, here we aimed to replicate the findings of Jones, Tree and Ward (2019). The findings of the current study revealed that young Caucasian adults constantly associated the high agreeable face with low agreeable trait words. For example, the high agreeable image was frequently paired with low agreeable words such as "cold" and "unkind" and low agreeable image was frequently paired with high agreeable words such as "kind" and "sympathetic". The agreeableness IAT effect from Jones et al (2019) study was not replicated in this study and has produced contradictory results to our prediction.

Substantial evidence has indicated that extraversion is a robust and accurately identified trait amongst the Big-Five dimension (See Chapter 5). Whereas the evidence for agreeableness trait judgements is rather inconclusive considering that several studies have produced mixed results. Empirical evidence has generally suggested that agreeableness traits are found to produce unreliable results, judged less accurately and, in many cases negligible levels of accuracy (e.g., Borkenau & Liebler, 1992; Funder & Dobroth, 1987; Zebrowitz & Collins, 1997; Gosling, Gaddis, & Vazire, 2007; Al Moubayed et al., 2014; Ames & Bianchi, 2008; Satchell et al., 2019). The nature of this mechanism remains unclear. Based on an extensive review of published evidence, we argue that perceivers tend to readily judge agreeableness at early impressions and form confirmation biases through selective attention and interpretation. Moreover, at rudimental levels of cognition, agreeableness personality judgements can be driven by perceivers self-perception of agreeableness (e.g., John & Robins, 1993). As a result, it is plausible that the perceiver's initial judgement remains uncorrected and perceived continually to be true for that initial judgement (e.g., Denrell., 2005). Hence these initial judgments show limited accuracy.

Furthermore, attractiveness and facial maturity are known to be vital for distinguishing dimensions in person perception (e.g., Rhodes, 2006; Zebrowitz & Montepare 2006). We want to imply that for future studies to use composite faces of women who are in a higher age category for young adults. Making accurate judgements of personality traits is acknowledged to be a very challenging cognitive process. Another possible explanation is that the composite facial stimuli used in our study were very similar looking which could have caused the observers to indicate mismatch. As suggested by previous studies, agreeableness personality can be associated with approachability, conscientiousness, and extraversion (e.g., Little &

Perrett, 2007; Sutherland et al., 2013; Ames, & Bianchi, 2008), which in turn suggests that these composite faces could have projected other possible personality traits. However, to acknowledge the power issue in this study, we also suggest that future studies should also consider larger sample size.

It was further investigated whether this ability can be driven by socially disrupted behavioural factors such as autism traits, alexithymia traits and cognitive factors such as facial memory and emotion perception. The findings revealed that there was no relationship between implicit personality judgements and the other factors mentioned above. Consistent with our findings so far, the ability to form implicit personality judgements remain independent of our other cognitive and behavioural measures.

6.6 Conclusion

In conclusion, individuals make implicit judgements of agreeableness personality traits. However, these judgements were not accurate, given the participants of this study associated cues for low agreeable faces with high agreeable trait words and high agreeable faces with low agreeableness trait words. The reason behind this association is somehow inconclusive, however, we suggest for future studies to use composite images of women in the higher range of age category and larger sample size. However, in line with the results of the previous chapter, the performance patterns on our test of personality judgements were independent of factors such as autism, alexithymia, facial memory, and emotion perception.

Chapter VII

Implicit Neuroticism trait judgements from faces

In the previous chapters, we have discussed that extraversion personality traits can be judged implicitly and accurately from faces among a non-clinical young adult population and individuals with Developmental Prosopagnosia. This accurate implicit personality judgement pattern did not extend accurately to the agreeableness personality trait in the young adult sample. Nonetheless, in both cases, face-trait judgements appear to be unrelated to autism traits, alexithymia traits, facial memory or emotion expression perception abilities.

The aims of the previous empirical chapters focused on positively regarded traits such as extraversion and agreeableness – and in this chapter, we have focused on a third personality trait – neuroticism, a negatively regarded trait among the Big-Five personality traits. Thus, in this case, we sought to determine whether neuroticism personality trait judgements can be made implicitly and accurately using neuroticism composite facial stimuli. As before, we also sought to further explore whether implicit judgements of neuroticism personality traits can be predicted by individual traits of autism and alexithymia, self-perception of neuroticism, facial memory, and emotion perception in non-clinical young adult populations. If this is true, this study will be the first to demonstrate implicit judgements of neuroticism personality traits from composite faces using the IAT paradigm.

7.1 Neuroticism trait judgements from faces

Several studies have demonstrated that neuroticism (also referred to as emotional stability) personality traits can be accurately interpreted from faces explicitly (Kramer & Ward, 2010; Little & Perrett, 2007; Naumann, Vazire, Rentfrow & Gosling, 2009; Penton-Voak 2006; Walker & Vetter 2016; Satchell et al., 2019). Using the Realistic Accuracy Model (RAM; Funder, 1995), it is also suggested that this ability to judge neuroticism personality traits varies based on the environmental situation (Hirachmüller et al., 2015). Funder (1999) claimed that it is essential to contain knowledge about the relationship between personality and behaviour which is critical in the utilization phase of the RAM. However, the methodologies of these studies are relatively consistent where observers are usually presented with photographs of unfamiliar faces and asked to differentiate the nature of the individual's face image. Participants are asked *explicitly* to rate or select the statement that best describes the image presented (for example, Neuroticism: in general, which image is more Anxious – Calm) and thus as ever, findings may be confounded by demand characteristics.

On the contrary, using short samples of behavioural information available from online platforms, researchers aimed at identifying whether personality judgements can be made at zero acquaintance from the information available on social media such as Facebook; and have revealed that observers are extremely poor and least accurate at making judgements of neuroticism personality traits as compared to good accuracy for extraversion personality traits (e.g. Back et al., 2010; Borkenau et al., 2009; Darbyshire et al., 2016; Gosling, Gaddis, & Vazire, 2007; Ivcevic & Ambady, 2012). However, no studies as far have considered implicit personality trait inferences of neuroticism using composite facial stimuli. If findings are supported, given that negative traits such as neuroticism can communicate behavioural intentions such as anxiety and depression, attention to this construct can significantly benefit the fields of psychopathology.

As such, based on these findings, the present chapter aimed is to:

1) explore *implicit* judgements of neuroticism personality traits from composite faces.
2) as before we sought to identify whether implicit judgements of neuroticism personality traits were related to other attributes such as autism spectrum, alexithymia, self-perception of neuroticism, facial memory and emotion perception. In addition, we sought to determine if self-rated levels of neuroticism predicted IAT performance (i.e., might higher neurotics show larger neuroticism IAT effects).

7.2. Method

This study followed the experimental structure outlined in the general methods section (see Chapter 4, pg. 67) with an inclusion of the personality inventory measure described below.

Mini–International personality inventory (IPIP; Donnellan et al., 2006): the IPIP is a short version of the questionnaire measuring the five-factor model of personality developed by Goldberg (1999). The IPIP consists of 20 questions that measure the big 5 traits with 4 questions per trait. Participants were asked to indicate how much they agree or disagree with each statement using the Likert scale where ‘’1 = strongly disagree to 5 = strongly agree’’. After scoring the questionnaire, only neuroticism personality trait scores for all participants were included in the statistical analysis.

Questionnaires measuring autism quotient (AQ), alexithymia quotient (TAS) and personality inventory (Mini IPIP) were presented. Those were followed by a novel version of the neuroticism IAT with facial composites (See Figure 7.1), a standard

Figure 7.1: Neuroticism composite images

HIGH (Jane) LOW (Mary)

Neuroticism

the upright version of the CFMT and Emotion task with a time limit. We used composite images of women scoring high and low scores on neuroticism personality traits. Using a within-group research design, participants (n = 120, age M = 24.58, SD = 4.89; 71 females, 49 males) were recruited using prolific.ac and Swansea University participant pool. Students who registered to take part in the study through the participant pool, came to the face research lab Swansea to take part in the study. Participants were compensated £3 or course credits, respectively, for their participation. Of the 120 participants, 8 participants scored high on the AQ scale (AQ score of ≥ 32) and 19 participants scored high on the TAS-20 scale (TAS-20 score of ≥ 61). To control for a possible other-ethnicity effect, this study only recruited the Caucasian young adult population (age range 18-35). No exclusions were made to the young adult group based on high autism traits, high alexithymia traits, poor face memory and poor face emotion recognition in order to include the variability across the general population to incorporate individual differences. However, excluding participants did not change the findings presented below (refer to appendix F pg. 307 for analysis excluding individuals scoring high on AQ and TAS scales; 2SDs below the mean for CFMT and Emotion task). All participants had normal or corrected-to-normal vision, reported no history of neurological or psychiatric disorders, and provided signed consent prior to participation. See table 7.1 for participant descriptive statistics.

Table 7.1: Descriptive Statistics for young adults' neuroticism IAT and other cognitive factors (N = 120)

	Mean	**Std. Deviation**	**Minimum**	**Maximum**
Age	24.58	4.89	18	35
IAT D score	.164	.393	-1.006	1.104
AQ	19.30	7.86	3	44
TAS20	47.96	10.92	26	76
Mini-IPIP (Neuroticism)	12.80	3.55	4	20
CFMT	51.98	9.82	24	71
Emotion task	65.68	10.55	30	85

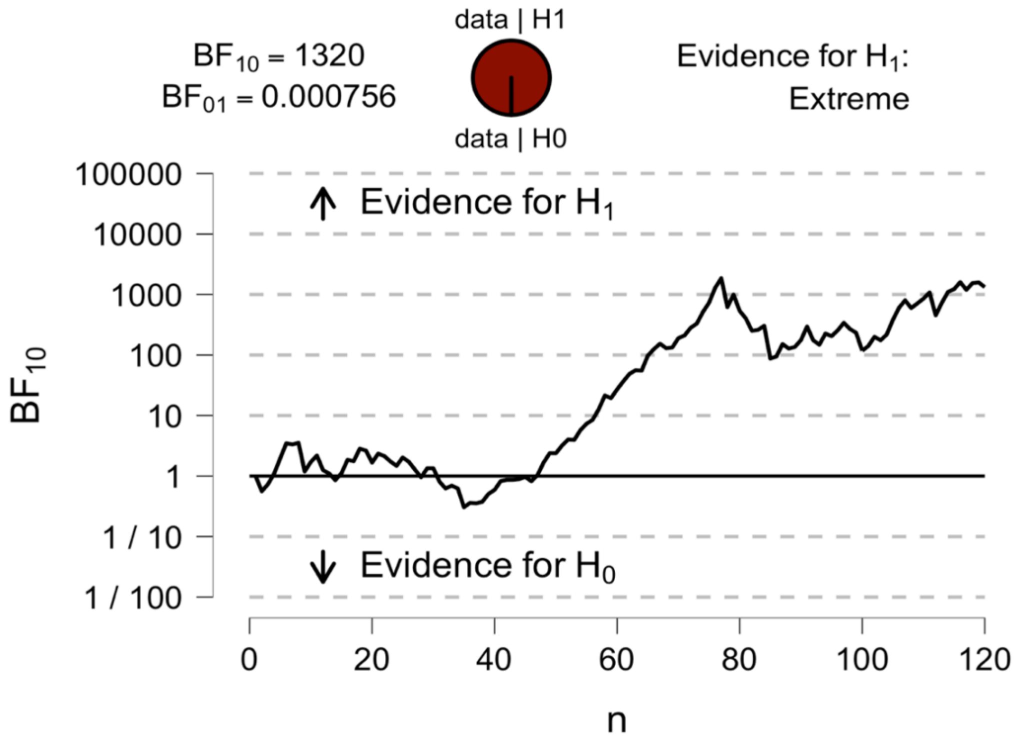
Note: IAT D – neuroticism implicit personality, other cognitive factors: AQ – Autism traits, TAS20- alexithymia traits, mini-IPIP – self-perception of personality, CFMT – face memory, Emotion task – emotion perception.

7.3. Results and Discussion

7.3.1 Do young adults show accurate implicit recognition for neuroticism traits from faces?

The reaction time data obtained from the neuroticism IAT was converted into IAT D scores using python codes following the scoring algorithm (Greenwald, Nosek & Banaji, 2003) detailed in the general methods section in Chapter 4. It was ensured that there were approximately an equal number of participants in both conditions, congruent then incongruent (N = 56, M = .129, SD = 0.351); incongruent then congruent (N = 64, M = .195, SD = 0.426). An independent sample t-test was conducted to ensure there were no significant differences within groups t (118) = -.917, p = .361.

A one-sample *t*-test against chance (zero) was conducted to identify whether there was a significant relationship between faces and personality trait words. The results revealed that the young adults were accurately able to make implicit associations of neuroticism personality trait from faces *IAT D* = 0.164 (SD = .39), 95% CI [.093, .235] t (119) = 4.59, p < .001, d = .42. Participants were faster and more accurate on trials where high neuroticism faces were paired with high neuroticism words and on trials where low neuroticism faces were paired with low neuroticism words. Facial composites of neuroticism personality traits were implicitly and accurately associated with corresponding trait words. Using IAT and composite images, this study is the first to report *implicit* and accurate judgements of neuroticism personality traits. Furthermore, a Bayesian one-sample t-test revealed that these results strongly evidence the alternative hypothesis H_1 with BF_{10} = 1322.55, this also supports the results of the frequentist method. See Figure 7.2 for the sequential analysis of the



Bayesian approach.

Figure 7. 2: Sequential analysis of Bayesian approach for neuroticism IAT

Note. The trend line represents the degree of evidence in favour of the alternate hypothesis (above the line for alternative hypothesis H_1 and below the line for null hypothesis H_0).

7.3.2 Correlational analysis between measures

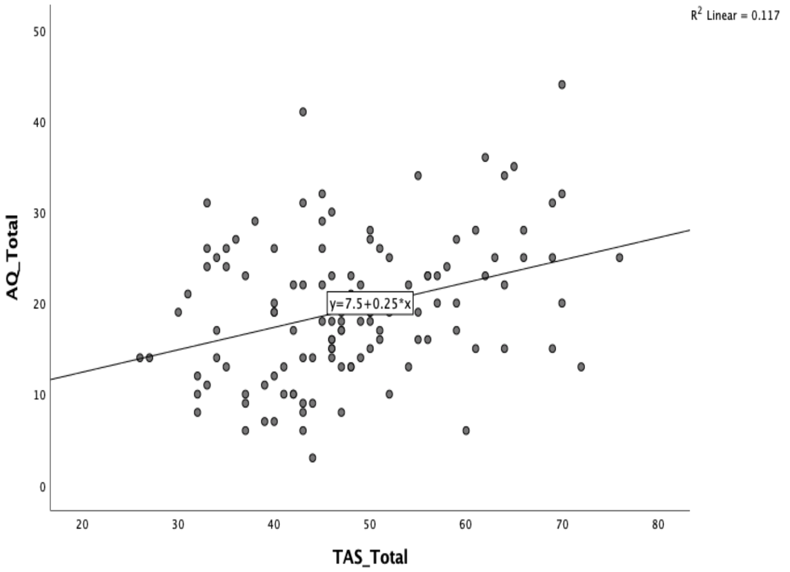
A two-tailed Spearman's correlation was conducted to explore the relationship between implicit neuroticism trait judgements (Neuroticism IAT), autism traits (AQ and subscales), alexithymia traits (TAS20 and subscales), self-perception of neuroticism (Mini IPIP neuroticism scores), facial memory (CFMT) and emotion perception (Emotion matching task).

The correlational analysis reported below has revealed specifically expected associations such as a positive association between autism traits and alexithymia traits (e.g., Bird & Cook, 2013; Cook, Brewer & Shah, 2013), where high autism traits were associated with high alexithymia traits (*rs* (119) = .319, p < .001; see figure 7.3); a positive association between alexithymia traits and neuroticism self-report measure (e.g. Luminet, Bagby & Warner, 1999; Lyvers, Boileau & Thorberg, 2019), where high alexithymia scores were associated with high neuroticism traits (*rs* (119) = .216, *p* = .018); however after applying Bonferroni's correction these results were non-significant. Similarly, there was a positive association between self-report neuroticism and TAS20 subscale – difficulty in identifying feelings, where high scores indicating difficulties in identifying feelings were associated with high self-report neuroticism scores (*rs* (119) = .352, *p* <.001; see figure 7.4). Several studies have predominantly associated alexithymia and neuroticism self-report measures and these studies have largely suggested that both these measures evaluate emotional distress and hence tend to be highly correlated (See Rosenberg et al., 2016; Luminet et al., 1999; Barańczuk, 2019). There was a negative association between TAS20 subscale – externally oriented thinking and emotion matching task, where individuals with difficulties in externally oriented thinking tend to have difficulties in emotion perception (*rs* (119) = -.356, *p* <.001; e.g., Calder, Lawrence & Young, 2001; Lane et al., 1996; Parker, Prkachin & Prkachin, 2005).

There was a positive association between autism traits and self-reported neuroticism traits (rs (119) = .195, *p* = .033), where high autism traits were associated with high neuroticism traits. However, after applying Bonferroni corrections, these results were non-significant. Previous research studies have reported an association between high AQ scores and its sub-scales with high neuroticism personality traits

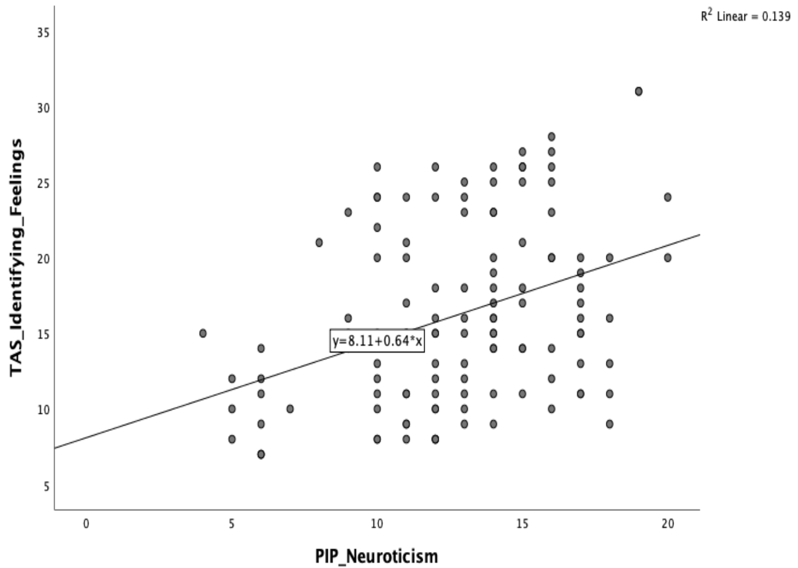
(Austin, 2005; Murphy et al., 2005; Wakabayashi, Baron-Cohen, & Wheelwright, 2006). However, these associations were non-significant within this study after applying Bonferroni corrections.

Figure 7.3: Correlation plots for autism and alexithymia traits



Note: Scatterplot for total scores on the AQ- autism and TAS20 - alexithymia scales.

Figure 7.4: Correlation plot for TAS20 subscale - difficulty identifying feelings vs self-report neuroticism



Note: Scatterplot for total scores on the TAS- difficulty identifying feelings and self-perception neuroticism scales.

Similarly, there was a positive association between self-report neuroticism scores and the emotion matching task (*rs* (119) = .247, *p* = .006). Previous studies have suggested that individuals who self-reported with high anxiety were poor at emotion perception (Davis et al., 2011; Demenescu, 2010; Palermo et al., 2018). As such neuroticism personality traits may be associated with poor emotion recognition abilities. However, after applying Bonferroni's correction these results were non-significant.

Correlational analysis indicated a significant negative association between neuroticism IAT and AQ scores (*rs* (119) = -.211, *p* = .021, where individuals with low AQ scores were better at neuroticism personality trait judgements from faces. However, after applying Bonferroni's correction this correlation was non-significant. We also conducted a Bayesian correlation for IAT and AQ scores and the results revealed that there were no significant associations between autism traits and implicit neuroticism judgements (BF_{10} = 0.577). Specifically, a negative association between IAT scores and attention switch AQ subscale (rs (119) = – 0.196, *p* = 0.032). After applying Bonferroni's correction, these results were non-significant. All other correlational analyses between AQ and TAS20 subscales against IAT produced non-significant correlations. However, certain comparisons that are reported above need further research to fully explore and substantiate these associations. It is also interesting to note that self-reported neuroticism traits were not associated with implicit neuroticism personality trait judgements, where the ability to identify neuroticism personality traits from faces is unrelated to self-perception of neuroticism (e.g., Shevlin et al., 2003; Borkenau et al., 2009). See also regression analysis reported below in section 7.3.3).

7. 3.3. Multiple Linear regression analysis

A multiple linear regression analysis (using the enter method) was conducted to identify whether this ability to form implicit associations of neuroticism personality trait judgements from faces can be predicted by factors such as autism quotient, alexithymia quotient, self-neuroticism rating, facial memory, or emotion perception. Tests for Multicollinearity were conducted by calculating the Variance of Inflation Factor (VIF) in SPSS. A rule was employed where VIF values < 10, were acceptable measures of Multicollinearity (Gordon, 2015; O'Brien, 2007). Given that for all variables VIF factors were < 2, as such all variables were included in the regression model.

Table 7. 2: Linear Regression analysis for Neuroticism IAT

	t	p	b	F	df	p
Young						
Model				2.013	5, 114	0.082
AQ	-1.854	0.066	-0.181			
TAS20	0.811	0.419	0.081			
Self-perception	0.631	0.530	0.060			
CFMT	-2.201	0.030	-0.211			
Emotion task	0.715	0.476	0.070			

Note: Self-perception of neuroticism, AQ – Autism traits, TAS20- alexithymia traits, CFMT – face memory, Emotion task – emotion perception.

Results of the linear regression indicated that there was no significant effect between IAT and AQ, TAS, mini IPIP, CFMT, and Emotion task (F (5, 114) = 2.013, p = 0.082, R^2=.081). These findings appear to indicate that the ability to identify neuroticism personality from faces implicitly is independent of autism traits, alexithymia traits, self-perception of neuroticism, facial memory, and perception of facial expression. See table 7.2 above for regression analysis.

Given that, although the regression model for neuroticism IAT was non-significant, there is a small significant facial memory predictor. It appears from the result that facial memory negatively influences neuroticism trait judgement. All VIF scores for the variables were below 2, suggesting there was no multicollinearity in the data. However, there was no correlation between facial memory and neuroticism IAT and hence it is possible that this predictor is a result of false-positive (Type 1 error; Shear & Zumbo., 2013) and could be disregarded. Furthermore, if such results are possible, it could further suggest that individuals with face processing deficits (such as Developmental Prosopagnosics) might be able to form accurate neuroticism personality judgements. Regardless of this, this effect between the CFMT and the IAT may be occurring due to chance. Moreover, the overall accuracy score on the CFMT on the population is low compared to other groups. Thus, it is possible that such effects could imply that low scorers on the CFMT are still intact with neuroticism personality associations. Other factors unrelated to the presence of DP that may cause participants to perform poorly on tasks include lack of motivation, misinterpretation of task instructions, lack of motor coordination with computer skills and test anxiety (Butcher et al., 2000). Furthermore, specifically in regard to the CFMT, it has been reported that routine testing of student populations has produced CFMT scores within the prosopagnosia range among non-clinical populations (Bowles et al., 2009). The reason behind such patterns of findings is yet to be widely understood.

7.4 Summary of findings

The present chapter explored whether neuroticism personality trait judgements can be made implicitly and accurately from faces using the implicit association paradigm; and whether this ability is influenced by autism quotient, alexithymia quotient, self-perception of neuroticism, facial memory, or expression perception.

The main findings of this chapter are:

1) Neuroticism personality traits can be implicitly and accurately judged from faces.
2) The ability to form implicit judgements of neuroticism personality traits is independent of factors such as autistic traits, alexithymia traits, self-perception of neuroticism, facial memory, and emotion perception, suggesting a unique ability.
3) There were significant associations between autism and alexithymia, alexithymia and self-perception of neuroticism.

7.5 General Discussion

<u>Neuroticism personality traits in young adults</u>

So far in this thesis, the focus of personality judgments has been on positively regarded traits such as extraversion and agreeableness. As before, we sought to identify whether implicit judgements of *neuroticism* (a negatively regarded trait amongst the big-five personality traits) were related to other attributes such as autism spectrum, alexithymia spectrum, facial memory, and emotion perception. In addition, we sought to determine if self-related levels of neuroticism predicted IAT performance (i.e., might higher levels of neuroticism show larger neuroticism IAT effects).

As outlined earlier on within this chapter, previous studies have provided inconsistent findings for facial judgements of neuroticism, demonstrating that neuroticism is one of the least accurate trait judgements (e.g., Back et al., 2010; Borkenau et al., 2009; Darbyshire et al., 2016; Gosling, Gaddis, & Vazire, 2007; Ivcevic & Ambady, 2012). However, novel findings have been reported in this chapter using an individual differences approach, where the findings demonstrated that young adults are able to form implicit accurate judgements of neuroticism personality traits from composite facial stimuli. Further, are there other mechanisms that predict the ability to make implicit accurate neuroticism personality judgements? The regression analysis revealed that this ability was not driven by cognitive and behavioural factors such as facial memory, emotion perception, co-occurring autism, alexithymia or self-rated levels of neuroticism.

It is well-known that neuroticism is environmentally driven and differs based on social situations (Hirachmüller et al., 2015). The current findings of this thesis, consistent with previous literature have suggested that self-perception of neuroticism is nevertheless unrelated to perceivers ratings of trait judgements from faces (e.g., Satchell et al., 2019; Shevlin et al., 2003). Given that neuroticism is a negatively regarded trait and its characteristic description involves traits such as anxiousness and generic difficulties with social interaction, evidence suggests that this trait is highly correlated with autism traits (e.g., Schriber, Robins, & Soloman, 2014). However, the ability to make implicit personality judgements of neuroticism is unrelated to autistic traits. Moreover, it is interesting to note that the correlational analysis of this study showed a marginal relationship between implicit neuroticism judgement and autism traits. Previous studies using self-report measures have associated high AQ scores with high neuroticism personality traits (Austin, 2005; Murphy et al., 2000; Piven et al., 1997; Wakabayashi, Baron-Cohen, & Wheelwright, 2006). It is also suggested that individuals with autism spectrum disorders show normal trait judgements for dominance and trustworthiness (Ewing et al., 2015; Latimier et al., 2019; Mathersul et al., 2013; White et al., 2006). However, for better clarity of results, in future studies, we suggest that this factor should be explored extensively. This could in turn develop and better understand the existential theoretical frameworks of the face and personality perception (e.g., Bruce & Young, 1986).

Furthermore, it is well-established that neuroticism personality trait characteristics involve experiencing negative affect and anxiousness (Canli et al., 2001; Costa & McCrae, 1980; Ormeal et al., 2012). As such, neuroticism has an existential relationship with cognitive and clinical neuroscience including psychopathology, where it constantly shows a robust association with anxiety disorders, depression and substance abuse (Kotov et al., 2010; Lahey, 2009). Researchers have already shown that depressive symptoms are available from static, non-expressive composite images (e.g., Scott et al., 2013). One might argue that facial blemishes can give away details about mood which can be inaccurate and hence the use of neutral facial stimuli improves the quality of the results produced. However, this ability can communicate several important issues “e.g., depression, mood, predict behaviour” (Scott & Kramer, 2016). Hence, greater attention to this construct can significantly benefit the fields of psychopathology research and clinical practice.

7.6 Conclusion

This Chapter has reported novel findings of implicit personality associations where face trait judgements of neuroticism personality traits can be judged accurately and implicitly from faces. Similar to the findings of the previous chapters, implicit associations of neuroticism personality traits were not predicted by other factors such as autism traits, alexithymia traits, facial memory and emotion expression perception.

Chapter VIII

Summary – Part I

The current Chapter presents a summary of key findings from the previous empirical chapters (5, 6 and 7), exploring the performances of young adult populations and automatic trait inferences from faces. In this thesis, we measured whether Caucasian young adult populations are accurately able to make implicit personality judgements of extraversion, agreeableness and neuroticism personality traits using composite images. Throughout these chapters, the methodologies were relatively consistent. We used a novel version of the implicit association task (IAT; Greenwald, McGhee & Schwartz, 1998) to measure first impressions. We further explored whether the ability to form facial first impressions can be predicted by other *cognitive/behavioural* factors such as autism traits, alexithymia traits, facial memory or emotion perception. We included questionnaires measuring participants' autism traits (Baron-Cohen et al., 2001), and alexithymia traits (Taylor, Bagby & Parker, 2003); and tasks measuring facial memory (Duchaine & Nakayama, 2006) and emotion perception (Palermo et al., 2013). A summary of key findings from the first three empirical chapters is presented below.

Extraversion personality traits from faces

In Chapter 5, we have demonstrated that young adults make accurate facial first impressions of extraversion personality traits using composite images. As a consequence, this work replicates the findings of previous work in the literature (e.g., Kramer & Ward., 2010; Jones, Tree & Ward., 2019). The current work builds on this by demonstrating that our ability to form an accurate facial first impression of extraversion personality traits is unrelated to autistic traits, alexithymia traits, facial memory, and emotion perception.

Based on the findings of neurologically intact young adults on the extraversion IAT, we were motivated to investigate whether this ability is driven by facial identity recognition, in other words, *how do individuals with facial identity recognition deficits perform?* This would also highlight the potential mechanisms underpinning trait-judgements and face identity recognition abilities. The findings demonstrated that, individuals at the limits of face processing ability (Developmental Prosopagnosia, DP) were also able to form accurate implicit extraversion trait judgements. However, there are considerable limitations to this finding given the varied age range and small sample size. Moreover, consistent with the literature, the DP sample showed low accuracy for facial memory, and high accuracy for emotion perception in time unconstrained conditions – consistent with dissociation of face emotion and recognition processing. However, not including a timer in the emotion matching task is considered a potential limitation, although latency responses have been reported. Similar to findings of the testing of young adults on the extraversion IAT, the DP data revealed that extraversion implicit personality judgements were not predicted by autism traits, alexithymia traits, facial memory, or emotion perception.

Agreeableness personality traits from faces

In our second study, we explored whether a group of young adults were able to successfully make implicit judgements of agreeableness personality traits from composite faces. On balance we found that response judgement was not accurate as the participants of this study constantly associated low agreeable faces with high agreeable trait words and high agreeable faces with low agreeableness trait words. Although the ability to form implicit personality judgement patterns did not extend accurately to the agreeableness personality trait, nonetheless, both extraversion and agreeableness personality trait judgements appear to be unrelated to autistic traits, alexithymia traits, facial memory, and emotion perception performances.

Based on the findings reported above (chapters 5 and 6), Chapter 7 sought to determine whether a 'negatively' regarded trait such as neuroticism could be implicitly signalled from faces (in a similar manner to the 'positive' trait, extraversion). And in addition, consistent with our previous work, we sought to determine if this ability was predicted by cognitive facets such as facial memory and emotion perception; behavioural aspects such as autism traits, alexithymia traits and self-perception of neuroticism.

Neuroticism personality traits from faces

In Chapter 7, novel findings are reported for implicit personality associations; in that, we find evidence that participants could indeed make implicit face trait judgements of neuroticism accurately. This is the first time our IAT testing of personality traits has demonstrated that the trait of neuroticism can be signalled from faces. Similar to the findings of previous chapters, implicit associations of neuroticism personality traits are independent and unrelated to other factors such as autism, alexithymia, facial memory, and emotion perception. In addition, there was no evidence that trait judgement success was related to self-perception of neuroticism.

Throughout these empirical chapters, in line with the literature, there was a positive correlation between autism and alexithymia traits (e.g., Bird & Cook, 2013; Cook et al., 2013), face memory and emotion perception (Franklin & Adams., 2010; Palermo et al., 2013). Consistent with the literature, there was a negative association between autism and face memory (e.g., Davies et al., 2017; Lewis et al., 2018). There was a novel correlation between alexithymia traits and face memory. All other correlations were non-significant after applying Bonferroni's correction and considering Bayesian correlations. In sum, all additional behavioural and cognitive measures such as autism, alexithymia, face-based memory and emotion processing measures appear to have no relationship to the variability of performances on the IAT face-based trait judgement tasks. Given that this ability to form facial first impressions is not driven by cognitive processes, i.e., since none of these key measures seems a good prospect to elucidate how the process of personality from faces works, the following chapters considered whether implicit trait-judgement abilities are *meta cultural or age-related*.

The theoretical framework proposed by Over and Cook (2018) has claimed that trait judgements are influenced by cultural factors (See Chapter 9). Firstly, based on this framework, in the following chapter, we have conducted experiments measuring implicit personality associations of extraversion personality traits among other-ethnicity samples (Indian sample) measuring cultural influences on trait judgements that are reported in Chapter 9.

Secondly, previous studies have demonstrated an own-age bias (e.g., wright & Stroud, 2002), and age-related cognitive decline for face emotion (Calder et al., 2003; Sullivan et al., 2017) and face identity recognition (e.g., Lindholm et al., 2005; Searcy et al., 2005), and given the focus of much work tends to involve the recruitment of younger populations, we also sought to determine whether the ageing process has a detrimental effect upon implicit trait associations or whether older adult participants show a similar overall pattern of performance to younger participants in their face-trait judgements of extraversion and neuroticism personality traits from faces (See Chapter 10). If ageing has an impact on face-trait judgements, this will certainly contribute to existing literature to better understand the potential mechanisms involved in trait judgements. As before, it was also investigated whether trait judgement abilities are predicted by autism traits, alexithymia traits, face memory and emotion expression perception.

Chapter IX

The impact of culture and ethnicity on implicit extraversion trait judgements

The previous work presented in this thesis has established the case that different implicit personality traits can be signalled from faces, and this ability appears to be unrelated to other cognitive and behavioural factors such as face memory, emotion perception, autism quotient and alexithymia quotient. Given so far in this thesis it has been demonstrated that Caucasian young adults are able to form accurate implicit personality judgements from Caucasian facial stimuli, in this Chapter we sought to establish the generalizability of this finding to non-Caucasian populations – thus asking the question: does ethnicity play a role in the process of implicit identification of personality from faces?

9.1. The impact of culture and ethnicity on face processing.

Culture is referred to as "*the extensively circulated information that is represented in people's minds, and expressions about their communication and behaviour*" (Sperber & Hirschfeld, 2004). Decades of research on cultural cognition have suggested that cognitive processes related to automatic associations have profoundly been moulded by cultural context (Haidt, 2001). Face perception abilities and knowledge about other's personality traits can develop based on an individual's previous experiences. Previously it has been suggested that individuals tend to form impressions of trustworthiness based on a previous encounter or associated knowledge about others' behavioural traits and tend to associate this knowledge with novel individuals with similar facial appearances (e.g., Falvello et al., 2015; Verosky & Todorov, 2010). As such, observers tend to generalise the perceived information based on the previous encounter and extend this information to other individuals based on facial appearance (Park & Schaller, 2009; Zebrowitz, Bronstad, & Montepare, 2011; Zebrowitz et al., 2012).

Previous studies have demonstrated that observers are generally better at recognizing own-ethnicity faces than other-ethnicity faces, a finding that is known as the other-ethnicity effect or own-ethnicity bias (e.g., Chiroro et al., 2008; Meissner & Brigham, 2001; Sporer, 2001; Walker & Tanaka, 2003). One of the widely accepted explanations for this effect is explained by the observers perceptual learning processes and the social contact hypothesis. As such, the processes involved in demonstrating the other-ethnicity effects are impacted by the level of social factors such as the degree of experience an individual has with other-ethnicity, i.e., when an individual has exposure to other-ethnicity groups, their performance might be similar to that of own-ethnicity participants (Walker & Hewstone, 2006; Walker et al., 2008). On the contrary, recent work by Wong et al (2020) has suggested that social contact with other-ethnicity does not necessarily improve other-ethnicity judgements. Furthermore, work by Sporer (1999) has reported that Turkish participants did not differ in their ability to recognize Turkish and German faces, whereas German participants demonstrated an own-ethnicity effect. Similarly, another study reported that white South African participants demonstrated an own-ethnicity effect whereas black South African students showed superior performance for white faces (Wright, Boyd, & Tredoux, 2003). While most studies report other-ethnicity effects, these findings have varied widely between studies. As such, it is possible that environmental factors related to population distribution and social contact may affect other-ethnicity effects.

While several first impressions are based on the kernel of truth hypothesis (Bonnefon, Hopfensitz, & De Neys, 2015), others seem to be unrelated to behavioural characteristics of the individuals whose impressions are being formed (Todorov et al., 2008). Research by Sutherland et al., (2018) has suggested that independent of culture, individuals form similar first impressions of strangers. Observers automatically tend to form a range of characteristics to a stranger when viewing their photographs. Frequent encounters with other-ethnicity or own-ethnicity faces can shape the initial encoding process of faces (Walker & Tanaka, 2003). We often tend to learn about strangers' traits through direct observation or communication through others, e.g., characters portrayed in movies (England, Descartes, & Collier-Meek, 2011; Feinberg, Willer, & Schultz, 2014). As such, it has been demonstrated that individuals tend to form associations between appearance and personality traits (e.g., individuals wearing glasses are more intelligent and trustworthy; Hellstörm & Tekle, 1994). Although some first impressions of traits show better than chance accuracy (Boshyan et al., 2014; Zebrowitz et al., 2014), impressions can also be wrong (Rule et al., 2013; Todorov et al., 2015).

Over and Cook (2017) proposed a novel theoretical framework known as Trait inference mapping (TIM) to explain automatic first impressions. According to the TIM, *"spontaneous trait inferences can be understood as mappings between locations in face space and trait space"*. The face space is a multidimensional space within the visual system that encodes both familiar and unfamiliar faces. This space is known to emerge ontogenetically. Trait space contains conceptual knowledge of others' traits that are gathered throughout development. When an observer concurrently associates a stranger's facial appearance in face space and certain aspects of that strangers' characteristic traits in trait space, a face-trait mapping is formed. Repeated encounters of a specific face shape or facial feature that represents a particular trait, enables a mapping between face and trait representations. Once these mappings are made, automatic trait judgements from faces are formed; when an unfamiliar face is encountered close to a mapped location in the face space, excitation spontaneously propagates to the corresponding trait space. Over and Cook (2017) have suggested dual routes to trait inferences: The 'automatic route' which is responsible for the spontaneous first impressions of unfamiliar faces; and the 'controlled route' which is responsible for placing strangers in the trait space after reviewing previous experiences of the observer with target's behaviour and appearance.

As such from the literature presented above, we suggest that culture plays a pivotal role in face-based trait judgements. In Chapter 5 we have established that Caucasian young adult participants were able to make accurate implicit associations on extraversion personality traits using Caucasian composite images. As such, the current chapter aimed at inspecting whether such performance is generalizable across ethnicity to determine whether cultural concepts play a role in the ability to make accurate implicit personality associations. Considering other-ethnicity effects, are own ethnicity participants better judges of personality traits from faces? To answer these questions, we conducted a study using an Indian sample to identify whether Indian participants are able to make spontaneous associations of Caucasian extraverted facial composites with corresponding trait words. We also compared this data against a Caucasian young adult sample.

9.2. Methods

Using a within-group research design, young adult Indian participants (n = 60, age M = 24.78, SD = 2.92; 32 females, 28 males) were recruited via circulation of emails where the study link was sent to the participants, and through social media platforms. Of the 60 participants, no participant scored high on the AQ scale (AQ > 32), and 7 participants scored high on the TAS-20 scale (Alexithymia > 61). The Indian sample data was compared against the young adult Caucasian sample (n = 118, *age* M = 23.50, SD = 4.79; 68 females, 50 males) that we had recruited for Chapter 5, to identify possible group differences in the implicit association task. See Table 9.1 for group descriptive statistics.

This study followed a similar experimental structure outlined in the general methods section (see Chapter 4, pg. 67). However, in the current study, we only used questionnaires measuring Autism Quotient (AQ), Alexithymia quotient (TAS), and the extraversion Implicit Association Task (IAT). The questionnaires and tasks used in this study were designed using Gorilla software for psychology (Anwyl-Irvine et al., 2016), and analysed using Python programming software. Using a randomised balanced order, after completing the questionnaires measuring autism and alexithymia, one group of participants completed the congruent then incongruent version of the IAT, and another group of participants completed Incongruent then congruent IAT.

Table 9. 1: Descriptive Statistics for Indian and Caucasian group performances on extraversion IAT

Group		N	Mean	SD	Minimum	Maximum
Indian	**Age**	60	24.78	2.92	18	34
	IATD	60	-0.007	0.35	-1.068	0.57
	AQ	60	20.28	5.28	9	29
	TAS20	60	49.27	11.38	24	77
Caucasian	**Age**	118	23.50	4.79	18	35
	IATD	118	0.13	0.35	-0.79	0.97
	AQ	118	19.09	8.46	4	45
	TAS20	118	50.27	12.45	24	89

Note: IAT D – extraversion implicit personality, AQ – Autism traits, TAS20-alexithymia traits.

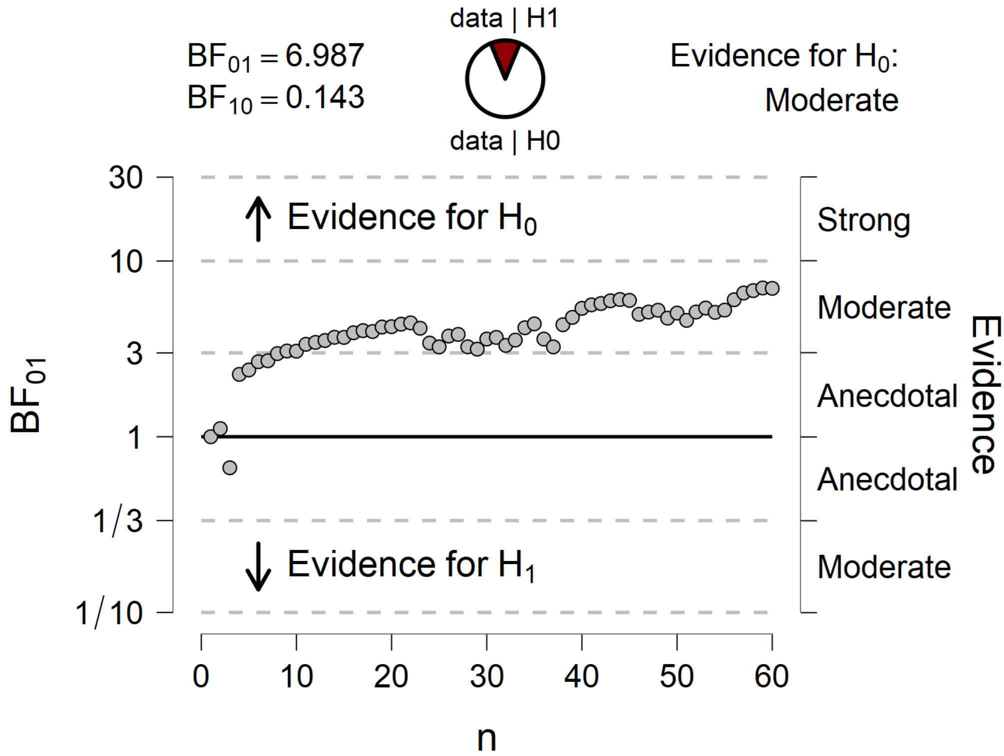
9.3. Results and discussion

9.3.1. Do other-ethnicity participants perform the same way on the extraversion IAT?

The reaction time data obtained from the extraversion IAT for other-ethnicity (Indian) participants were converted into IAT D scores based on the improved scoring algorithm (Greenwald, Nosek & Banaji, 2003) using Python codes. A one-sample *t*-test against zero was conducted to identify whether there was a significant relationship between faces and personality trait words. The results revealed that the Indian young adult sample showed a non-significant association between facial composites and personality trait words *IAT D* = -.007 (*SD* = .348), 95% CI [-.27, 0.23] t (59) = -.17, p = .87. It is interesting to note that the IAT D score is approximately zero, denoting that there is not much difference in response latency between conditions.

To further explore the null hypothesis, we considered a Bayesian approach. A Bayesian one-sample *t*-test was conducted on the extraversion IAT scores against the null hypothesis. The results moderately evidenced the null hypothesis with BF_{01} = 6.99, suggesting that these results support the acceptance of the null hypothesis (See figure 9.1 for sequential analysis of the Bayesian approach). In sum, it appears that the Indian participants were not reliably able to accurately determine extraversion traits implicitly from Caucasian composite facial stimuli (unlike our Caucasian sample in Chapter 5, pg. 96).

Figure 9 1: Bayesian sequential analysis for extraversion IAT performance in other-ethnicity samples

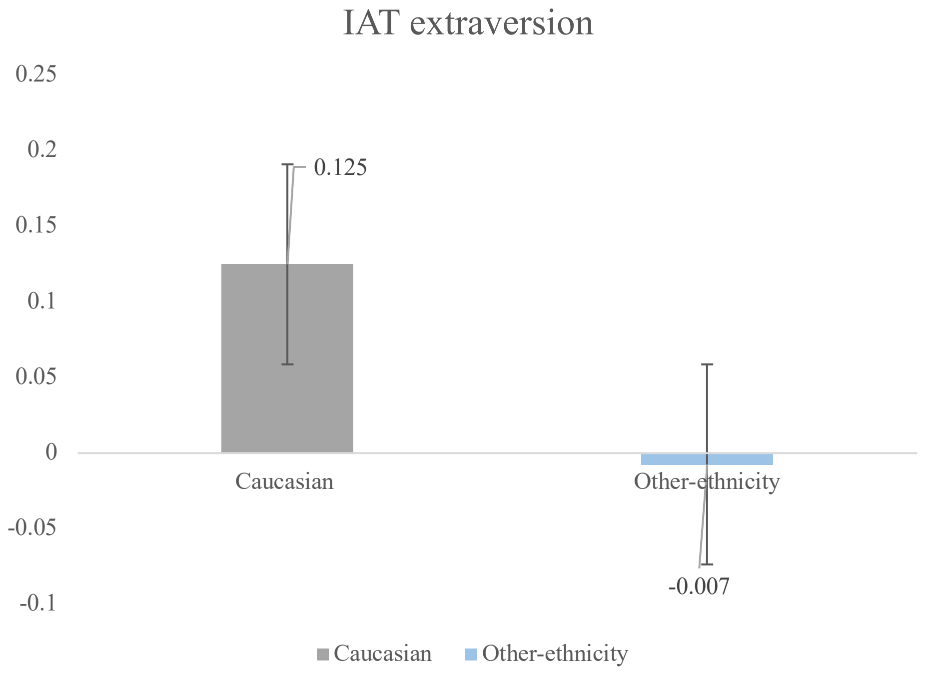


Note. The trend line represents the degree of evidence in favour of the null hypothesis (above the line for null hypothesis H_0 and below the line for alternative hypothesis H_1).

9.3.2 Group differences between other-ethnicity and Caucasian samples

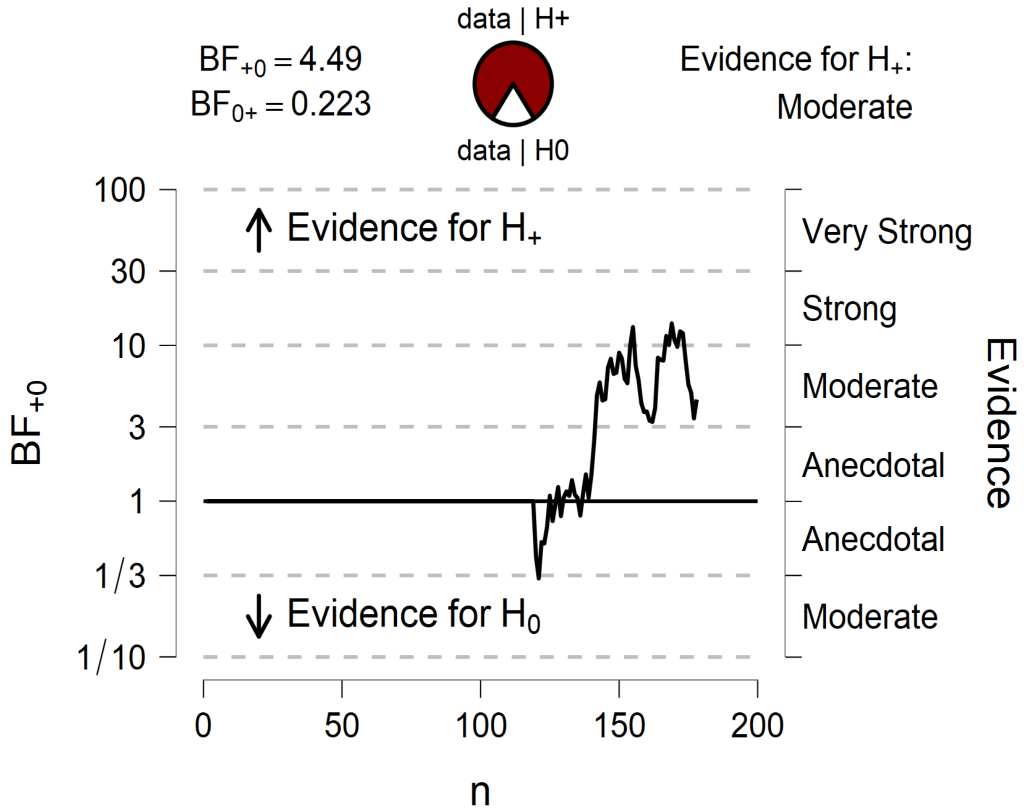
A two-tailed independent sample t-test was conducted to determine whether there were differences in the performances of Indian and Caucasian samples in identifying extraversion implicit personality trait judgements from faces using the IAT. A significant group difference has been reported for Caucasian and Indian participants (t (176) = 2.378, p = .018, d = .38). The findings of this study revealed that Caucasian participants were statistically significantly better at associating Caucasian composite extraversion images and extraversion trait words compared to the Indian sample. See figure 9.2 for group differences in extraversion IAT.

Figure 9.2: group differences between other-ethnicity and Caucasian samples for Extraversion IAT



In order to rule out group differences driven by varying sample sizes; here we have also reported Bayesian methods. The Bayesian independent sample t-test revealed that there is moderate evidence towards the alternative hypothesis BF_{10} = 4.490 where the Caucasian group were better than the Indian sample at making implicit personality judgements using Caucasian composite faces (See figure 9.3). In general, the pattern appears to be that non-Caucasian participants (Indians) are clearly less able to interpret the face based 'signals' for extraversion in our Caucasian face stimuli – this has implications for the generalizability of our findings in earlier chapters.

Figure 9 3: Bayesian sequential analysis showing group differences between other-ethnicity and Caucasian samples

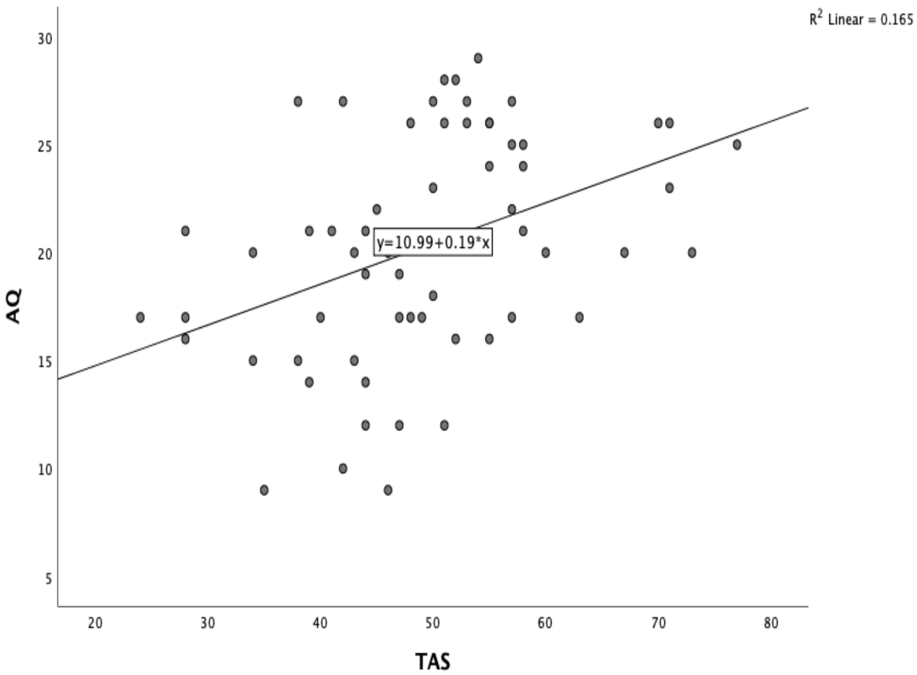


Note. The trend line represents the degree of evidence in favour of the alternate hypothesis (above the line for alternative hypothesis H_1 and below the line for null hypothesis H_0).

9.3.3 Correlational analysis between measures

A two-tailed Spearman's correlation was conducted to explore the association between AQ, TAS and extraversion IAT measures on the Indian participants. There was a significant positive correlation between AQ and TAS20 (rs (59) = .427, p < .001). This finding is consistent with the literature where, the low levels of autism traits were associated with low levels of alexithymia traits (e.g., Cook et al., 2013; see figure 9.4). All other correlations were non-significant.

Figure 9.4: Correlational analysis between autism and alexithymia scales among other-ethnicity samples



Note: Scatterplot for total scores on the AQ- autism and TAS20 - alexithymia scales.

9.3.4: Regression analysis

A multiple linear regression analysis (using the enter method) was conducted to identify whether the performance of other-ethnicity samples on implicit extraversion trait judgements from faces are predicted by autism and alexithymia traits. Tests for Multicollinearity were conducted by calculating the Variance of Inflation Factor (VIF) in SPSS. A rule was employed where VIF values < 10, were acceptable measures of Multicollinearity (Gordon, 2015; O'Brien, 2007). Given that for all variables VIF factors were < 2, as such all variables were included in the regression model. Results of the linear regression indicated that there was no significant effect between IAT and autism, alexithymia traits (F (2, 57) = 3.25, p = .06, R^2=.10). See table 9.2 for regression analysis.

Table 9. 2: Multiple linear regression analysis for extraversion IAT performances among other-ethnicity samples

	t	p	b	F	df	p
Young						
Model				3.25	2, 57	.06
AQ	-2.16	.066	-.02			
TAS20	2.11	.069	.009			

Note: AQ- autism traits, TAS20 – alexithymia traits

9.4 Summary of findings

The current chapter explored whether other ethnicity plays a role in the ability to form accurate implicit extraversion personality judgements from faces, in order to determine the generalizability of our earlier findings. The findings of this study have demonstrated that Indian participants failed to show an IAT effect, thus suggesting that extraversion trait judgements are "culturally" specific. To our knowledge, this is the first study to report other-ethnicity effects among Indian samples.

9.5 General Discussion

<u>Culture and ethnicity effects on extraversion personality trait judgements</u>

As we have already established in Chapters 5, 6 and 7, so far, the overall findings for implicit personality judgements from faces using own-ethnicity samples have demonstrated that young Caucasian samples are able to predict extraversion and neuroticism personality traits implicitly and accurately for unfamiliar faces using composite Caucasian facial stimuli. Here we establish the generalizability of this finding to non-Caucasian populations. Thus, asking the question of whether successful trait judgement performance extends across to other ethnicities (with different cultural norms). To answer this question, we investigated in the current chapter whether other-ethnicity (Indian) individuals are able to make accurate implicit judgements of extraversion personality trait judgements using Caucasian young women's composite facial stimuli and whether this ability was driven by co-occurring autism or alexithymia traits. We have also compared the data against Caucasian young adult's data from Chapter 5.

The main findings of the current chapter revealed that our other-ethnicity (Indian) sample were not reliably able to accurately determine extraversion traits implicitly unlike our Caucasian sample in Chapter 5. Additionally, this ability was not predicted by autism and alexithymia traits. In general, the pattern appears to be that non-Caucasian participants (Indians) are clearly less able to interpret the face based 'signals' for extraversion in our Caucasian face stimuli. Hence, this has implications for the generalizability of the findings reported in earlier chapters. These results imply that the processes utilised to interpret the 'signals' for extraversion in our Caucasian face stimuli, is not universally true of all participants and may well be culturally determined. The interpretation of these findings is that there likely exists an ethnicity effect in identifying personality from faces – that is, the ethnicity of the 'observer' is clearly important, and likely it may be important for both the observer and the observed ethnicities to match (i.e., same ethnicity for both). This interpretation is based on the fact that Caucasian young adults were able to make accurate implicit judgements of extraversion personality traits from Caucasian composite images when compared to the Indian young adult sample. We suggest that the degree of other-ethnicity exposure plays a role in the ability to perceptually categorize other-ethnicity faces (Hancock & Rhodes, 2008; Meissner & Brigham, 2001; Walker & Hewstone, 2006). Observers are generally known to be better at recognizing own-ethnicity faces than other-ethnicity faces (e.g., Meissner & Brigham, 2001; Walker & Tanaka, 2003).

On the contrary, within our study, additional analysis was conducted at comparing accuracies for word and image categories (at pairing “Jane” and “Mary” images with category trait words) among other ethnicity and own ethnicity groups. The findings revealed that both groups were 90% accurate at associating trait words and images (refer to Appendix D, pg. 306), thus eliminating perceptual difficulties. This further suggests that other-ethnicity groups are in fact accurate at pairing word and image categories; however, they fail to recognize that cues to personality are present from target images. As such, this finding suggests that extraversion implicit judgements are more “culturally” specific, given own-ethnicity groups were both highly accurate and also produce an IAT effect, therefore suggesting that own-ethnicity groups implicitly detect cues to personality from target images and word categories.

However, to further unpack this issue, future studies must also explore face-trait judgements using Indian composite images to confirm this theory and similarly use the stimuli on Caucasian participants. That is, if Indian/Caucasian participants successful trait judgements are confined only to individuals matching their ethnicity, this would indicate an important clue about the processes underpinning face trait judgements. Individuals tend to form impressions of other-ethnicity individuals based on information that is passed on from ancestors or portrayal of characters from social media (England, Descartes, & Collier-Meek, 2011; Feinberg, Willer, & Schultz, 2014). Frequent encounters with other-ethnicity or own-ethnicity faces can shape the initial encoding process of faces (Walker & Tanaka, 2003). It has been previously established that people tend to form personality impressions of unfamiliar faces based on face shape and other facial cues present from encounters with people with similarities in facial features (e.g., Falvello et al., 2015; Verosky & Todorov, 2010). Researchers have also demonstrated that the process of the own-ethnicity effect is impacted by the level of social factors such as the degree of experience an individual has with another-ethnicity, i.e., when an individual has exposure to other-ethnicity groups, their performance might be similar to that of own-ethnicity participants (Walker et al., 2008; Walker & Hewstone, 2006). On the contrary, recent studies have demonstrated that own-ethnicity bias is unaffected by social contact (Wong et al., 2020). However, not including a social contact questionnaire in the current study is considered as a potential limitation.

Large scale visual memory studies have revealed that individuals have remarkable capacities to remember precise information from images (Brady et al., 2008; Vogt & Magnussen, 2007). This further suggests that observers possess the ability of facial memory independent of their previous experiences but are also able to reproduce memorable information across populations. For example, atypical faces are more likely to be remembered than familiar faces (e.g., Bartlett, Hurry, & Thorley, 1984; Valentine., 1991). Psychological factors play an essential role in culture. Some of these factors are more to do with emotion than cognition. There is evidently an interrelationship between emotion perception and cultural differences (Hunberg & Bodenhausen, 2003). This again is another explanation as to why other-ethnicity groups fail to recognize cues to personality present from Caucasian facial stimuli. Another possible explanation is the overgeneralization hypothesis, suggesting that universally, the functional mechanisms involved in the perception of emotions appear to be inter-linked to personality that can be misread from faces across cultures. Future studies could explore emotion perception along with personality judgements to bridge the gap in the literature (e.g., Elfenbein & Ambady, 2002; Russell, 1994). Another potential limitation in the current study is that we have not included measures for emotion and face identity recognition similar to previous chapters; however, the aim of the current chapter was to specifically establish whether other-ethnicity factors play a role in implicit extraversion trait judgements.

Thus, we suggest for future studies to establish the role of emotion and identity recognition processes associated with trait judgements among other-ethnicity groups. Furthermore, considering the population and diversity of India, a small sample size (N = 60) from predominantly one geographical location might not be sufficient to provide evidence to support other-ethnicity effects. Given there is mixed evidence regarding the social contact hypothesis, not including a contact questionnaire in our study could be considered as a potential drawback. Although statistically there was no IAT effect, with larger sample size and wider sample from different geographical locations, there is a possibility where other-ethnicity individuals with social contact would be able to form accurate first impressions. Given we have not measured face memory and emotion perception abilities among the other-ethnicity groups unlike our previous studies, this is also considered as a potential limitation. Thus, we imply future studies to include these cognitive measures to understand the potential mechanisms underpinning trait judgements using other-ethnicity groups.

9.6 Conclusion

In sum, we suggest that observers can reliably infer personality from faces, but this may be moderated by cultural factors and/or own versus other ethnicity experiences. In any case, this novel finding must be considered with some caution given the current study has considerable limitations. One of the potential limitations to the present study is the lack of information on exposure to Caucasian groups – it had been assumed that given the ubiquity of Western media, Indian participants would have some familiarity with Caucasian faces, but we had no means of independently measuring this. In order to make strong claims about the other-ethnicity/ own-ethnicity effects on trait judgements, we imply for future research to include replicating the ethnicity effect by developing Indian composite faces and testing Caucasian populations and vice versa. Increases in sample size will also likely produce a better quality of results as there remains a node of uncertainty based on whether the participants of this study had exposure to Caucasians. It would be interesting to also explore whether negative traits such as neuroticism can be predicted across cultures.

Chapter X

Impact of age on implicit judgements of Extraversion and Neuroticism personality traits

In the previous Chapters, we have demonstrated that factors such as autism, alexithymia, memory for faces, and emotion perception are unrelated to implicit personality judgements of *extraversion, agreeableness, and neuroticism* personality traits in *young* adults. We have also demonstrated that there is likely an other-ethnicity effect for implicit extraversion trait judgements, where own-ethnicity groups appear to be better at identifying implicit extraversion trait judgements from own-ethnicity faces compared to other-ethnicity groups. In the current Chapter, we seek to identify whether age plays an important role in implicit personality judgements – specifically judgements of extraversion and neuroticism. In addition, consistent with the previous studies we will also explore whether such judgements are moderated by autism traits, alexithymia traits, face memory and emotion perception.

10.1 Impact of age on personality judgements

Research has consistently demonstrated that age plays a major role in face recognition (Fulton & Bartlett, 1991). Face recognition studies using older adult samples have suggested that there exists a positivity bias among older adults. For example, older adults demonstrate a tendency to evaluate faces to be more trustworthy and less hostile with the bias marked extremely for threatening-looking faces or other negative stimuli (Bailey et al., 2013; Castle et al., 2012; Mather & Carstensen, 2003; Ruffman, Sullivan, & Edge, 2006; Zebrowitz et al., 2013). Furthermore, studies have demonstrated that older adults tend to perform poorer than younger adults in judgements of criminality (Smailes et al., 2018), aggressiveness (Boshyan, et al., 2014), and trustworthiness (Bailey et al., 2013). Overall, these studies have implied that older adults often exhibit poor personality judgements. However, these studies have predominantly used young adults' facial stimuli. Moreover, it is of note that, despite the extant literature available on first impressions from faces, there is a limited number of studies investigating the differences in positive and negatively regarded trait judgement mechanisms across ages.

The apparent age of a face acts as a relevant cue to personality judgements (Donnellan & Lucas, 2008; Satchell et al., 2019). In particular, participants can demonstrate an own-age bias, such that individuals demonstrate superior facial memory for own age faces versus other age faces (Wright & Stroud, 2002). Several face-based visual memory studies have investigated the impact of varying age of the faces presented across age groups (e.g., Anastasi & Rhodes, 2006; Fulton & Bartett, 1991; Perfect & Moon, 2005; Wright & Stroud, 2002) – and these have largely found that individuals tend to be better at identifying own-age faces compared to other-age faces. For example, Anastasi & Rhodes (2006) employed a recognition task using facial photographs of various ages to measure own-age bias in young (ages 18-25), middle-aged (ages 35-45) and older adults (ages 55-78) populations. The findings of this work revealed an own-age bias such that, when group age-matched stimulus set age, performance was the most superior. Similar to these findings, work by Fulton and Bartett (1991) also demonstrated that young adults were better at identifying young faces better than older faces, whereas no such 'bias' pattern was seen among older adults, where the older participants displayed no differences in accuracy for identifying both young and old faces. However, several other studies have found that even older adults show superior performance on age-matched face stimulus sets (e.g., Anastasi & Rhodes, 2005, 2006; Bäckman, 1991; Perfect & Harris, 2003; Perfect & Moon, 2005; Rhodes & Anastasi, 2012).

Age-related cognitive decline is evident from studies investigating face memory (e.g., Lamont, Stewart-Williams, & Podd, 2005; Lindholm, 2005) and face perception (e.g., Grady et al., 2000) in the cognitive psychology literature. Several studies using young adult faces as stimuli have reported that older adults exhibit poorer memory for faces in comparison with younger adults (Anastasi & Rhodes, 2005, 2006; Lamont, Stewart-Williams, & Podd, 2005; Searcy, Barlett & Memon, 2000; Searcy et al., 2001). It has been suggested that age-related decline begins at approximately 50 years of age. For example, Bowles et al., (2009) conducted a study on facial memory using young adults, middle-aged and older adults' samples who completed the Cambridge face memory task (CFMT). The findings of this study revealed that young adults and an early middle age group performed similarly, and participants who were in their 50's (ages 50-59) performed poorly compared to young adults, suggesting that age-related decline in face memory approximately begins in 50 years of age. However, studies investigating implicit and explicit memory have suggested that older adults tend to have better implicit memory than younger adults; and young adults tend to have better explicit memory than older adults (e.g., Gopie, Craik, & Hasher, 2011; Light & Singh, 1987). These studies suggested that age-related cognitive decline is more evident for explicit memory and is unaffected for implicit memory. Furthermore, these results may occur due to age-related changes in processing information associated with memory encoding and retrieval.

In addition to facial memory, it is also well known that there exists an age-related decline in emotion recognition among older adults. A large body of evidence has reported that older adults are often less accurate at identifying emotions from faces in comparison to younger adults (Calder et al., 2003; Isaacowitz et al., 2007; Ruffman et al., 2008; Sullivan et al., 2017; Visser, 2020). On the contrary, work by Palermo et al., (2018) has demonstrated that there was no association between age and emotion perception abilities suggesting that emotion perception is unaffected by age. Studies have reported that older adults tend to demonstrate better accuracy for positive emotions than negative emotions (e.g., Marther & Cartersen, 2003). Previous research has also indicated that individuals tend to process negative stimuli quicker than positive or neutral stimuli (Kuhbandner, Spachtholz & Pastötter, 2016; MacLeod & Ruthford, 1992; Mogg & Bradley, 1998). Given that the evidence considered for emotion processing among older adults have largely produced mixed results; and the differences in processing positive and negative affect characteristics largely vary between studies, in the current thesis we have considered age-related differences in positive and negatively regarded trait judgements and its associations with face memory and emotion perception.

In sum, the literature presented above suggests that ageing impacts a variety of judgements from faces (i.e., recognition and emotional judgements), we sought to establish if there might be age-related effects on the types of implicit personality judgements we have established in our testing of younger adults. In all, it is apparent that older participant groups can vary relative to younger participants in a number of the key dimensions of interest that we have identified earlier – and thus it may be the case that older adults may not be performing equivalently on our two IAT automatic personality trait judgement tasks. For the moment, this remains a key unanswered question that is explored by the current study. As such, we have considered whether variation in age affects trait judgements – that is the degree to which we may expect that testing with older populations may yield differing results from that seen in younger populations; and whether there likely exists an 'age effect' in processing implicit judgements of extraversion and neuroticism among an older adult sample. In this current chapter, we have conducted two behavioural experiments measuring implicit personality judgements among the older adult population, to determine comparative performance. In Experiment 1, using our individual differences approach, we have measured implicit personality judgements of *extraversion* personality trait and its relationship with autism traits, alexithymia traits, facial memory, and emotion perception in the older adult population (thus largely replicating what we have undertaken in our testing of younger adults earlier). In Experiment 2, we have measured implicit personality judgements of *neuroticism* personality traits and their relationship with autism traits, alexithymia traits, facial memory, and emotion perception in the older adult population. In addition, we sought to determine whether self-rated levels of neuroticism predicted IAT performance - in order to explore whether individuals with higher levels of neuroticism may be better at perceiving the same traits in others.

10.2 Experiment 1: Extraversion personality judgements from faces among the Older adult population

We have demonstrated in Chapter 5 that non-clinical young adult participants are able to make spontaneous implicit associations for extraversion personality traits using composite faces. Here we want to investigate whether older adults are able to make accurate implicit judgements of extraversion personality traits from faces using composite images and whether this ability is also predicted by other factors such as autism, alexithymia, face memory or emotion perception.

10.2.1 Method

A power analysis was conducted Using G* power (Faul et al., 2007) for older adults, expecting a minimum $n = 64$ in each study, where $\alpha = .05$, $\beta = .80$ and expected a conventionally medium effect size >.3. Where power issues have been reported based on sample size not being reached, a Bayesian approach has been reported for null hypothesis testing (See Dienes, 2014). This study followed the experimental structure outlined in the general methods section (see Chapter 4, pg. 68) with certain changes in the Emotion matching task structure that are described below. Questionnaires measuring the autism quotient (AQ) and alexithymia quotient were presented. Those were followed by the Extraversion IAT with facial composites - we used facial composite images of Caucasian young women (age *M* = 21.03, *SD* = 1.94) portraying neutral emotion who possessed high and low scores on extraversion personality traits (images are identical to the methodology used in Chapter 5 for Extraversion IAT), standard upright version of the CFMT and Emotion matching task without time limit. Using a between-group research design, older adult samples (*n* = 62, age *M* = 69.76, *SD* = 7.18; 32 females, 30 males) were recruited from the Swansea older adult volunteer participant panel.

Table 10.2.1: Descriptive Statistics for older adults performance on extraversion IAT and other factors (N = 62)

	Mean	**SD**	**Minimum**	**Maximum**
Age	69.76	7.17	57	89
IAT D	0.0003	0.48	-1.028	1.223
AQ	17.484	7.23	7	36
TAS20	44.565	11.92	23	88
CFMT	47.968	11.30	24	72
Emotion task	70.855	8.49	42	90

Note: IAT D – extraversion implicit personality, other factors: AQ – Autism traits, TAS20- alexithymia traits, CFMT – face memory, Emotion task – emotion perception.

All older adult participants took part in the study at the face research lab Swansea. Of the 62 participants, 1 participant scored high on the AQ scale (AQ score of ≥ 32) and 7 participants scored high on the TAS-20 scale (TAS-20 score of ≥ 61). To control for possible other ethnicity effects, this study only recruited a Caucasian older adult population (over 55 years of age). See table 10.2.1 above for participant descriptive statistics.

100 item Emotion-matching task (*Palermo et al., 2013*): this task involves identifying the odd emotion presented from faces displaying two similar emotions and one dissimilar emotion (e.g., one happy and two surprised faces). In the original task (See chapter 4 for detailed procedure), a 4500ms timer was included for image presentation after which the image disappears and an additional time window of 7000ms to make responses. If the participants are unable to make responses within this time frame, the response is encoded as ''timed out''. Several researchers have demonstrated that older adults take longer to process information compared to younger adults (e.g., Smailes et al., 2019; Zebrowitz et al., 2013). Initially, we conducted a pilot study examining whether older adults are able to complete the task efficiently with the timer but several blocks within the task were timed out for older adults. Hence, for a better quality of results, we have excluded the timer in the emotion matching task for older adults.

10.2.2. Results and Discussion

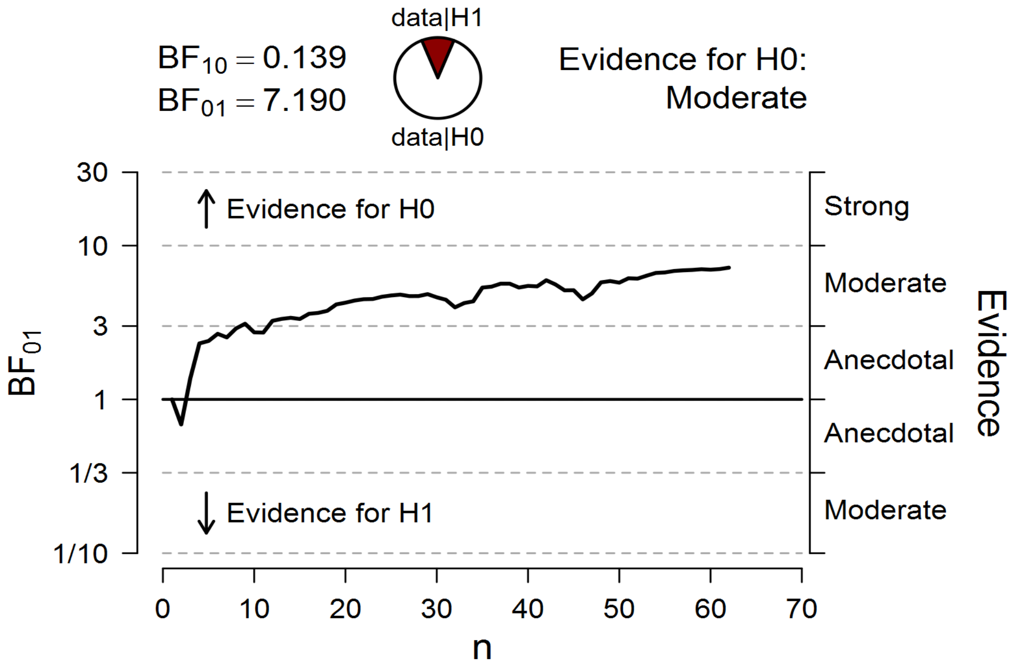
10.2.2.1 Do older adults perform the same way on the extraversion IAT?

The reaction time data obtained from the extraversion IAT was converted into IAT D scores using Python codes following the scoring algorithm (Greenwald, Nosek & Banaji, 2003) detailed in the general methods section in Chapter 4 (pg. 67). It was ensured that there were approximately equal number of participants in both conditions, congruent then incongruent (*N* = 32, *M* = -0.042, *SD* = 0.530); incongruent then congruent (*N* = 30, *M* = 0.045, *SD* = 0.426).

A one-sample *t*-test against chance (zero) was conducted to identify whether there was a significant relationship between faces and personality trait words. The results revealed that the older adults' sample did not significantly produce an extraversion IAT effect, *IAT D* = .0003 (*SD* = .48), 95% CI [-.12, .12] *t* (61) = .006, *p* = .996. It appears that older adults were unable to reliably make accurate implicit judgements of extraversion personality traits from faces. It is interesting to note that the IAT D score is approximately zero, denoting that there is not much difference in response latency between conditions.

To further explore the null hypothesis, we considered a Bayesian approach. A Bayesian one-sample t-test was conducted on the null hypothesis. The results revealed that there was moderate evidence for the null hypothesis H_0 with BF_{01} = 7.190, suggesting that these results support the acceptance of the null hypothesis. See Figure 10.2.1 for the sequential analysis of the Bayesian approach.

Figure 10.2. 1: Bayesian sequential analysis for Extraversion IAT among older adults

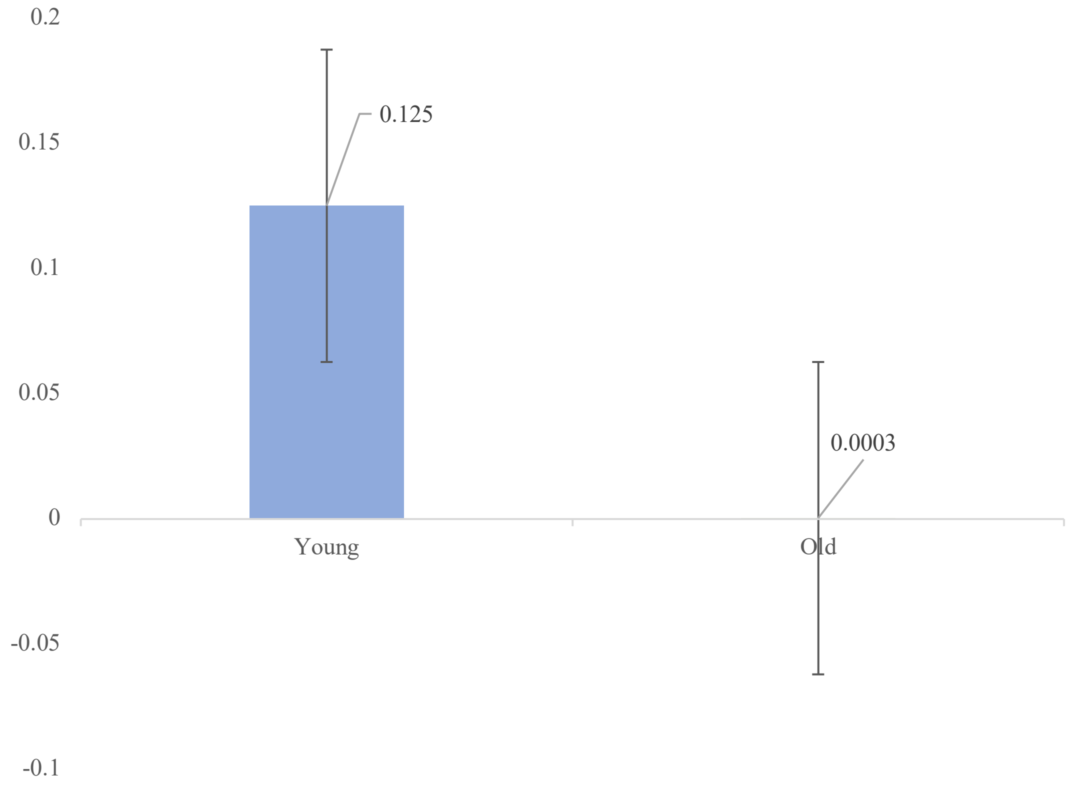


Note. The trend line represents the degree of evidence in favour of the null hypothesis (above the line for null hypothesis H_0 and below the line for alternative hypothesis H_1).

10.2.2.2. Group differences between young and older adult samples in Extraversion IAT

A two-tailed Mann-Whitney U-test was conducted to determine whether there were differences in the performances of young and older adult samples in identifying extraversion implicit personality trait judgements from faces using the IAT. To report group differences, we included the young adult extraversion IAT data from Chapter 5 (Experiment 1a, pg. 93) to conduct statistical analysis. A significant group difference was found between young and older adult participants in the extraversion IAT (U = 4323, p = .045, r = .18). The findings of this study revealed that young adults were better at associating extraversion images and extraversion trait words compared to the older adult sample (See figure 10.2.2). However, it is important to note that the

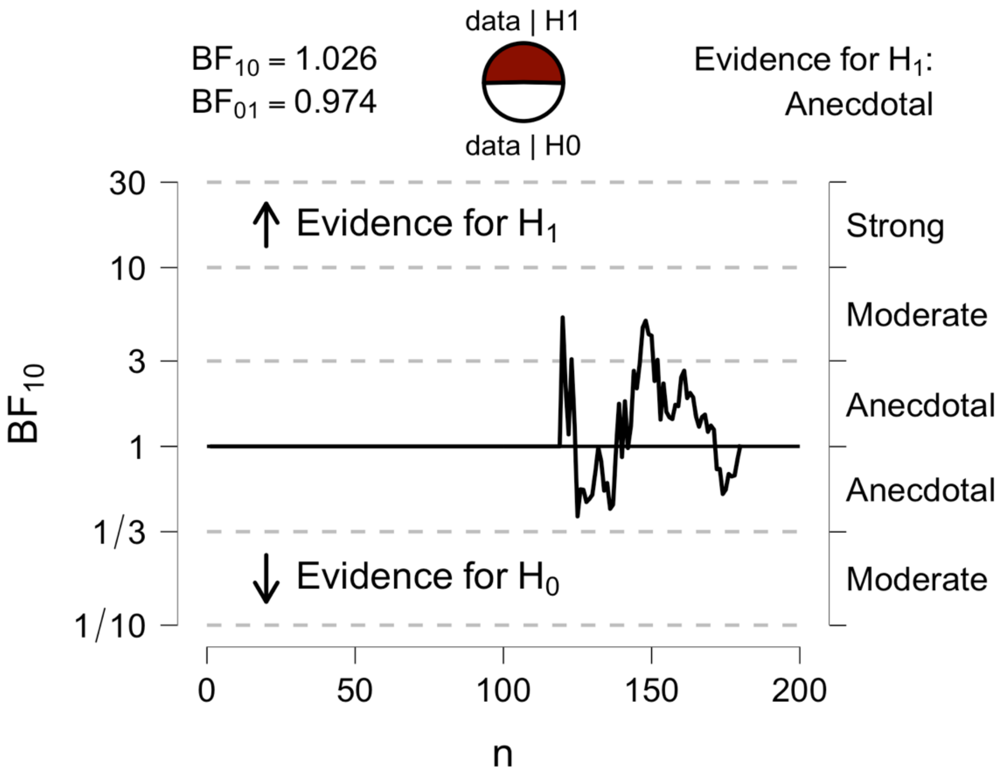
Figure 10.2.2:Extraversion IAT group differences between young and older adult samples



effect reported is small and therefore additional data is required to support this finding.

Furthermore, in order to rule out group differences driven by varying sample sizes; here we have also reported Bayesian methods. The Bayesian independent sample *t*-test revealed that there is anecdotal evidence towards the alternative hypothesis $BF_{10} = 1.026$. The sequential analysis (See figure 10.2.3) indicates that no conclusive results can be reached. Furthermore, it is interesting to note that the trend line on the data favours more towards the alternative hypothesis. Therefore, despite the frequentist approach indicating a significant difference, based on the findings of the Bayesian approach, there is minimal evidence to reject the null hypothesis.

Figure 10.2.3: Bayesian Sequential analysis showing group differences between young and older adults performances on the Extraversion IAT



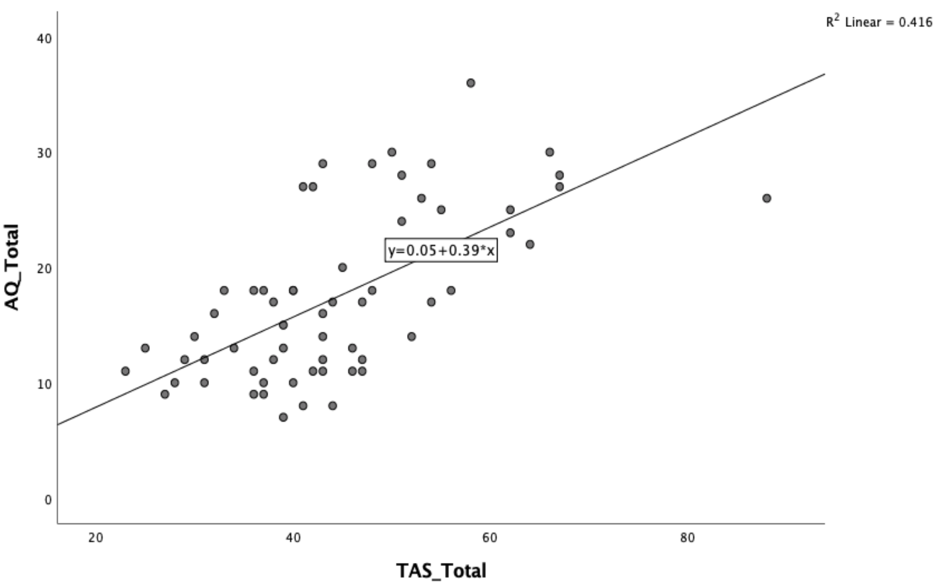
Note: The trend line represents the degree of evidence in favour of the alternative hypothesis H_1 (above the line for alternative hypothesis H_1 and below the line for null hypothesis H_0).

10.2.2.3. Correlational analysis between measures for older adults extraversion IAT

A two-tailed Pearson's and Spearman's correlation (where appropriate) was conducted to explore the relationship between implicit extraversion trait judgements (Extraversion IAT), autism traits (AQ and subscales), alexithymia traits (TAS20 and subscales), facial memory (CFMT) and emotion perception (Emotion matching task) among older adults.

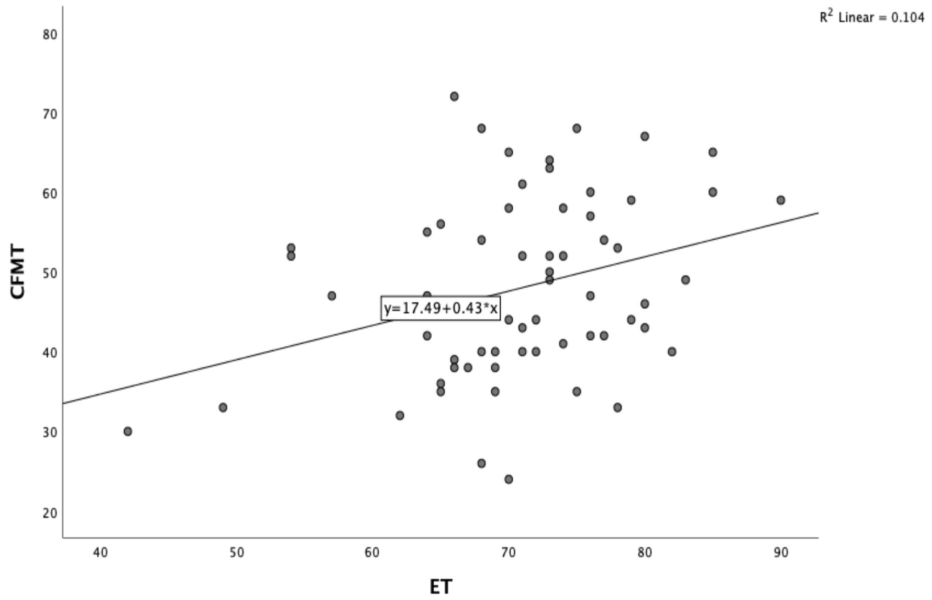
For the older adult group, consistent with previous work (e.g., Bird & Cook, 2013; Cook, Brewer & Shah, 2013), the correlations indicated a positive association between AQ and TAS scales (r (61) = .645, $p < .001$; see figure 10.2.4), demonstrating that increase in autism-like traits are associated with an increase in alexithymia traits. As demonstrated in previous work (Franklin & Adams, 2010; Palermo et al., 2013), there was a significant positive association between CFMT and Emotion task (*r* (61) = .323, *p* = .010; see figure 10.2.5), demonstrating that individuals with better face memory are also better at identifying emotions from faces. All other correlations were non-significant after applying Bonferroni corrections and considering Bayesian correlations. Additionally, we conducted a correlational analysis exploring whether extraversion IAT correlated with age (young and older adults). There was a negative association between extraversion IAT and age (*rs* (178) = -.165, *p* <.05), where accuracy for extraversion (IAT) implicit associations decreased with age. All other cognitive and behavioural measures produced non-significant correlations against extraversion IAT (See figure 10.2.6). Given this effect is weak, further research is required to explore and substantiate this association.

Figure 10.2. 4: Correlation plots for Autism traits vs Alexithymia traits among older adults



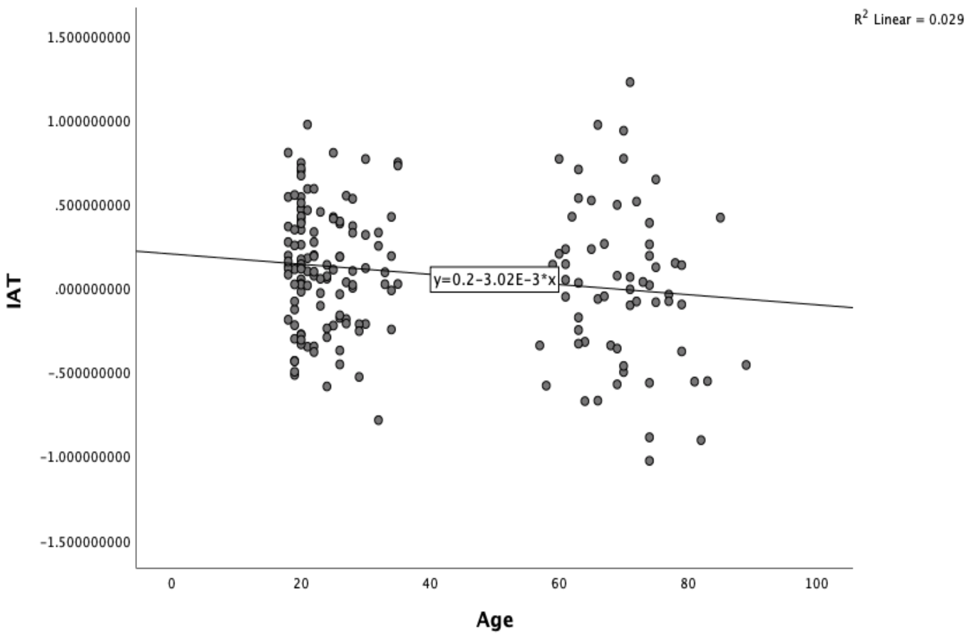
Note: Scatterplot for total scores on the AQ- autism and TAS20 - alexithymia scales.

Figure 10.2.5: Correlation plots for Facial memory and Emotion perception among older adults



Note: Scatterplot for total correct responses on the CFMT- face memory and ET – emotion perception tasks.

Figure 10.2.6: Correlation plots for age and Extraversion IAT



Note: Scatterplot for age and IAT- implicit trait judgement measure.

10.2.2.4. Regression analysis

A multiple linear regression analysis (using enter method) was conducted to explore whether implicit extraversion personality judgements were significantly predicted by age, autism quotient, alexithymia quotient, facial memory, and emotion perception. Tests for Multicollinearity were conducted by calculating the Variance of Inflation Factor (VIF) in SPSS. A rule was employed where VIF values < 10, were acceptable measures of Multicollinearity (Gordon, 2015; O'Brien, 2007). Given that for all variables VIF factors were < 2, as such all variables were included in the regression model. Firstly, we considered whether age was a significant predictor for extraversion trait judgements performance on the IAT for young and older adults.

The results indicated that (F (1, 178) = 5.299, $p < .05$, $R^2 = .029$), age significantly predicts extraversion implicit associations ($\beta = -0.17$, $p < .05$). Secondly, regression analysis was conducted on the older adults' group extraversion IAT performance versus factors such as autism quotient, alexithymia quotient, facial memory, and emotion perception. As such the results indicated that that was no significant effect between extraversion IAT and AQ, TAS, CFMT and Emotion task (F (4, 57) = .202, $p = .32$, $R^2 = .078$). Consistent with the findings reported in previous empirical chapters, the regression analysis revealed that implicit extraversion trait judgements from faces are unrelated to factors such as autism quotient, alexithymia quotient, facial memory, and emotion perception, implying a unique ability (See Table 10.2.2 for detailed results of the regression).

Table 10.2.2: Multiple linear Regression analysis for older adults extraversion IAT

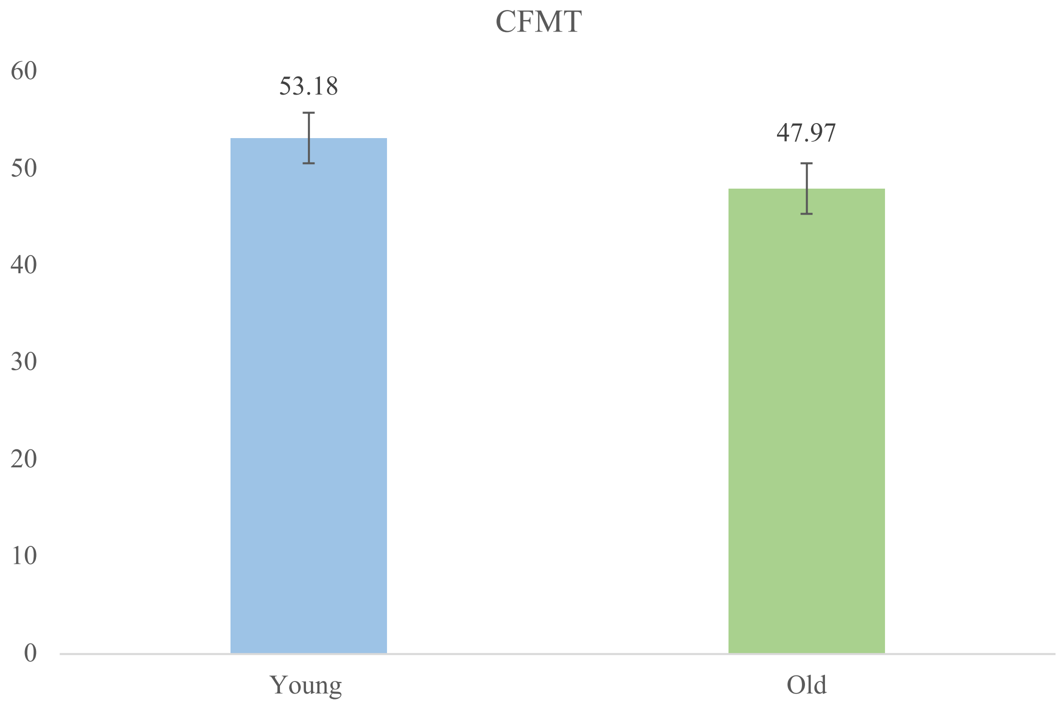
	t	p	β	F	df	p
IAT						
Model				5.299	1,178	.022
Age	-2.30	.022	-0.170			
Older adults	**(IAT)**					
Model				1.202	4,57	.320
AQ	-.137	.891	-.023			
TAS20	-.810	.421	-.135			
CFMT	1.499	.139	.203			
Emotion task	.467	.642	.065			

Note: AQ – Autism traits, TAS20- alexithymia traits, CFMT – face memory, Emotion task – emotion perception.

10.2.2.5 Exploring age-related effects on face recognition memory

A one-tailed independent sample t-test was conducted to determine whether there were differences in the performances of young and older adult samples for facial memory using the CFMT. A significant group difference was found between young and older adults' performance in the CFMT (t (178) = 3.272, p < .001, d = .51), indicating that younger adults were indeed better at face recognition (see figure 10.5 for group differences in CFMT), a finding that is consistent with other previous work (e.g., Lamont et al., 2005; Lindholm, 2005).

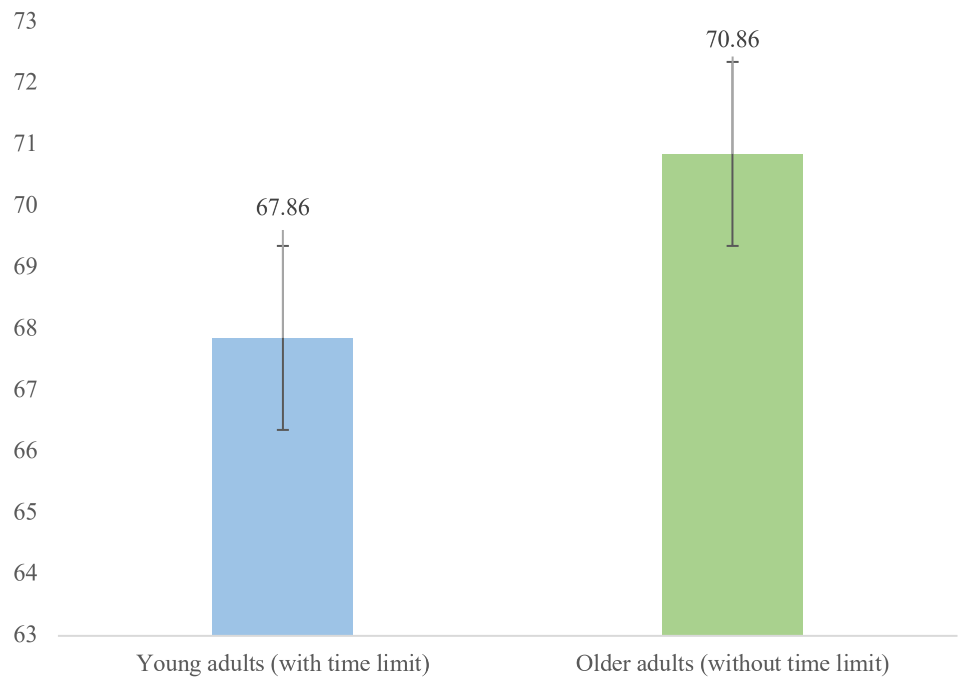
Figure 10.2.7: group differences in the face memory task performances for young and older adults.



10.2.2.6 Emotion perception abilities among older adults

Group differences are reported for younger and older adults on the emotion matching task as a comparison although there are potential differences in the methodology which is reported in the Methods section (10.2.1). An independent sample t-test revealed no significant difference between groups (p >.05). However, it is interesting to notice that older adults are able to accurately sort emotions from faces (M = 70.855, SD = 8.491) and as comparison mean accuracy for younger participants was (M = 67.42, SD = 8.257). Also see figure 10.6 for group differences. From these findings, it appears that with higher processing time, older adults show better accuracy for facial expression perception from faces. However, we also compared the response latency from the emotion matching task. An independent sample t-test on the average

Figure 10.2.8: group differences for young and older adults in their performances of emotion perception



reaction times revealed that older adults' groups (average latency *M* = 4496.162, *SD* = 1614.680) significantly take longer than young adults (average latency *M* = 2081.40, *SD* = 410.10) groups in emotion perception abilities (t (175) = 15.33, p<.001, d = 2.44).

10.2.3 Summary of findings

From the findings reported in Experiment 1, it appears that older adults were unable to make accurate spontaneous associations between extraversion composite faces and extraversion trait words. Moreover, older adults' performance on the extraversion IAT was not predicted by other cognitive and behavioural factors such as autistic traits, alexithymia traits, facial memory, and emotion perception. Additionally, age was a significant predictor for extraversion IAT where young adults were better at making implicit extraversion judgements from young composite stimuli in comparison with older adults. Furthermore, Older adults also show an age-related decline in facial memory. When older adults are given a longer time to process emotions from faces, they are able to accurately differentiate emotions from faces.

In all, we have established that older adults are unable to form accurate judgements of extraversion. Previous studies have suggested that older adults show poor accuracy for personality judgements such as trustworthiness (Bailey et al., 2015; Castle et al., 2012) and perception of threat (e.g., Ruffman, Sullivan, & Edge, 2006). Following this work, given we had also determined that young adults were able to make accurate judgements of neuroticism personality traits from faces in Chapter 7. As such, in Experiment 2, we sought to investigate whether older adults are similarly able to make spontaneous first impressions of neuroticism personality traits from faces.

10.3 Experiment 2: Neuroticism personality traits from faces in the Older adult population

We have demonstrated in Chapter 7 that younger adults were able to make spontaneous implicit associations for *neuroticism* personality traits using young adult composite facial stimuli. Here we want to investigate whether *older* adults can make accurate implicit judgements of neuroticism personality traits from faces using composite images and if so, is this ability predicted by autism traits, alexithymia traits, self-perception of neuroticism, facial memory, and emotion perception.

10.3.1 Methods:

This study followed the experimental structure outlined in the general methods section (see Chapter 4, pg. 67) with an inclusion of a personality inventory measure described below. All other aspects of the method are identical to Experiment 1 within this chapter, except the novel version of neuroticism IAT with young faces. Caucasian young women (age *M* = 21.03, *SD* = 1.94) portraying neutral emotion who possessed high and low scores of neuroticism personality traits in the short version of the international personality inventory were used as facial composites stimuli.

Mini–International personality inventory (IPIP; Donnellan et al., 2006): the IPIP is a short version of the questionnaire measuring the five-factor model of personality developed by Goldberg (1999). The IPIP consists of 20 questions that measure the big 5 traits with 4 questions per trait. Participants were asked to indicate how much they agree or disagree with each statement using the Likert scale where "1 = strongly disagree to 5= strongly agree". After scoring the questionnaire, only neuroticism personality trait scores for all participants were included in the statistical analysis.

Questionnaires measuring autism quotient (AQ), alexithymia quotient (TAS) and personality inventory (Mini IPIP) were presented. Those were followed by a novel version of the neuroticism IAT with facial composites, a standard upright version of the CFMT and an Emotion matching task without a time limit. Using a between-group research design, the older adult participants (*N* = 50, age *M* = 67.96, *SD* = 8.82; 31 females, 29 males) were recruited from the Swansea older adult volunteer participant panel. All the older adult participants came to the face research lab Swansea to take part in the study. Out of the 50 participants, 1 participant scored high on the AQ scale (AQ score of ≥ 32) and 3 participants scored high on the TAS-20 scale (TAS-20 score of ≥ 61). To control for possible other ethnicity effects, this study only recruited the Caucasian older adult population (age 55 above). See table 10.3.1 for participant descriptive statistics.

Table 10.3.1: Descriptive Statistics for older adults' performance on neuroticism IAT and other factors (N = 50)

	Mean	Std. Deviation	Minimum	Maximum
Age	67.960	8.822	55	89
IAT D score	.140	.422	-.596	1.152
AQ	14.940	6.988	6	33
TAS20	42.680	11.790	22	75
Mini-IPIP (Neuroticism)	9.780	3.112	4	16
CFMT	48	10.654	22	71
Emotion task	69.760	9.417	37	85

Note: IAT D – neuroticism implicit personality, other factors: AQ – Autism traits, TAS20- alexithymia traits, mini-IPIP – self-perception of personality, CFMT – face memory, Emotion task – emotion perception.

10.3.2 Results and Discussion

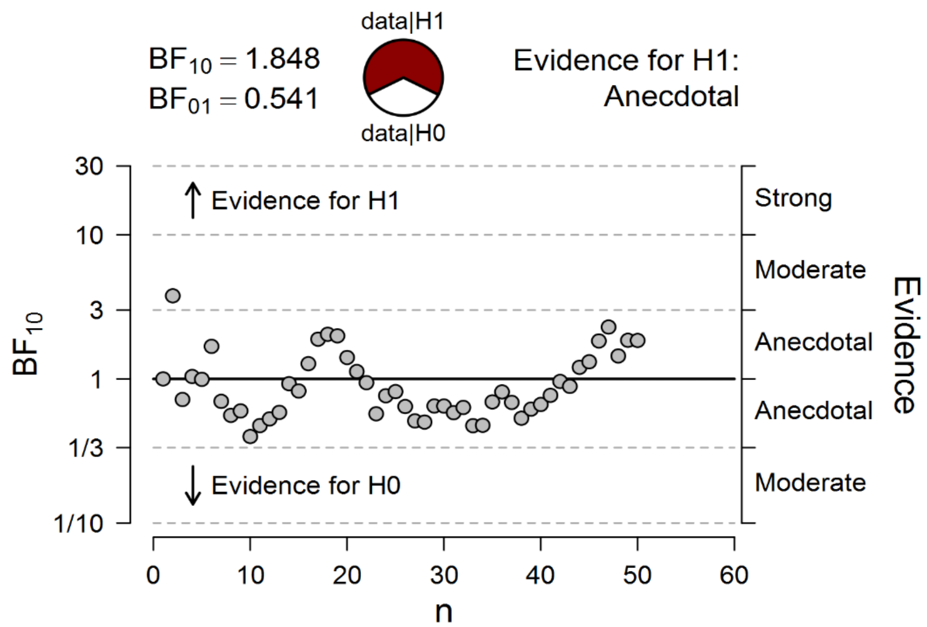
10.3.2.1 Do older adults from accurate implicit neuroticism trait judgements?

The reaction time data obtained from the neuroticism IAT was converted into IAT D scores using Python codes following the scoring algorithm (Greenwald, Nosek & Banaji, 2003) detailed in the general methods section in Chapter 4 (pg. 67). It was ensured that there were approximately equal number of participants in both conditions, congruent then incongruent (N = 24, M = .056, SD = .422); incongruent then congruent (N = 26, M = .218, SD = .416).

A one-sample t-test against chance (zero) was conducted to identify whether there was a significant relationship between faces and personality trait words. The results revealed that the older adults were accurately able to make implicit associations of neuroticism personality trait from faces $IAT\ D$ = 0.14 (SD = .42), 95% CI [.020,

.260] t (49) = 2.346, p = .023, d = .33. Participants were faster and more accurate on trials where high neuroticism faces were paired with high neuroticism words and on trials where low neuroticism faces were paired with low neuroticism words. These results are thus the first to reveal that neuroticism personality traits can be judged accurately and implicitly from facial structure among the older adult population. However, a Bayesian one-sample t-test revealed that these results show anecdotal evidence for the alternative hypothesis H_1 with BF_{10} = 1.848, suggesting that additional data is required to substantiate this finding. However, it is interesting to note from the figure presented below (See Figure 10.3.1 for the sequential analysis of the Bayesian approach) that the trendline is favouring the alternative hypothesis H_1, suggesting that older adults can make accurate implicit judgements of neuroticism personality traits from faces.

Figure 10.3.1: Bayesian sequential analysis for older adults neuroticism IAT performance

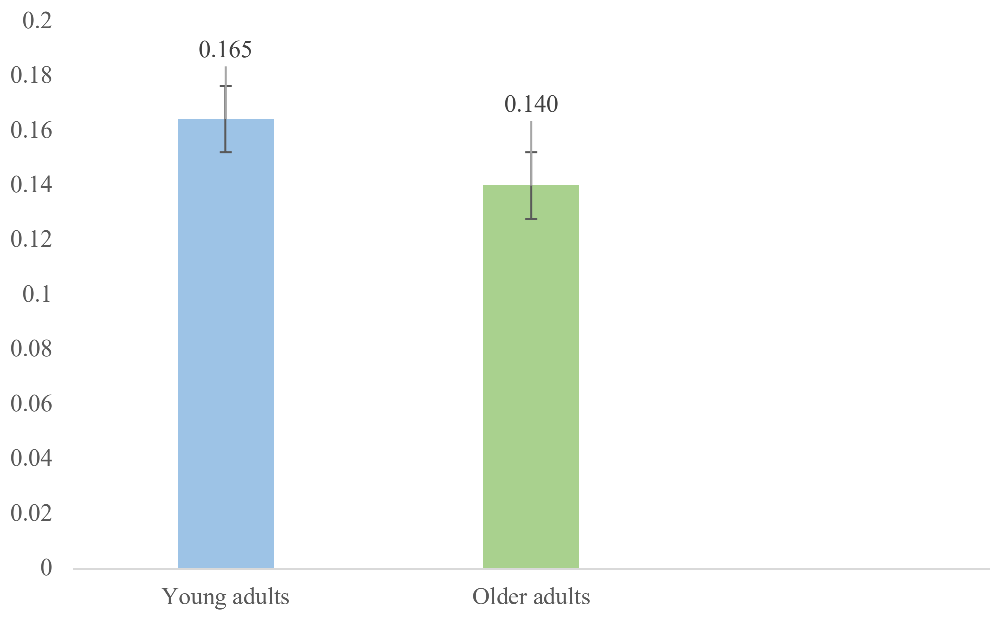


Note. The trend line represents the degree of evidence in favour of the alternate hypothesis (above the line for alternative hypothesis H_1 and below the line for null hypothesis H_0).

10.3.2.2 Neuroticism IAT performance across age groups.

Using the young adult neuroticism IAT data from Chapter 7 (pg. 143), we have compared the differences between young and older adult group performances on the neuroticism IAT. An independent sample *t*-test was conducted to determine whether there were differences in the relative performances of the two age group samples on our neuroticism IAT task and the results revealed that there were no significant group differences between young and older adults' performance on the neuroticism IAT ($p > .05$; See figure 10.3.2).

Figure 10.3.2: group differences between young and older adults in the neuroticism IAT.

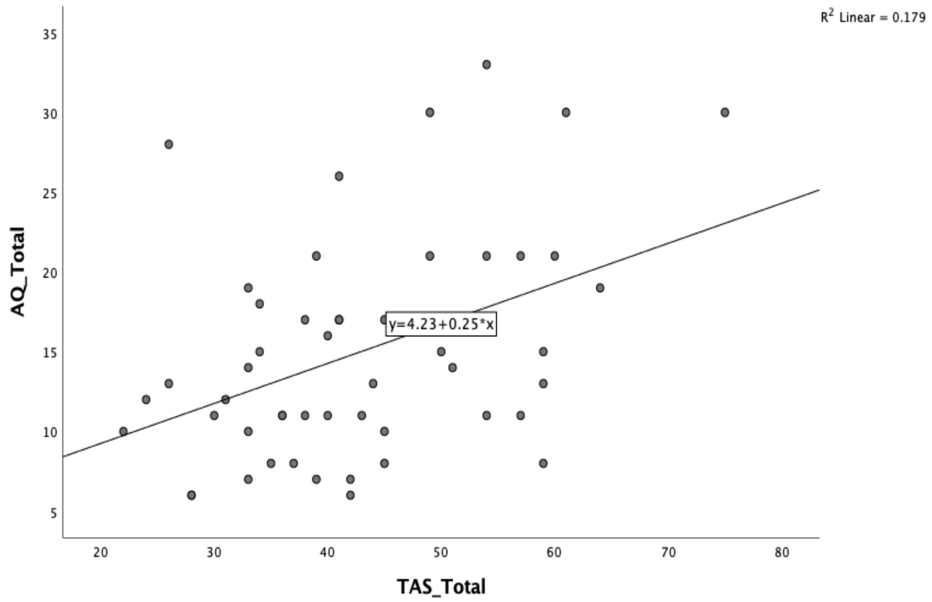


10.3.2.3. Correlational analysis between measures for older adults neuroticism IAT

A two-tailed Spearman's correlation was conducted to explore the relationship between implicit neuroticism trait judgements (Neuroticism IAT), autism traits (AQ and subscales), alexithymia traits (TAS20 and subscales), self-perception of neuroticism (Mini IPIP neuroticism scores), facial memory (CFMT) and emotion perception (Emotion matching task) among older adult samples.

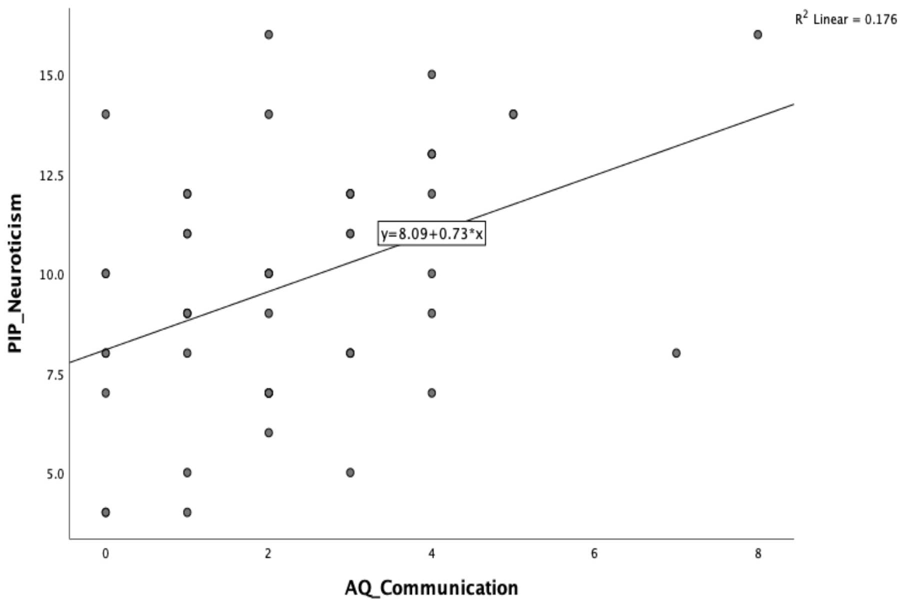
Similar to the findings reported in Experiment 1, Neuroticism IAT produced non-significant correlations against other cognitive and behavioural factors. Similarly, supporting previous work (e.g., Darbyshire et al., 2016; Satchell et al., 2019), self-perception of neuroticism was unrelated to implicit judgements of neuroticism. The results of Spearman's rho indicated a positive association between AQ and TAS scales (*rs* (48) = .0.376, *p* <. 007), where high autism scores were associated with high alexithymia scores (e.g., Bird & Cook, 2013; Cook, Brewer & Shah, 2013; see figure 10.3.3); a positive association between AQ subscale – communication and self-reported neuroticism scores (*rs* (48) = 0.390, *p* = 0.005), where high scores on the communication sub-scale were associated with high self-reported neuroticism scores (see figure 10.3.4). As demonstrated in previous work (Palermo et al., 2013; Franklin & Adams., 2010), there was a positive association between facial memory and emotion perception among the older adult group (*rs* (48) = .0.341, *p* = 0.015), where high accuracy for facial memory was associated with high accuracy for emotion perception (e.g., Franklin & Adams, 2010; Palermo et al., 2013; see figure 10.3.5). However, after applying Bonferroni's correction, these correlations were non-significant. All other correlations were non-significant between measures after applying Bonferroni's corrections and considering Bayesian correlations.

Figure 10.3. 3: Correlation plots for Autism traits vs Alexithymia traits among older adults



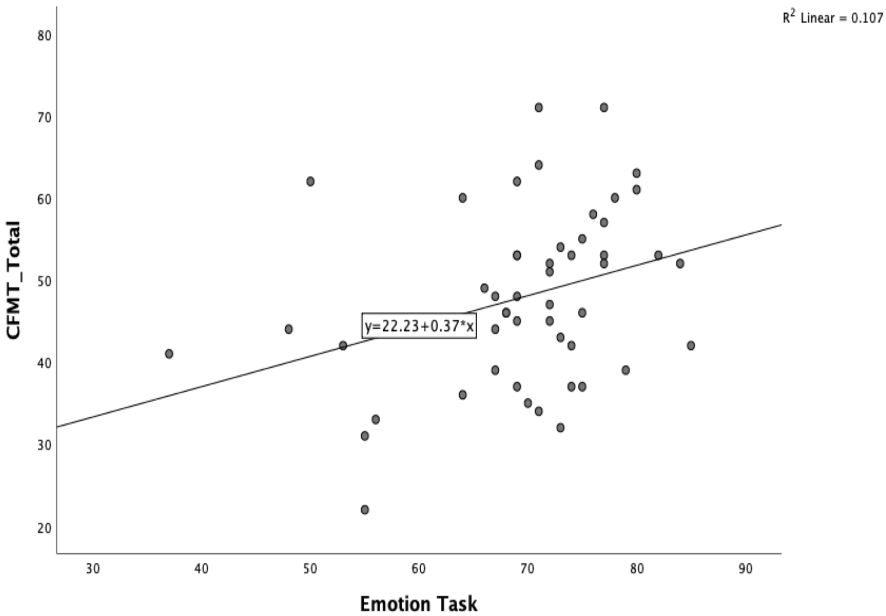
Note: Scatterplot for total scores on the AQ- autism and TAS20 - alexithymia scales.

Figure 10.3. 4: Correlation plots for self-report neuroticism vs Autism Quotient subscale - Communication



Note: Scatterplot for total scores on the AQ- subscale – difficulties with communication and self-perception neuroticism scales.

Figure 10.3.5: Correlation plots for facial memory vs emotion perception among older adults



Note: Scatterplot for total correct responses on the CFMT- face memory and emotion perception tasks among older adults

Additionally, we explored age (young and older adult groups) against other measures. There was a negative association between Age and AQ-subscale attention switch (*rs* = -.255, *p*<.001), where difficulties in attention switching were associated with lower age. Similarly, there was a negative association between age and alexithymia traits (*rs* (168) = -.249, *p* = .001), where young adults appear to report more alexithymia like traits compared to older adults. Specifically, the TAS-subscale describing feelings negatively correlated with age (*rs* (168) = -.29, *p* <.001). There was a negative association between age and self-perception neuroticism (*rs* (168) = -.235, *p* = .002), where young adults self-reported to have more neuroticism traits in comparison with older adults. However, the means of both groups are on the lower band of these scales. These correlations were non-significant after applying Bonferroni's corrections and considering Bayesian correlations.

10.3.2.4. Regression analysis

A multiple linear regression analysis (using the enter method) was conducted to explore whether this ability to form implicit associations of neuroticism personality trait judgements from faces can be predicted by factors such as autism quotient, alexithymia quotient, self-neuroticism rating, facial memory, or emotion perception (See table 10.3.2). Additionally, similar to Experiment 1, age was included as a predictor for young (from Chapter 7) and older adults' performance on the neuroticism IAT. Tests for Multicollinearity were conducted by calculating the Variance of Inflation Factor (VIF) in SPSS. For all variables, VIF factors were < 2, as such no variables were excluded in the regression model.

Table 10.3.2: Multiple Linear regression Analysis for Older adults performance on the Neuroticism IAT

	t	p	β	F	df	p
IAT						
Model				0.001	1,168	0.97
Age	-.033	0.97	-0.003			
Older adults IAT						
Model				0.236	5, 44	0.945
AQ	0.967	0.339	0.164			
TAS20	-0.204	0.839	-0.035			
Self-perception	-0.253	0.801	-0.042			
CFMT	0.123	0.903	0.020			
Emotion task	-0.503	0.617	-0.080			

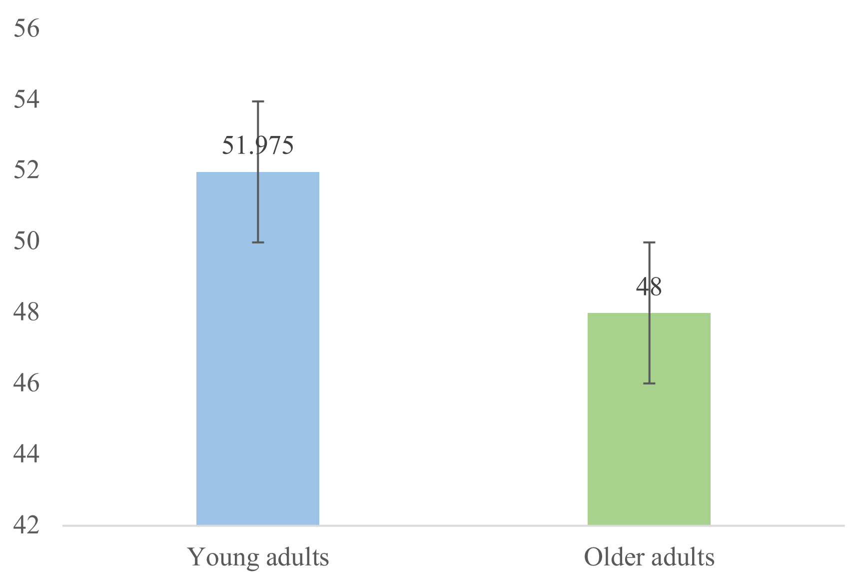
Note: Self-perception of neuroticism, AQ – Autism traits, TAS20- alexithymia traits, CFMT – face memory, Emotion task – emotion perception.

Consistent with the findings reported in previous Chapters, the findings of the current study indicated that older adults' performance on the neuroticism IAT was not predicted by age, autism traits, alexithymia traits, self-perception of neuroticism, facial memory, or emotion perception (F (5, 44) = .236, p = .945, R^2=.026). The results suggest that the ability to identify neuroticism personality traits implicitly from faces is unrelated to other cognitive and behavioural factors including age.

10.3.2.5 Exploring age-related effects on face recognition memory

A one-tailed independent sample t-test was conducted for young and older adults performance on the CFMT. The results revealed that there was a significant group difference between young and older participants accuracy for facial memory (t (159) = 3.174, p = .002, d = .541). The findings of this study revealed that young adults statistically significantly show better accuracy for facial memory compared to older adults. This is similar to the findings reported in Experiment 1 and other related studies (e.g., Boshyan et al., 2014; Lamont, Stewart-Williams, & Podd, 2005). See figure 10.3.6 for group differences.

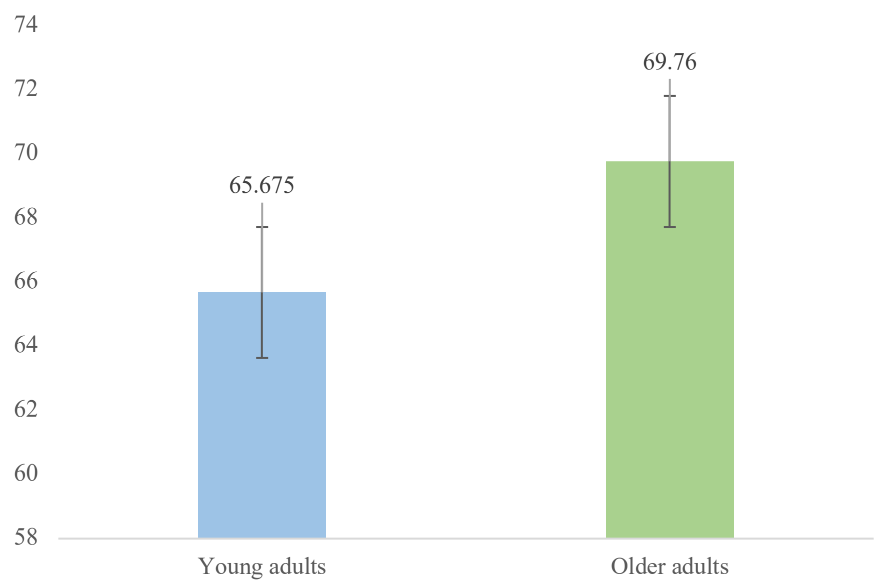
Figure 10.3.6: Showing group differences in the CFMT for young and older adults.



10.3.2.6 Emotion perception among older adults

Group differences are reported for younger and older adults on the emotion matching task as a comparison although there are potential differences in the methodology which is reported in the Methods section (10.2.1). An independent sample t-test revealed no significant difference between groups ($p>.05$). However, it is interesting to notice that older adults are able to accurately sort emotions from faces (M = 69.76, SD = 9.417) with a similar mean accuracy to that of the younger participants (M = 65.68, SD = 10.55; also see figure 10.3.7 for group differences). Therefore, from these findings, we suggest that with higher processing time, older adults show better accuracy for facial expression perception from faces. These findings are consistent with what was reported in our extraversion sample group comparisons discussed earlier. The older adults' group (average latency M = 4311.756, SD = 1486.13) significantly take longer than young adults (average latency M = 1898.76, SD = 560.37) groups in emotion perception abilities ($t(168) = 15.40, p<.001, d = 2.59$).

Figure 10.3. 7: Young and Older adults' performances on emotion perception



10.3.3. Summary of findings

1) Unlike implicit judgements of extraversion personality traits from faces, older adults were able to make accurate implicit judgements of neuroticism personality traits from faces. Despite using young women composite images in this study, older adults were able to form accurate judgements. This ability was also unrelated to autistic traits, alexithymia traits, self-perception of neuroticism, facial memory, and emotion perception (consistent with our previous work with younger participants in Chapter 7). Supporting previous research, the current study's findings have reported that self-perception of neuroticism does not affect personality trait judgements accuracy of strangers (e.g., Satchell et al., 2019; Shevlin et al., 2003). Although several studies have implied that older adults tend to show positivity bias (e.g., Castle et al., 2012; Zebrowitz et al., 2013), in this study older adults were able to make accurate implicit judgements of neuroticism personality trait which is regarded as a negative personality trait.

2) Age and facial memory: Consistent with previous literature (e.g., Anastasi & Rhodes, 2005, 2006; Bowles et al., 2009; Searcy, Barlett & Memon, 2000; Searcy, Bartlett, Memon, & Swanson, 2001; Lamont, Stewart-Williams, & Podd, 2005; Boshyan et al., 2014), in Experiments 1 and 2, we have reported that older adults are less accurate and show age-related decline in tasks relating to facial memory. Younger adults tend to show better accuracy for face recognition memory compared to older adults.

3) Age and emotion perception: Despite several studies suggesting that older adults exhibit poor accuracy for identifying emotions from faces (Calder et al., 2003; Isaacowitz et al., 2007; Ruffman et al., 2008), in this current Chapter we have demonstrated that older adults appear to show (in principle) better accuracy for facial emotion perception. It also appears that there is no own-age bias in matching emotions from faces.

4) there were significant correlations between autism and alexithymia traits; face memory and emotion perception abilities; self-perception neuroticism and autism-subscale communication among older adults.

10.4 General Discussion

The current Chapter explored whether age plays a major role in making spontaneous associations of extraversion and neuroticism personality trait judgements using the IAT and whether such ability is related to autism traits, alexithymia traits, self-perception of neuroticism, facial memory, and emotion perception.

The Impact of Age on implicit personality judgements

Given that the ability to make implicit accurate judgements of personality remains a unique automatic process independent of cognitive and behavioural factors, we then investigated whether this pattern generalised to older participants. Our previous study (Chapter 9) suggested that ethnicity may moderate accurate face base trait judgements, as a consequence we sought to determine if a within ethnicity factor (age) may equally moderate performance. In this case, we sought to determine if older adults could reliability make implicit trait judgements specifically for extraversion and neuroticism. Within our thesis, these two traits have demonstrated accurate implicit judgements from faces in a young adult Caucasian sample. Hence it was interesting to explore a positively regarded trait such as extraversion and a negatively regarded trait such as neuroticism personality judgements using older adult samples. In addition, consistent with the previous studies we explored whether these judgements are moderated by cognitive and behavioural factors such as autism traits, alexithymia traits, self-perception of neuroticism (for neuroticism IAT), facial memory and emotion perception.

The findings of the current Chapter are the first to report implicit personality trait associations for extraversion and neuroticism traits among an older adult sample using young women composite facial stimuli. The findings of our studies demonstrated that older adult participants presented an own-age effect for implicit personality judgements of extraversion where older adults were unable to reliably make accurate implicit judgements of extraversion personality traits from young composite facial stimuli. Supporting previous evidence, the younger adult sample were better at face trait judgements of extraversion for young facial stimuli compared to older adults (e.g., Anastasi & Rhodes., 2006; Bäckman, 1991). Unlike extraversion, older adults were able to make accurate implicit judgements of neuroticism from young composite facial stimuli. These results are thus the first to reveal such associations among older adults. There were no group differences reported for young and older adults in their neuroticism trait judgements performances. However, in either of these studies, the relationship between trait judgements and autism traits, alexithymia traits, facial memory and emotion perception remain unrelated and independent.

These results imply that whatever process is utilised that interprets the 'signals' for extraversion in our young adults face stimuli, this is not universally true of all participants. On the contrary, the processes utilised to interpret the 'signals' of neuroticism from young composite facial stimuli appears to be universally true across ages. Our interpretation of these findings is that there likely exists a variation in the mechanism employed to make implicit trait judgements on the nature of the trait itself. Thus, there may be differences in the way positive and negative traits are processed in the cognitive face processing system. As such, suggesting that cues to negative traits such as neuroticism are strongly available from young faces as compared to extraversion personality traits.

It has been implied that people tend to be more proficient and show better accuracy for recognizing individuals from their own group compared to other groups. For example, face recognition studies using unfamiliar faces have reported that participants tend to be better at identifying unfamiliar faces of own ethnicity, age, and gender (Childs et al., 2021; Fulton & Bartett., 1991; Meissner & Brigham, 2001; Over & Cook, 2018; Wright & Stroud, 2002). Furthermore, studies on implicit and explicit memory have suggested that older adults tend to be better than younger adults with implicit memory (Gopie et al., 2011; Light & Singh, 1987). Additionally, studies have also reported that older adults tend to show a positivity bias where they interpret untrustworthy faces as more trustworthy and approachable in comparison with young adults and the ratings did not differ for judgements of trustworthiness across ages (Castle et al., 2012; Smailes et al., 2018). It has also been suggested that older adults remember positive information better than negative information (e.g., Charles, Mather, & Carstensen., 2003; Mather & Cartensen., 2003). Given in our studies, older adults are able to form accurate judgements for neuroticism but not extraversion using young facial stimuli, a general own-age bias effect is unlikely to explain the different patterns of performance. Given that facial memory was unrelated to implicit personality judgements across ages (for extraversion and neuroticism), own-age bias and positivity bias does not explain the findings reported in our studies; we suggest that mechanisms employed for personality perception by young and older adults could differ at implicit levels of cognition based on the trait affect itself (extraversion and neuroticism).

Given that in comparison with young adults, older adults tend to show a positivity bias where they interpret untrustworthy faces as more trustworthy and approachable, and do not differ in judgements of trustworthiness from faces for young and older adults (Castle et al., 2012; Smailes et al., 2018); we imply that facial cues about negatively perceived traits are known to be better remembered. In relation to facial memory, studies have reported that negative traits such as untrustworthiness are more memorable from faces (Bayliss & Tipper, 2006; Mealey, Daood, & Krage, 1996; Rule, Slepian, & Ambady, 2012). Negative traits might signal facial cues that communicate potential harm (Buchner et al., 2009; Suzuki & Suga, 2010; Young et al., 2012). On the contrary, it has also been suggested that older adults remember positive information better than negative information (e.g., Charles, Mather, & Carstensen., 2003; Mather & Cartensen., 2003). However, the findings have revealed that there was no own-age bias for neuroticism face judgements, we suggest that neuroticism personality trait characteristics are more clearly available from young faces. The reasons for the variability of the findings presented across both studies may centre on cue availability from faces for positive and negative traits that underlie social perceptions. For example, Zebrowitz et al., (2013) has suggested that traits such as hostility and competence can be clearly communicated from young facial stimuli and variations in health and aggressiveness from older facial stimuli.

Further, age-related differences in memory and emotion perception abilities have been reported. Consistent with previous literature, older adults performed poorly on tasks related to facial memory compared to young adults. Implying that there is an age-related decline in facial memory (Bowles et al., 2009; Searcy, Barlett & Memon., 2000). In addition to facial memory, it is also well known that there exists an age-related decline in emotion recognition among older adults. A large body of evidence has reported that older adults are often less accurate at identifying emotions from faces in comparison to younger adults (Calder et al., 2003; Isaacowitz et al., 2007; Ruffman et al., 2008; Sullivan et al., 2017; Visser, 2020). Our findings, on the contrary, has revealed that older adults show normal emotion recognition abilities in time unconstrained conditions, i.e., older adults show equivalent accuracy performance when provided more time to do so. This is consistent with research indicating that age-related changes are generally linked to information processing speed (e.g., Ketcham & Stelmach, 2001) and thus reflects a general impact in the way that older adults exhibit longer responses when using computers. Previous research has indicated that when response times are not provided, it is possible that the high accuracy in such tasks that appear to indicate a normal performance may be shadowed by the application of successful, but abnormal facial feature matching strategies (Busigny et al., 2014; Duchaine & Nakayama, 2004; Farah, 2004). This finding is also supported in this thesis, where the results of the emotion expression perception tasks indicated that older adults were significantly slower than young adults.

Although studies presented above have suggested that ageing impacts a variety of judgements from faces such as facial memory and emotion perception, the age-related effects on personality judgements remain unclear as there is a selective process for discriminating traits based on the affect characteristics of the trait itself. Additionally, the current findings only demonstrate own-age bias using young adult facial stimuli. As such stronger claims to own-age bias will be demonstrated by developing composite facial stimuli using older adult faces and administering the same to young and older adults. Importantly thought, consistent with the findings of this thesis, the ability to form implicit personality judgements is unrelated to cognitive and behavioural factors such as facial memory, emotion perception, autism traits, alexithymia traits and self-perception of neuroticism across ages.

10.5 Conclusion

In summary, the current chapter is the first to report implicit personality associations for extraversion and neuroticism personality traits among an older adult population, which indicate for this group, face-based trait judgements of neuroticism personality traits can be judged accurately and implicitly from faces but not extraversion. Similar to the findings of previous Chapters, implicit associations of personality traits are independent of other cognitive and behavioural factors such as autism, alexithymia, facial memory, and emotion perception.

In future studies, it would be desirable to investigate age effects in younger adults by using older adult composite facial stimuli and investigate the same in older adult populations. We also suggest future studies to replicate the findings of this Chapter using a larger sample size. Computer-based tasks are usually difficult for older adults as they exhibit motor function difficulties. The constant usage of keyboard responses in turn makes it challenging for older adults. Although they were allowed to take short breaks between tasks based on the design of the experiment itself, this is still an issue that must be considered.

Chapter XI

Summary – Part 2

The current Chapter presents a summary of key findings reported in Chapter 9 and Chapter 10. In these Chapters, we explored whether the ability to identify personality from faces could be explained by meta-cultural or age-related concepts. In so doing we sought to determine if the performance seen in our young Caucasian participant sample would generalise to (a) a young non-Caucasian sample and/or (b) an older adult Caucasian sample.

Do trait judgements generalise across ethnicities of participant samples?

In order to determine the generalizability of our earlier findings, in Chapter 9 we explored whether other ethnicity plays a role in the ability to form facial first impressions of extraversion personality trait. The Indian sample completed the extraversion Implicit association task, and questionnaires measuring autism and alexithymia traits. The findings reported in Chapter 9 has revealed that non-Caucasian participants (Indians) were less able to interpret face-based ‘signals’ of extraversion personality traits using Caucasian composite face stimuli. This ability was unrelated to autism and alexithymia traits in the Indian sample. In sum, it appears that a non-Caucasian sample reportedly failed to identify extraversion personality traits from Caucasian faces, as such demonstrating that extraversion trait judgements are ‘culturally’ specific. However, this study has considerable limitations and thus, the other-ethnicity effects reported in Chapter 9 is interpreted with some caution given we have not measured social contact information; and other cognitive factors (emotion and memory) that may potentially play a role in other-ethnicity trait judgements. However, in the own-ethnicity groups, implicit trait judgements were unrelated to face emotion and face memory recognition abilities. These findings also have potential implications for future research.

Can same ethnicity older adults make implicit personality trait judgements at levels consistent with younger adults?

In Chapter 10, we aimed to identify whether age played an important role in implicit personality judgements - specifically for extraversion and neuroticism personality traits. In addition, we also explored whether such judgments are moderated by autism traits, alexithymia traits, face memory and emotion perception. In the neuroticism study, we also investigated whether self-perception of neuroticism predicted implicit personality judgements. In both studies, we used Caucasian young facial composites as stimuli in the implicit association task (Greenwald, McGhee & Schwartz, 1998) to measure personality judgements. We used questionnaires to measure autism traits (Baron-Cohen et al., 2001), alexithymia traits (Taylor, Bagby & Parker, 2003), and self-perception of neuroticism traits (Donnellan et al., 2006). We used tasks such as the Cambridge face memory task (Duchaine & Nakayama, 2006) to measure facial memory and emotion matching task (Palermo et al., 2013) to measure emotion perception. However, in the emotion matching task, a time limit to complete the task was not included. Below, the key findings of extraversion and neuroticism studies are presented.

Extraversion*:* the findings reported in Experiment 1 of Chapter 10 revealed that older adults were unable to form accurate facial first impressions of extraversion personality traits using young composite facial stimuli. This performance was also unrelated to autistic traits, alexithymia traits, facial memory, and emotion perception. In order to report comparative performance across ages, we compared young adults' extraversion IAT data against older adults. The results revealed that the performance of young adults was better than older adults in the extraversion IAT. Furthermore, age significantly predicted the extraversion IAT performance.

Neuroticism*:* the findings reported in Experiment 2 of Chapter 10 revealed that older adults were able to make accurate judgements of neuroticism personality traits from faces. Further, the analyses revealed that this ability was unrelated to autistic traits, alexithymia traits, self-perception of neuroticism, facial memory, and emotion perception. No significant group differences were reported for young (from Chapter 7) and older adult groups.

In both studies, older adults were poor at facial memory recognition in comparison with young adults. However, when given longer time latency to sort emotions, older adults showed higher accuracy in the emotion matching task. Consistent with the literature, older adults reported a positive association between autism and alexithymia traits, and a positive association between facial memory and emotion perception.

Chapter XII

General Discussion

The purpose of this thesis was to investigate whether individuals are able to form accurate implicit judgements of extraversion, agreeableness, and neuroticism personality traits from composite faces, and whether such effects are robust across individuals with developmental prosopagnosia (DP), age and other-ethnicity groups; if so, whether cognitive factors such as autism, alexithymia, face memory and emotion expression recognition mechanisms could predict implicit face-trait judgement abilities. With this in mind, this chapter firstly presents a summary of findings (12.2); a discussion of findings (12.3); and a discussion on the theoretical underpinnings related to our empirical research in light of the present findings (12.4). The current chapter concludes with recommendations for future research and limitations from the present thesis from sections 12.5 to 12.6 respectively.

12.1 Pretext

The context in which this thesis was developed currently views implicit face-based trait judgements as an independent process in the face perception system; and certain traits (positive and negative) are possibly processed differently within the cognitive system. There is a plethora of research demonstrating that individuals can make accurate personality judgements from faces with limited previous interaction (Back, Schmukle, & Egloff, 2010; Borkenau et al., 2009; Funder, 1980, 2012; Hassin & Trope., 2000; Hall et al., 2008; Penton-Voaak et al., 1999). Several studies on personality judgements were conducted predominantly using explicit methodologies. Explicit methodologies specifically investigating the Big-Five personality dimension has been criticized based on socially desirable outcomes and faking tendencies (e.g., Borkenau & Ostendorf, 1992; Greenwald, McGhee, & Schwartz, 1998; Fazio, & Olson, 2003). Therefore, a different approach to face-trait judgements such as the implicit automatic approach was considered. The implicit association task (IAT;

Greenwald et al., 1998) is a highly valid measure that is predominantly used to measure implicit self-concept and stereotypes, where it reveals attitudes and other automatic associations for individuals who prefer not to express such attitudes. The IAT is expected to reveal conflicting evaluations of participants using explicit self-report measures (e.g., Asendorpf, Banse & Mucke, 2002). The observer's disposition to make personality judgements from facial cues alone and in the absence of behavioural cues is perhaps surprising. Individuals seem to make such inferences of personality traits automatically and without deliberation (Hassin & Trope, 2000) and many aspects of trait perception can be considered to be "intuitive" (Kahneman, 2003). Further, work by Jones et al., (2019) using the IAT has demonstrated that individuals can make accurate implicit face-trait judgements for extraversion and agreeableness personality traits.

However, the degree to which trait inferences from faces will be accurate could depend on the trait dimension, with some traits showing accuracy (e.g., extraversion) and others not (e.g., agreeableness). With respect to the inclusion of contrast of automatic face-trait judgements across Extraversion and Neuroticism traits and different age populations - it is of note that, despite the extant literature available on first impressions from faces, there is a limited number of studies investigating the differences in positive and negatively regarded trait judgement mechanisms across ages. Currently, it is not clear what factors determine the degree of accuracy for implicit personality trait judgements. This gives rise to the question of whether accurate judgements of personality traits are partial to deliberative conditions or a part of an independent and automatic process. To address this question, we explored whether face-based trait judgements for positively (extraversion, agreeableness), and negatively (neuroticism) regarded traits among the big-five can be made implicitly and accurately using young adult composite facial stimuli.

If face-based trait judgements are available from faces, what other factors aid in achieving such judgements spontaneously and accurately? We hypothesised that two major possibilities could be linked to face-based trait judgements. Firstly, we considered whether trait judgements share some overlap with the processes underpinning face recognition more generally. Previously it has been suggested that there is some evidence of a link between face identity (memory for faces) and trait judgements (Bainbridge et al., 2013; Davis et al., 2011; Lander & Poyarekar, 2015; Li et al., 2010; Lin et al., 2019; Megreya & Bindermann, 2013; Oosterhof & Todorov, 2008; Rule et al., 2012; Satchell et al., 2019; Wiese et al., 2014). As such, we aimed to explore a potential association between trait judgements and memory, which was explored by testing a group of participants with poor face recognition capabilities, the DP group, to better understand these mechanisms. For example, previously it has been established that individuals who are impaired in face memory show normal trait judgement abilities similar to that of non-clinical participants (e.g., Todorov & Duchaine, 2008). In which case, if DPs can infer trait-judgements from faces, this would further contribute to theoretical frameworks explaining independent or shared mechanisms utilised in face perception for identity and trait judgements (e.g., Bruce & Young, 1986; Gobbini & Haxby, 2007).

Secondly, we considered whether trait judgements share some overlap with the processes underpinning aspects of emotion processing more generally. Previously it has been suggested that personality judgements appear to be an extension of the mechanism involved in processing the emotionality of facial expressions (Baron &

Oosterhof, 2008; Knutson, 1996; McArthur & Baron, 1983; Montepare & Dobish, 2003; Todorov & Duchaine, 2008; Todorov, Zebrowitz & Collins, 1997). The evidence considered in the literature review indicates that there may well be overlap between functional processes linked to emotion processing and particular trait judgements in the general population – however, two key dimensions linked to poor emotion processing have been identified that are relevant for consideration. On the one hand, populations with higher levels of autism (even sub-clinically) have been reported to be poor at emotion processing, so might such individuals also do poorly on trait judgements (and thus suggesting a link between the two)? On the other hand, populations with higher levels of alexithymia have also been reported to be poor at emotion processing, and thus a link here might also suggest an overlap between emotion/trait processing from faces. Previous studies have reported atypical trait judgement performances among individuals with autism (Adolphs et al., 2001) and alexithymia (Brewer et al., 2015). However, very few studies have considered trait judgement abilities among these two groups. Therefore, we hypothesised that there will be some similar variability in individuals' performance on face-based trait judgement. That is, do people who might perform particularly very well/very poorly on face memory and emotion perception tasks also reliably perform in a similar manner for face-based trait judgements?

Thirdly, we predicted that there might be no overlap that occurs and that the mechanisms that underpin an individuals' ability to make face-based trait judgements imply separate cognitive processes entirely. Additionally, we also explored whether trait judgement ability could be *meta cultural or age-related*. The theoretical framework proposed by Over and Cook (2018) has claimed that trait judgements are influenced by cultural factors. As such, we have conducted experiments measuring implicit personality associations of extraversion personality traits among other-ethnicity samples (Indian sample) measuring cultural influences. Furthermore, given that the impact of the ageing process is strongly reported for face memory (Anastasi & Rhodes, 2006; Lamont et al., 2005; Lindholm, 2005; Searcy et al., 2001), emotion recognition (Calder et al., 2003; Ruffman et al., 2008; Visser et al., 2020), and the focus of much work tends to involve the recruitment of younger (typically student) populations, we also sought to determine whether the ageing process has a detrimental effect upon implicit trait associations or whether older adult participants show a similar overall pattern of performance to younger participants in their face-trait judgements of extraversion and neuroticism personality traits from faces.

With this in mind, we explored the relationship between implicit trait judgements of extraversion (among individuals with DP, across ages and culture), agreeableness, and neuroticism (across ages) and other cognitive factors such as facial memory, emotion perception and behavioural factors such as autism, alexithymia and self-perception of personality (for neuroticism).

12.2 Summary of findings

The first key finding of Chapter 5 demonstrated that young adults make accurate facial first impressions of extraversion personality traits using composite images, and this ability was unrelated to individual autistic traits, alexithymia traits, facial memory, and emotion perception (Experiment 1a).

The second key finding of Chapter 5 revealed that DP participants were able to form accurate implicit face-based extraversion trait judgements (Experiment 1b), and this ability was not predicted by autism traits, alexithymia traits, facial memory, or emotion perception. Additionally, face perception abilities were also unrelated to trait judgements among DPs However, there are considerable limitations to this study; controlling for age and increase in sample size would further this finding, and as such this finding must be interpreted with some caution. The DP sample showed low accuracy for facial memory compared to non-clinical young adults, and high accuracy in the emotion matching task in time unconstrained conditions. However, the DPs were significantly slower than non-clinical young adults in the emotion matching task.

The key findings of Chapter 6 revealed that implicit agreeableness personality traits are available from faces. However, these judgements were not accurate, as the participants of this study associated low agreeable faces with high agreeable trait words and high agreeable faces with low agreeableness trait words (a pattern the reverse to what was expected). Despite this unexpected result, this performance was unrelated to our measures of autistic traits, alexithymia traits, facial memory, and emotion perception performance.

The first key finding of Chapter 7 demonstrated that young adults make accurate implicit neuroticism trait judgements, and this ability was unrelated to other factors such as autism, alexithymia, facial memory, and emotion perception. This was also unrelated to individual self-perception of neuroticism.

The key findings reported in Chapter 9 have revealed that non-Caucasian participants (Indians) were less able to interpret face-based ‘signals’ of extraversion personality traits using Caucasian composite stimuli. This ability was unrelated to autism and alexithymia traits in the Indian sample.

The first key finding of Chapter 10 (Experiment 1) revealed that older adults were unable to form accurate facial first impressions of extraversion personality traits using young composite facial stimuli (that is the pattern found with younger participants presented in Chapter 5 was not replicated). There was a significant difference in the extraversion IAT performance between young and older adults. Furthermore, age was a significant predictor for the extraversion IAT where young adults demonstrated superior performance in the extraversion IAT. However, older adults' performance in the IAT was also unrelated to autistic traits, alexithymia traits, facial memory, and emotion perception. The second key finding of Chapter 10 (Experiment 2) revealed that older adults *were* able to make accurate judgements of neuroticism personality traits from faces and this ability was unrelated to age, autistic traits, alexithymia traits, self-perception of neuroticism, facial memory, and emotion perception. There were no group differences between young and older adults' performances on the neuroticism IAT. Older adults performed significantly worse than young adults on face memory tasks. Older adults were highly accurate in the emotion matching task in time unconstrained conditions to sort emotions. However, older adults also significantly take longer than young adults in the emotion matching task.

Correlations between cognitive and behavioural attributes

In the current work, there were several key cognitive and behavioural attributes that were measured within individuals to see if there was any relationship between these variables and performance on our implicit trait judgement tasks. This also enabled us to check that a number of well-established reported effects regarding the relationship between key variables was present – which could give us good confidence that the measures we were using were indeed valid. As it happens, many of these observed effects were replicated and these are discussed below.

Throughout the experimental chapters, there was a common finding demonstrating a positive relationship between autism and alexithymia scales. As we predicted, consistent with previous literature, the findings exhibited a pattern where an increase in autism-like traits also showed an increase in alexithymia traits (Bird & Cook, 2013; Cook, Brewer & Shah, 2013). Supporting this claim, a large number of studies also report that these two conditions co-occur in the general population (e.g., Cook et al., 2012).

Similarly, a negative association between alexithymia and emotion perception was reported. As predicted and consistent with the literature, individuals with high alexithymia traits tend to perform poorly on emotion recognition tasks (e.g., Prkachin, Casey & Prkachin, 2009). Work by Cook et al (2012) suggested that emotion recognition deficits among individuals with alexithymia are associated with difficulties in processing sensory descriptions of emotions and not directly associated with impairment in emotion recognition ability.

Similarly, there was a positive relationship between face memory and emotion perception. As predicted, the patterns followed an increase in accuracy of facial memory also showed an increase in the accuracy of emotion perception abilities. Consistent with theories suggesting that early perceptual stages of face processing are shared in common with face identity and facial expression perception (Calder & Young, 2005; Haxby et al., 2000; Gobbini & Haxby, 2007; Palermo et al., 2013).

There was an association demonstrated for autism and face memory, where high autism traits were correlated with poor facial memory recognition. Several studies have reported such associations between broader autism traits and facial memory (Brewer et al., 2019; Davies et al., 2017; Rhodes et al., 2013; Sasson et al., 2013; Lewis et al., 2018). Furthermore, recent evidence suggests that impaired face identity recognition is a potential endophenotype in autism i.e., it could be a co-occurring condition with prosopagnosia (Minio-Paluello et al., 2020).

Another interesting finding reported is a negative association between alexithymia traits and facial memory where individuals with high alexithymia scores tend to perform poorly on tasks related to facial memory. Given that autism and alexithymia are highly interrelated (Cook et al., 2013), similar to the relationship between autism and face memory, difficulties in emotion processing could be explained by co-occurring prosopagnosia condition. Given much focus is given to establishing emotion perception difficulties among individuals with alexithymia, studies measuring alexithymia prevalence in face recognition memory (e.g., Minio-Paluello et al., 2020; Cook et al., 2013; Brewer et al., 2019) have not reported the degree of associations between alexithymia and face memory. Furthermore, given face memory and face emotion perception abilities are highly correlated constructs, and individuals with alexithymia report to have poor emotion perception abilities, thus, it is possible that individuals with high alexithymia traits perform poorly on face memory recognition tasks. Further research exploring these conditions could illuminate theoretical frameworks (e.g., Bruce & Young., 1989) suggesting a dissociation between face identity and emotion expression abilities among individuals with alexithymia.

12.3 Discussion of findings

12.3.1 Implicit extraversion trait judgements among young adults

Previous work by Jones et al (2019) demonstrated that accurate implicit extraversion and agreeableness trait judgements are available from faces. If such judgements are readily available from faces, what other factors can predict trait judgements? Building on this work, in Chapter 5 we replicated previous findings of Jones et al (2019) for extraversion trait judgements using non-clinical young adult samples. This finding also reflects a generic association between positive trait words and extraversion trait composite images, and negative trait words with low extraversion composite images.

Visual cues associated with personality traits can be related to both trait-specific perception and social desirability (extraversion traits). These associations take place at implicit levels of cognition. Studies have associated trait inferences and attractiveness, where extraverted individuals are often perceived to be more attractive and as such, likely to be accurately inferred from faces (Kramer & Ward, 2010). Although attractiveness is perceived as an attribute of facial appearance, it is not yet widely established whether the association between trait judgements and attractiveness could be generalised to other traits such as agreeableness and neuroticism. Preliminary evidence has largely suggested that trait judgements often appear to be related to an individual's expression perception abilities. One of the predictions of this thesis was that there would be a positive relationship between implicit extraversion trait judgements and emotion expression perception. On the contrary, the findings of this study revealed no such associations between trait judgements and emotion expression perception. Following up Todorov and Duchaine's (2008) implication that trait judgements could be a by-product of expression perception ability, here in this thesis, the evidence predominantly suggests that expression perception and personality trait judgements remain unrelated. Similarly, there was no relationship between face memory and trait judgements. However, recent evidence has suggested a moderate association between face memory and extraversion trait judgements (e.g., Satchell et al., 2019), and on the contrary, the findings of the current thesis demonstrate that the ability to form implicit extraversion trait judgements is unrelated to face identity recognition. Theoretical models underpinning face processing has suggested that trait judgments possibly utilise some independent route in the cognitive system (Bruce & Young, 1986), and this has been discussed in detail in section 12.5. Similarly, there were no associations between implicit extraversion trait judgements and autism traits or alexithymia traits. Substantial evidence has indicated that extraversion trait judgements are the most robust and accurately identified trait amongst the big-five dimension. Based on these findings, we further explored whether this ability to form implicit personality inferences is limited to neurologically intact individuals with normal face processing abilities; and thus, considered individuals with DP.

12.3.2 Implicit Personality judgements of individuals with Developmental Prosopagnosia

Previous studies have suggested that DP groups demonstrate normal trustworthiness trait judgements similar to controls (e.g., Todorov & Duchaine., 2008; Knutson et al., 2011). Hence, we explored whether DP groups are able to form accurate implicit extraversion trait judgements from composite facial stimuli. As predicted, in this case, individuals with DP were able to form accurate implicit extraversion personality trait judgements. However, there are potential drawbacks to the findings reported in this study (Chapter 5, Experiment 1b). Controlling for age and increase in sample size would further this finding, and as such the findings reported for DPs must be interpreted with some caution.

Previous studies have reported that individuals with DP perform better than controls on composite face tasks (Avidan et al., 2011; Palermo et al., 2011). Individuals with normal face recognition abilities tend to find composite face tasks difficult as they are likely to incorporate holistic face processing, consequently processing composite faces as a whole. The DP groups are much less susceptible to difficulties in processing composite faces due to their tendency to process faces based on individual features of the face. Previously it has been reported that in some DP cases there are normal configural face processing (e.g., Susilo et al., 2010) and normal holistic face processing (Duchaine et al., 2007). As such, the use of composite faces has the advantage that non-facial cues and other idiosyncratic characteristics are eliminated, meaning that personality judgements are based upon generalised properties of the presented faces. Work by Kramer and Ward (2010) have reported that holistic processing is not necessary to form trait judgements, as such incomplete facial information is sufficient for trait judgements. Thus, it is possible for DPs to perform normally on face-trait judgement tasks using composite faces. Additionally, normal trait judgement abilities among DPs have been specifically reported for trustworthiness and attractiveness traits (Todorov & Duchaine., 2007, 2008; Rezlescu, Susilo, Barton & Duchaine., 2014; Carbon, Grüter, Weber, & Lueschow., 2010). Using a single case study, Knutson et al (2001) has reported normal social IAT effects for DPs. Making implicit trait inferences about strangers' personality traits is a task functionally distinctive from tasks that involve tracking the identity of familiar people over time. Thus, mechanisms used for trait judgements may be different from mechanisms for representing person identity. Supporting such claims, the evidence from our extraversion study revealed no association between facial memory and personality trait judgements.

Moreover, identity recognition and expression recognition has been shown to be unrelated among DP groups (Duchaine, Parker, & Nakayama, 2003; Humphreys, Avidan, & Behrmann, 2007). Supporting this claim, the current findings revealed that there was no association between face memory and emotion perception abilities among DPs, although there is a considerable methodological limitation in the emotion matching task. Furthermore, previous studies have suggested that DPs exhibit deficits in holistic processing of identity but show normal emotion perception (Bentin et al., 2007; Duchaine et al., 2007; Fisher et al., 2017; Humphreys, Avidan, & Behrmann, 2007; Palermo et al., 2011). On the contrary, larger single case series have reported that DPs also exhibit poor emotion recognition abilities (e.g., Biotti & Cook, 2016; De Haan & Campbell, 1991; Duchaine et al., 2006, 2009). The current findings demonstrated that individuals with DP are able to differentiate emotions from faces with accuracy similar to non-clinical young adults in time unconstrained conditions. However, this finding is interpreted with some caution given the methodological limitation in the emotion matching task where a timer was not included for the presentation of stimuli; thus, the presence of atypicality cannot be completely ignored. In other words, it is likely that the advantage in processing emotions among DPs is only seen after longer exposure to faces. However, the average response times for DPs in the emotion expression perception tasks has been reported. Previous research has indicated that when response times are not provided, it is possible that the high accuracy in such tasks that appear to indicate a normal performance maybe shadowed by the application of successful, but abnormal facial feature matching strategies (Busigny et al., 2014; Duchaine & Nakayama, 2004; Farah, 2004). In support of such claims, researchers measuring reaction times indicated that DPs were significantly slower than controls at perceptual tasks (e.g., Behrmann et al., 2005; Humphreys et al., 2007). This finding is also supported in this thesis where the results of the emotion expression perception tasks indicated that DPs were much slower than controls.

Nevertheless, the regression analysis revealed that the ability to form implicit personality judgements of extraversion personality traits among DPs are unrelated and independent of factors such as facial memory, emotion expression perception, autism and alexithymia traits. As such, these findings suggest that implicit face-trait judgements possibly involve mechanisms that are functionally independent and unrelated to facial identity deficits. This could further imply that this construct uses mechanisms that are different from processing other cognitive face mechanisms such as emotion recognition. However, there are potential limitations to this study. This study included a varied age range and small sample size; controlling for age and increase in sample size can increase the reliability of the findings reported. Additionally, there was no timer included in the emotion matching task, and as such the findings reported for DPs does not exclude the possibility of atypicality. Thus, the lack of including timer in the emotion task is also considered as a potential limitation although average latency response duration has been reported.

12.3.3 Implicit agreeableness trait judgements among young adults

Based on the pattern of findings reported for young adults' extraversion IAT, we also considered another positively regarded trait among the big-five such as implicit agreeableness trait judgements among young adults. Recent work by Jones et al (2019) has reported accurate implicit agreeableness trait judgements among young adults. Building on this work, unlike extraversion trait judgements, the findings for agreeableness traits revealed that participants associated high agreeable face with low agreeable trait words. For example, high agreeable images were frequently paired with low agreeable words such as 'cold' and 'unkind' and low agreeable images were frequently paired with high agreeable words such as 'kind' and 'sympathetic'. The agreeableness IAT effect from Jones et al (2019) study was not replicated in this study and has produced contradictory results to what was expected. However, empirical evidence has generally suggested that agreeableness traits are found to produce unreliable results and, in many cases, negligible levels of accuracy (e.g., Al Moubayed et al., 2014; Ames & Bianchi, 2008; Borkenau & Liebler, 1992; Funder & Dobroth, 1987; Gosling, Gaddis, & Vazire, 2007; Satchell et al., 2019; Zebrowitz & Collins, 1997). The nature of this mechanism remains unclear. Based on an extensive review of published evidence, we argue that perceivers tend to readily judge agreeableness at early impressions and form confirmation biases through selective attention and interpretation. Moreover, at rudimental levels of cognition, agreeableness personality judgements can be driven by perceivers self-perception of agreeableness (e.g., John & Robins, 1993). As a result, it is plausible that the perceiver's initial judgement remains uncorrected and perceived continually to be true for that initial judgement (e.g., Denrell, 2005). Hence these initial judgments show limited accuracy.

Furthermore, Attractiveness and facial maturity are known to be vital for distinguishing dimensions in person perception (e.g., Rhodes, 2006; Zebrowitz & Montepare, 2006). We want to imply that for future studies to use composite faces of women who are in a higher age category for young adults. Making accurate judgements of personality traits is acknowledged to be a very challenging cognitive process. Another possible explanation is that the composite facial stimuli used in our study were very similar looking which could have caused the observers to indicate mismatch, and this is also considered to be a potential limitation. However, to acknowledge the power issue in this study, it is suggested for future studies to also consider a larger sample size. However, consistent with the findings reported in our extraversion study, agreeableness trait judgements were also unrelated to autism traits, alexithymia traits, face memory and emotion perception.

12.3.4 Implicit Neuroticism trait judgements among young adults

The focus of personality judgments in the previous sections has considered positively regarded traits such as extraversion and agreeableness. Chapter 7 aimed to identify whether implicit judgements of *neuroticism*, a negatively regarded trait amongst the big-five personality traits, were related to other factors such as autism spectrum, alexithymia spectrum, facial memory and emotion perception. In addition, we sought to determine if self-related levels of neuroticism predicted IAT performance (i.e., might higher levels of neuroticism show larger neuroticism IAT effects).

Previous studies have provided inconsistent findings for neuroticism traits, where studies have largely implied low accuracy for neuroticism trait judgements (e.g., Back et al., 2010; Borkenau et al., 2009; Darbyshire et al., 2016; Gosling, Gaddis, & Vazire, 2007; Ivcevic & Ambady, 2012). However, novel findings are presented in Chapter 7, where the findings demonstrated that young adults are able to form accurate implicit judgements for neuroticism personality traits using composite facial stimuli. Further, the regression analysis revealed that this ability was not driven by cognitive and behavioural factors such as facial memory, emotion perception, co-occurring autism, alexithymia or self-rated levels of neuroticism. This finding is also consistent with previous findings reported within this thesis for extraversion and agreeableness trait judgements.

The current findings of this thesis, consistent with previous literature, have revealed that self-perception of neuroticism is nevertheless unrelated to implicit neuroticism trait judgements from faces (Satchell et al., 2019; Shevlin et al., 2003).

Neuroticism traits are largely viewed as negatively regarded traits given its characteristic description involves experiencing negative affect, anxiousness, and generic difficulties with social interaction (Canli et al., 2001; Costa & McCrae, 1980; Ormeal et al., 2012). As such, evidence suggests that this trait is highly correlated with autism traits (Schriber, Robins, & Soloman, 2014). However, the ability to make implicit personality judgements of neuroticism is unrelated to autistic traits.

Neuroticism traits have an existential relationship with cognitive and clinical neuroscience including psychopathology, where it reportedly shows a robust association with anxiety disorders, depression and substance abuse (Kotov et al., 2010; Lahey, 2009). Researchers have already shown that depressive symptoms are available from static, non-expressive composite images (e.g., Scott et al., 2013). One might argue that facial blemishes can give away details about mood which can be inaccurate and hence the use of neutral facial stimuli improves the quality of the results produced. However, this ability can communicate several important issues such as depression, mood, predict behaviour (Scott & Kramer, 2016). Hence, greater attention to this construct can significantly benefit the fields of psychopathology research and clinical practice.

12.3.3 How does other-ethnicity impact extraversion personality trait judgements

As already established in Chapters 5, 6 and 7, so far, the overall findings for implicit personality judgements from faces using own-ethnicity samples have demonstrated that young Caucasian samples are able to predict extraversion and neuroticism personality traits implicitly and accurately for unfamiliar faces using composite Caucasian facial stimuli. Here we establish the generalizability of this finding to non-Caucasian populations. Thus, asking the question whether other-ethnicity factor plays a role in implicit personality judgements similar to own-ethnicity? To answer this question, Chapter 9 investigated whether other-ethnicity (Indian) individuals are able to make accurate implicit judgements of extraversion personality trait judgements using Caucasian young women's composite facial stimuli and whether this ability was driven by co-occurring autism or alexithymia traits. We have also compared the data against Caucasian young adult's data from Chapter 5.

The main findings of chapter 9 revealed that other-ethnicity Indian samples were not reliably able to accurately determine extraversion traits implicitly unlike our Caucasian sample in chapter 5 (experiment 1a). In general, the pattern appears to be that non-Caucasian participants (Indians) are less able to interpret the face based 'signals' for extraversion in our Caucasian face stimuli. Our interpretation of these findings is that there likely exists an ethnicity effect in identifying personality from faces – that is, the ethnicity of the 'observer' is clearly important, and likely it may be important for both the observer and the observed ethnicities to match (i.e., same ethnicity for both). Additional analysis was conducted at comparing accuracies for word and image categories (at pairing "Jane" and "Mary" images with category trait words) among other ethnicity and own ethnicity groups. The findings revealed that both groups were 90% accurate at associating trait words and images (refer to Appendix D, pg. 306), thus eliminating perceptual difficulties. This further suggests that other-ethnicity groups are in fact accurate at pairing word and image categories; however, they appear to fail to recognize that cues to personality are present from the target images. As such, this finding suggests that extraversion implicit judgements are more "culturally" specific, given own-ethnicity groups were both highly accurate and also produce an IAT effect, therefore suggesting that own-ethnicity groups implicitly detect cues to personality from target images and word categories.

In line with the previous literature, the current findings also demonstrate that own-ethnicity individuals are better at recognizing own-ethnicity faces compared to other-ethnicity groups (e.g., Meissner & Brigham, 2001; Walker & Tanaka, 2003). However, to make strong claims about other-ethnicity effects reported in this study, future studies must also create intra-cultural IAT using other-ethnicity (Indian) composite images to confirm this theory and utilise the same stimuli on Caucasian participants. That is, if Indian/Caucasian participants successful trait judgements are confined only to individuals matching their ethnicity, this would indicate an important clue about the processes underpinning face-trait judgements.

Furthermore, individuals tend to form impressions of other-ethnicity individuals based on information that is passed on from ancestors or portrayal of characters from social media (England, Descartes, & Collier-Meek, 2011; Feinberg, Willer, & Schultz, 2014). Frequent encounters with other-ethnicity or own-ethnicity faces can shape the initial encoding process of faces (Walker & Tanaka, 2003). It has been previously established that people tend to form personality impressions of unfamiliar faces based on face shape and other facial cues present from encounters with people with similarities in facial features (e.g., Falvello et al., 2015; Verosky & Todorov, 2010). Researchers have also demonstrated that the process of the own-ethnicity effect is impacted by the level of social factors such as the degree of experience an individual has with another ethnicity, i.e., when an individual has exposure to other-ethnicity groups, their performance might be similar to that of own-ethnicity participants (Walker et al., 2008; Walker & Hewstone, 2006). On the contrary, recent studies have demonstrated that own-ethnicity bias is unaffected by social contact (Wong et al., 2020). As such, one of the potential limitations of the present study is the lack of information on exposure to Caucasian groups – it had been assumed that given the ubiquity of Western media, Indian participants would have some familiarity with Caucasian faces, but we had no means of independently measuring this. Future research should include replicating the ethnicity effect by developing Indian composite faces and testing Caucasian populations and vice versa. An increase in sample size will produce a better quality of results as there remains a node of uncertainty based on whether the participants of this study had exposure to Caucasians.

Large scale visual memory studies have suggested that observers possess the ability of facial memory independent of their previous experiences but are also able to reproduce memorable information across populations (Brady et al., 2008; Vogt & Magnussen, 2007). Psychological and environmental factors play an essential role in culture. Some of these factors are more to do with emotion than cognition. There is evidently an interrelationship between emotion perception and cultural differences (Hunberg & Bodenhausen, 2003). This again is another explanation as to why other-ethnicity groups fail to recognize cues to personality present from Caucasian facial stimuli. Another possible explanation is the overgeneralization hypothesis, suggesting that universally there the perception of emotions is possibly inter-linked to personality that can be misread from faces across cultures. Although, the findings of the current thesis have consistently reported no associations between trait judgements and emotion perception abilities among own-ethnicity groups, not including face memory and emotion perception measures to test the association between trait judgements and these factors among other-ethnicity groups is also another potential limitation to this study. Thus, we also implicate for future studies to establish the relationship between trait judgements along with the cognitive measures employed in this thesis using other-ethnicity groups.

Furthermore, considering the population and diversity of India, a small sample size ($N = 60$) from predominantly one geographical location might not be sufficient to provide evidence to support other-ethnicity effects. Given there is mixed evidence regarding the social contact hypothesis, not including a contact questionnaire in our study could be considered as a potential drawback. Although statistically there was no IAT effect, with a larger sample size and wider sample from different geographical locations, there is a possibility where other-ethnicity individuals with social contact would be able to form accurate first impressions. Therefore, we suggest that observers can reliably infer personality from faces but require knowledge about the target's culture to make accurate judgements.

12.3.4 The Impact of Age on implicit personality judgements

Given that the ability to make implicit accurate judgements of personality remains a unique automatic process independent of cognitive and behavioural factors, we then investigated whether this pattern generalised to older participants. Our previous study (Chapter 9) suggested that ethnicity may moderate accurate face base trait judgements, as a consequence we sought to determine if a within ethnicity factor (age) may equally moderate performance. In this case, we sought to determine if older adults could reliability make implicit trait judgements specifically for extraversion and neuroticism. Within our thesis, these two traits have demonstrated accurate implicit judgements from faces in a young adult Caucasian sample. Hence it was interesting to explore a positively regarded trait such as extraversion and a negatively regarded trait such as neuroticism personality judgements using older adult samples. In addition, consistent with the previous studies we explored whether these judgements are moderated by cognitive and behavioural factors such as autism traits, alexithymia traits, self-perception of neuroticism (for neuroticism IAT), facial memory and emotion perception

The findings of Chapter 10 are the first to report implicit personality trait associations for extraversion and neuroticism traits among an older adult sample using young women composite facial stimuli. We predicted that an own-age effect will moderate implicit trait judgement ability for extraversion and neuroticism traits, and as predicted the findings demonstrated that older adult participants presented an own-age effect for implicit personality judgements of extraversion where older adults were unable to reliably make accurate implicit judgements of extraversion personality traits from young composite facial stimuli. Additionally, age was a significant predictor for extraversion trait judgements and thus, supporting previous evidence, the younger adult sample was better at face trait judgements of extraversion for young facial stimuli compared to older adults (e.g., Anastasi & Rhodes, 2006; Bäckman., 1991). Unlike extraversion, older adults were able to make accurate implicit judgements of neuroticism from young composite facial stimuli; contrary to what was predicted. These results are thus the first to reveal such associations among older adults. There were no group differences reported for young and older adults in their neuroticism trait judgements performances. However, in either of these studies, the relationship between trait judgements and autism traits, alexithymia traits, facial memory and emotion perception remain unrelated and independent.

It has been implied that people tend to be more proficient and show better accuracy for recognizing individuals from their own group compared to other groups. For example, face recognition studies using unfamiliar faces have reported that participants tend to be better at identifying unfamiliar faces of own ethnicity, age, and gender (Childs et al., 2021; Fulton & Bartett., 1991; Meissner & Brigham, 2001; Over

& Cook, 2018; Wright & Stroud, 2002). Previously it has also been reported that, in comparison with young adults, older adults tend to show a positivity bias where they interpret untrustworthy faces as more trustworthy and approachable, and do not differ in judgements of trustworthiness from faces for young and older adults (Castle et al., 2012; Smailes et al., 2018). Given in our studies, older adults are able to form accurate judgements for neuroticism but not extraversion using young facial stimuli, a general own-age and positivity bias is unlikely to explain the different patterns of performance. Additionally, researchers have also implied that people are more sensitive to recognizing negative traits than positive traits (Oosterhof & Todorov, 2008). On the contrary, it has also been suggested that older adults remember positive information better than negative information (e.g., Charles, Mather, & Carstensen., 2003; Mather & Cartensen., 2003).

Studies have implied that older adults often exhibit poor personality judgements (e.g., Bailey et al., 2013; Boshyan, et al., 2014; Castle et al., 2012; Mather & Carstensen, 2003; Ruffman, Sullivan, & Edge, 2006; Smailes et al., 2018; Zebrowitz et al., 2013). Despite these studies implying that older adults are often poor and inaccurate at identifying personality from faces especially from young adult facial stimuli, the findings of the current thesis have demonstrated that older adults are accurate at implicit neuroticism trait judgements. With regard to facial memory, studies have reported that negative traits such as untrustworthiness are more memorable from faces (Bayliss & Tipper, 2006; Mealey, Daood, & Krage, 1996; Rule, Slepian, & Ambady, 2012). Negative traits might signal facial cues that communicate potential harm (Buchner et al., 2009; Young et al., 2012; Suzuki & Suga, 2010). The reasons for the variability of the findings presented across both studies may centre on cue availability from faces for positive and negative traits that underlie social perceptions. For example, Zebrowitz et al., (2013) has suggested that traits such as hostility and competence can be communicated clearly from young facial stimuli and variations in health and aggressiveness from older facial stimuli. Thus, we imply that cues to negatively regarded traits such as neuroticism are more clearly available from young adult facial stimuli. As such, we further suggest that the mechanisms employed for personality perception by young and older adults could differ at implicit levels of cognition based on the trait affect itself (extraversion and neuroticism).

Further, age-related differences in memory and emotion perception abilities have been reported. Consistent with previous literature, older adults performed poorly on tasks related to facial memory compared to young adults. Implying that there is an age-related decline in facial memory (Bowles et al., 2009; Searcy, Barlett & Memon, 2000). In addition to facial memory, it is also well known that there exists an age-related decline in emotion recognition among older adults. A large body of evidence has reported that older adults are often less accurate at identifying emotions from faces in comparison to younger adults (Calder et al., 2003; Isaacowitz et al., 2007; Ruffman et al., 2008; Sullivan et al., 2017; Visser, 2020). On the contrary, work by Palermo et al., (2018) has demonstrated that there was no association between age and emotion perception abilities suggesting that emotion perception abilities are unaffected by age. The findings of the current thesis have demonstrated that older adults show normal emotion recognition abilities in time unconstrained conditions, i.e., older adults show equivalent accuracy performance when provided more time to do so. This is consistent with research indicating that age-related changes are generally linked to information processing speed (e.g., Ketcham & Stelmach, 2001) and thus reflects a general impact in the way that older adults exhibit longer responses when using computers. However, the emotion perception abilities among older adults are reported with some caution given the high accuracy in the task is reflective of longer time duration affecting expression perception abilities, and thus, the possibility of atypicality cannot be disregarded. This is also regarded as one of the potential limitations apart from the small sample size. As mentioned earlier, previous research has indicated that when response times are not provided, it is possible that the high accuracy in such tasks that appear to indicate a normal performance is an application of successful, but abnormal facial feature matching strategies (Busigny et al., 2014; Duchaine & Nakayama, 2004; Farah, 2004). Additionally, we compared the average latency responses in the emotion matching task for young and older adults' sample and the findings revealed that older adults are significantly much slower than younger adults.

Although studies presented above have suggested that ageing impacts a variety of judgements from faces such as facial memory and emotion perception, the age-related effects on personality judgements remain unclear as there is a selective process for discriminating traits based on the affect characteristics of the trait itself. As such stronger claims to own-age bias will be demonstrated by developing composite facial stimuli using older adult faces and administering the same to young and older adults. Nevertheless, consistent with the findings of this thesis, the ability to form implicit personality judgements is unrelated to cognitive and behavioural factors such as facial memory, emotion perception, autism traits, alexithymia traits and self-perception of neuroticism across ages.

12.4 Theoretical implications

What have we learnt about the mechanisms underpinning personality from faces?

The findings present in this thesis have some wider implications for implicit trait judgement literature as a whole. Given that throughout the studies employed within this thesis, the mechanism used to infer implicit personality judgements were unrelated to social constructs of face processing mechanisms such as autism and alexithymia, and cognitive factors such as face memory and expression perception, the theoretical framework for explaining how trait judgements are made needs elaboration.

It was hypothesised in the introduction that there will be a positive relationship between face-trait judgements, emotion expression recognition, and face identity recognition. Support for this hypothesis comes from the functional (Bruce & Young, 1986) and neurological (Gobbini & Haxby, 2007; Haxby, Hoffman, & Gobbini, 2000) models of face perception. Several researchers have predominantly used the functional model of face processing (Bruce & Young, 1986) to explain the cognitive mechanisms underpinning face processing (see Chapter 2). Despite decades of research on how we extract various cues from faces, it is still widely debated whether face identity and expression perception abilities are processed and represented within a shared route or as independent systems.

Studies using the functional model have largely supported that face recognition and emotion recognition from faces are processed independently, although the initial process of recognition occurs using a common route (e.g., Calder & Young, 2005; Lander & Butcher, 2015; Todorov & Duchaine, 2008). For example, processes involving face identity recognition appear to be facilitated by familiarity and repetition priming, but this is not the case for expression perception (e.g., Ellis et al., 1990; Young et al., 1986). Therefore, participants can selectively attend to either identity or emotion without further interferences from the stimuli. Additionally, expression perception abilities are not influenced by face familiarity and vice versa (Campbell et al., 1996). The claims of an independent mechanism were suggested based on testing individuals with face identity deficits. It is well established that individuals with DP who predominantly exhibit face identity deficits to an extent demonstrate normal emotion perception abilities (Bentin et al., 2007; Duchaine et al., 2007; Fisher et al., 2017; Humphreys, Avidan, & Behrmann, 2007; Palermo et al., 2011). This finding has led cognitive neuropsychological approaches to view these two functional processes as independent mechanisms in the cognitive system. However, researchers have also questioned the normal emotion perception abilities among DP as discussed in section 12.3.2. (e.g., Biotti & Cook, 2016; De Haan & Campbell, 1991; Duchaine et al., 2006, 2009). As such, some caution must be applied when attempting to interpret the functional mechanisms employed by developmental populations.

The neurological model by Gobbini and Haxby (2007) focused on explaining the neural systems associated with face processing, specifically emphasising the processes associated with familiar face recognition. This model specifies the relationship between face emotion and identity processing by incorporating the neural mechanisms involved in face recognition. This model includes a distributed neural system that contains a 'core system' analysing the visual appearance of faces, and an extended system involving the extraction of additional information a face can convey such as information regarding familiar people, and processes that communicate social and emotional meaning extracted from faces (Haxby et al., 2000). For example, this model suggests that the superior temporal sulcus (STS) processes the arrangement of facial features to extract the expression present from the face and then integrates with the extended system to process the actual meaning of the expression; thus, involving a concerted activity of various neural areas that all contribute to a specific function. The claims of this neurological model support one of the hypotheses of this thesis, where the findings imply that there likely exists a causal relationship between face identity and expression perception. Although establishing the relationship between these two abilities were not the primary goal of this thesis.

This model implies that visual familiarity only plays a partial role in familiar face recognition, and person knowledge and emotional responses also play an equal role for successful recognition of familiar individuals. If one assumes that personality judgements are combinations of emotion perception tendencies (e.g., Plutchik 1980), it should be possible to find positive correlations between face expression perception and personality judgements. However, the findings reported in this thesis did not observe any associations between trait judgments and emotion perception. Previously it has been suggested that emotional expressions can communicate behavioural intentions (e.g., Adams & Kleck, 2005). Particularly, faces that are evaluated negatively may contain subtle cues that resemble angry expressions, and faces evaluated positively may contain cues to happy expressions. For example, work by Todorov (2008) suggests that subtle cues that represent emotions even from neutral stimuli can contain information about an individual's personality. This study has also implied that the function of the amygdala is better tuned to interpreting negative valence faces compared to positive valence faces. Overall, research suggesting a relationship between traits and emotions have been largely conducted on trustworthiness judgements. As such the mechanisms underpinning trait judgements may be differentially impacted by expression perception based on the trait being judged. For example, traits such as trustworthiness have more valence and as such it could be related to emotion perception.

However, it is not yet widely understood whether such associations extend to other types of personality traits, in this case, the big-five dimension. Additionally, previous studies establishing the activation of the amygdala during trait judgements has largely involved specifically testing trustworthiness. Previously, it has been reported that the activation of the amygdala was present for implicit trustworthiness judgements but there was no activation in the amygdala for untrustworthiness judgements (Delgado et al., 2005; Engell et al., 2007). Similarly, other studies have also demonstrated that the frontal operculum, an extended network to the STS, is important for the perception of facial expressions (Engell & Haxby, 2007; Said et al., 2010) but is not necessary for trait judgements (Dzhelyova et al., 2011). Furthermore, it has also been implied that unlike categorization of emotion perception, it is unclear which face properties are involved in trait judgement categorizations (Engell et al., 2007). Therefore, other trait dimensions should also be considered since there is no evidence to confirm that the activation of the amygdala would be involved in all dimensions of trait judgements (for example, big-five traits); as different neural regions are activated with regard to trait judgements; as mentioned earlier, activation of the amygdala for trustworthiness judgements (e.g., Engell et al., 2007; Winston et al., 2002), and activation of the anterior paracingulate cortex for attractiveness traits (e.g., Cloutier et al., 2008; Winston et al., 2007). To our knowledge, there are no studies that have examined implicit trait judgements using the big-five traits and the neural regions associated with them. Exploring these neurological underpinnings in more detail with a wider range of traits would contribute to a better understanding of trait judgements and the development of more accurate and reliable models.

Although face perception models have attempted to explain the relationship between different cognitive mechanisms, this still doesn't explain how accurate implicit trait judgement occur. Potentially, if emotion perception plays a critical role in evaluating trait judgements, how might individuals who currently possess poor emotion recognition abilities perform on trait judgement tasks? Preliminarily evidence suggests that individuals with autism and alexithymia who exhibit social communication and emotion perception difficulties show atypical performance for trustworthiness trait judgements (Brewer et al., 2015; Sprengelmeyer et al., 2015). Given this, we would expect to observe a relationship between autism and trait judgements, autism and emotion perception. On the contrary, there is no evidence of a link between trait judgements and autism/alexithymia traits across the general population in the current thesis. Additionally, studies have also reported that there were similar levels of associations for trait judgements and emotion perception between individuals with or without alexithymia (Brewer et al., 2015).

Neuroimaging studies using functional magnetic resonance imaging (fMRI) methods on face-trait judgements have largely been conducted on perceptions of attractiveness and trustworthiness (Adolphs et al., 1998; Engell, Haxby &Todorov, 2007; O'Doherty et al., 2003; Todorov & Engell, 2008). The independent mechanisms utilised for trait judgements and face identity has been explained by studies using fMRI, where activation in neural regions such as the inferotemporal cortex for person identity perception (e.g., Kanwisher et al., 1997; McCarthy et al., 1997; Wada & Yamamoto, 2001), and the amygdala for the perception of trustworthiness from faces (Adolphs, Tranel, & Damasio, 1998; Engell et al., 2007; Todorov, Baron & Oosterhof, 2008; Winston et al., 2002). Using fMRI methods has offered a unique route to investigate face processing and results suggest that face perception is mediated by distinct neural pathways involving multiple bilateral regions. For example, work by Todorov and Duchaine (2008) have suggested that the neural mechanisms underpinning trait impressions and face identity recognition are dissociable by comparing DP groups against bilateral amygdala damaged patients. We hypothesised in the introduction that there will be a positive relationship between trait judgements and face identity recognition. Previously it has been suggested that there is a moderate association between face identity (memory for faces) and trait judgements. For example, studies have suggested an association between facial attractiveness (Lin et al., 2019; Wiese et al., 2014), trustworthiness and dominance traits (Oosterhof & Todorov., 2008; Rule et al., 2012) with facial memory. Furthermore, it has also been suggested that a face that is perceived to be kind, trustworthy and atypical is often remembered better (Bainbridge et al., 2013). Additionally, studies exploring individual differences in trait judgements and facial memory have suggested a relationship between facial memory and extraversion trait judgements (Lander & Poyarekar, 2015; Li et al., 2010; Satchell et al., 2019), and facial memory and social anxiety (Davis et al., 2011; Megreya & Bindermann., 2013). However, contrary to our prediction, the main findings of this thesis revealed that there were no such associations between face identity and implicit face-trait judgements. Additionally, as explained in section 12.3.2, the DP groups were able to form accurate extraversion trait judgements. Evidence for this claim is also supported by Todorov and Duchaine (2008) research using DP participants. Therefore, it is suggested that making spontaneous trait judgements is a process functionally different compared to tasks measuring face identity recognition.

The findings of this thesis to an extent demonstrates a relationship between expression perception and face identity. Although some aspects of emotion and identity likely utilise a shared route in the visual processing system; these models have not incorporated the role of how trait inferences occur. The existing neurological models of face recognition have largely been extended to include the role of person knowledge for familiar face processing (e.g., Haxby et al., 2000; Gobbini & Haxby, 2007; Todorov et al., 2007), but have not incorporated the role of trait judgements.

Although no neurological claims are being made based on the findings of this thesis; we speculate that trait judgements likely utilise some independent process based on the pattern of findings consistently reported in this thesis. Furthermore, these findings are essential for building comprehensive models of face-based trait perception and social cognition.

Based on the behavioural studies employed within this thesis, the pattern of findings suggests a high likelihood that implicit trait judgements utilise some independent mechanisms, although there are no strong neurological claims made. Predominantly, cognitive neuroscience research on face perception has been conducted on face identity recognition and face emotion perception. Despite the wealth of behavioural evidence available for face-trait impressions, very few studies have considered the underlying neural regions associated with trait judgements, specifically the big-five trait dimension. Additionally, no studies have considered how implicit judgements for positive and negatively regarded traits differ neurologically or the impact of the ageing process on trait judgements. Researchers have also implied that people are more sensitive to recognizing negative traits than positive traits (Oosterhof & Todorov; 2008).

The present thesis suggests that faces contain structural similarities that are shared with emotions and face identity. There may be some shared aspects of face recognition at the early stages of visual perception that utilise similar processes to infer emotions, identity and traits; these perceptual processes can further differentiate for trait-specific processes and domain-specific traits independent of emotion and identity. Although the shared routes can be used to extract information regarding a specific process (e.g., emotion, identity, traits), information specific processes can be extracted regardless of whether other aspects of recognition are being processed or not. For example, information regarding personality can be processed regardless of whether information regarding emotions is present in the face. Thus, it is possible for trait judgements to utilise some independent mechanisms as opposed to a shared route. We further imply that there may be potential differences in the mechanisms underpinning trait judgements based on the nature of the trait itself (positive or negative).

Other theoretical models such as the Brunswik's lens model (1956) aimed at explaining the associations between self-perception of personality and trait judgements; and the Realistic Accuracy Model (RAM; Funder, 1995, 1999, 2012) focuses on how accurate personality judgements take place. It connects the processes that link an individual's personality trait with the observer's accurate judgement of that trait (Funder, 1995). In order to make accurate trait judgements, RAM posited four stages to facial cues such as relevance, availability, detection, and utilization. This may be true for explicit personality judgements but does not support the process of implicit accurate judgements considering this process demonstrates a unique independent route. The RAM also postulates that self-perception of personality influences how individuals process others' personalities. Given that in this thesis (Chapter 7) it has been demonstrated that implicit personality judgements are unrelated to self-perception of personality, this is contrary to the account provided in the RAM. The findings of this thesis also show implicit accurate trait judgements from neutral composite facial stimuli. Inferences of others' social traits from their faces can influence how we think and behave towards them, but little is known about how perceptions of people's traits may affect downstream cognitions, such as face memory and facial expression perception. Dimensional approaches provide a succinct, powerful framework for the study of face evaluation. However, they might not be sufficient to account for judgements in specific contexts of evaluation (Todorov, 2009). That is, while these models focus on identifying the commonalities among various judgements, interesting behavioural effects may be due to the variance that is specific to a judgement, and not shared with general components. The evidence demonstrated within this thesis on implicit personality judgements implies a need for new theoretical frameworks underpinning implicit personality judgements. Furthermore, we also speculate that the nature of trait judgements mechanisms could be different for non-clinical populations and developmental populations, and it is not yet widely understood what the impact of ageing is on this mechanism. However, a similar pattern of performance has been reported for both groups. It is possible that the interpretation of how trait judgement occurs likely varies across age based on the trait affect itself.

In summary, we have established throughout the studies conducted within the thesis, implicit personality judgements are independently processed and not predicted by facial memory, emotion perception or other social constructs. Evidently, the young adults and DP sample in this thesis are able to make accurate implicit judgements of extraversion personality traits, a positively regarded trait; whereas older adults and other-ethnicity samples do not produce the same effect; and on the contrary, young, and older adult groups both are able to form accurate judgements for neuroticism, a negatively regarded trait from young composite facial stimuli. Based on these key findings, we speculate '*implicit trait judgements as an independent process where negative traits and positive traits are processed differently within the cognitive system*'. The evidence that some personality traits (e.g., extraversion and neuroticism) are better judged and independently processed accurately across ages suggest that this mechanism uses discrete pathways in the face processing and cognitive system that is still yet to be fully understood.

We propose that, once a face is seen, the cognitive system automatically dissociates personality-specific processes and other perceptual processes. Given that the findings of our studies have revealed associations between social constructs such as autism and alexithymia, and other cognitive constructs such as face memory and emotion perception, we suggest that these constructs could be processed separately in the cognitive system. Similarly, the other perceptual processes were unrelated to trait judgements within the empirical chapters of this thesis, there may be a general trait-specific perceptual route in the cognitive system. Furthermore, within the processes involving implicit trait judgements, trait-specific processes may be dissociable based on the positivity and negativity of the trait characteristics. As discussed earlier, our results have demonstrated an age-effect and other-ethnicity effect on the extraversion trait judgements. There was no age-effect demonstrated for neuroticism trait judgements. Since negative traits can communicate increased levels of threat, our evidence suggests neuroticism is predicted across ages, we also predict that traits such as neuroticism can be universally recognized across ethnicities and ages. Although there is some evidence for extraversion in the current work, and trustworthiness trait judgements among the DP candidates (e.g., Todorov & Duchaine., 2008; Rezlescu, Susilo, Barton & Duchaine., 2014); there is as yet, a dearth of evidence for this independent process among the DP candidates and domain-specific trait judgements. Overall, we conclude that, potentially, trait judgements are processed independently in the face-processing system in comparison with other face-based perceptual processes. The current findings provide an important step toward understanding the nature and trajectory of face perception and face recognition changes across ages.

12.5 Limitations and implications

As with all empirical studies, this research is not without limitations, and these limitations can be used to direct future research. In Chapter 5, the results produced for DP's and trait judgements were likely inconclusive due to the sample size. Previously it has been suggested that age-related decline is eminent after 50 years of age. Considering the age of the DP participants in our study was mixed (age range 18 - 85), with only 5 participants aged 18-35 and 13 participants aged 35 - 50 out of 36, for future studies also it is suggested that age is controlled for among the DP sample; and comparisons made against age-matched control groups. Another limitation is that the entire DP sample completed the study online as opposed to in-person testing. Considering that older adults exhibit age-related motor decline, it would be ideal to conduct the study in a lab setting, to allow for alternative input/response modalities (for example, button box as opposed to keyboard responses).

Similarly, in Chapter 9 the sample size for our other-ethnicity sample was relatively small compared to the population of India, and as such does not necessarily constitute a representative sample. We also did not include a contact questionnaire which is also a potential drawback to the study, to allow for investigations of the social contact hypothesis. Additionally, given that we only measured implicit trait judgements and behavioural measures in Chapter 9, future studies will benefit by exploring expression perception and face identity abilities and the impact of these measures on trait judgements.

Methodological limitations: although the Cambridge Face Memory Task (CFMT) is a highly valid measure and is also one of the most highly used facial memory testing measures, there is a possibility of practice bias among the student population where familiarity with the CFMT is highly possible. It has also been reported that routine testing of student populations has produced CFMT scores within the prosopagnosia range among non-clinical populations (Bowles et al., 2009). The reason behind this pattern of findings has yet to be elucidated. However, given the CFMT is a widely used measure, it may be useful for the CFMT methodology to be replicated with novel facial stimuli sets.

As with all studies, the initial focus of this thesis aimed to understand what other processes can aid in accurate implicit trait judgements, and consider face identity as a critical factor, as such a well-established tool such as the CFMT was employed to explore the relationship between trait judgement and memory for faces. Nevertheless, recent evidence suggests using the extended version of the CFMT (Russell et al., 2009) that is specifically used in testing individual differences using an additional complex set of images, would also be useful in further establishing the relationship between trait judgements and facial memory. Furthermore, other face perception tasks (e.g., CFPT) could also be used to potentially explain the independent trait judgement mechanism.

Although the emotion perception task employed for DPs and older adults did not include a time limit (based on findings from the initial pilot test that led to the incompletion of the task), the reaction times that are reported are significantly longer for older adults and DP compared to non-clinical young adults. Thus, creating measures to increase the time latency and including a timer for these groups would aid in establishing whether there is atypicality present among DP and older adult groups.

Given that measuring accuracies for word and image categories in the IAT (refer to appendix 2) has revealed that older adults typically are less accurate than young adult groups in the image associations, we suggest that it is possible that these groups require a larger number of trials in the practice blocks to produce an IAT effect. However, in this thesis, we have employed shorter trials in the practice blocks, based on the inherent nature of high participant drop-out in online studies, the rate of which increases as a function of time on task. Additionally, measuring reaction time data online potentially involves server communications that can involve a lag in connecting portals, thus resulting in the possibility of reaction times measured online being not completely accurate. This is further compounded by the inability to control for the response mechanisms used, with some keyboards having high input latencies and certain operating systems taking longer to process this input.

Implications: Given that neuroticism personality traits were accurately inferred from faces across different age groups, current theoretical frameworks would benefit from a better understanding of the mechanisms involved in processing negative trait judgements using other-ethnicity samples and Developmental Prosopagnosia samples. We also suggest that it would be interesting to explore age effects by using older-adult composite facial stimuli and other-ethnicity facial stimuli to explore other-ethnicity effects to make stronger claims to the findings reported in this thesis. Moreover, exploring the effects of neurological mechanisms underpinning implicit trait judgements for positive and negative traits would add to theoretical frameworks that capture face trait judgements. As such, it would be interesting to study the brain regions associated with positive and negative trait inferences using fMRI and the IAT design employed within this thesis (specifically extraversion and neuroticism) to better understand the neural frameworks underpinning trait judgements. Finally, studying the face processing skills of clinical populations using the implicit paradigm could suggest new models for recognizing personality traits, and in principle, enable a better understanding of other mechanisms underpinning neurological concepts in automatic trait inferences.

12.6 Conclusion

In sum, the findings of the current thesis revealed that young adults (non-clinical populations) are able to form accurate judgements of extraversion and neuroticism personality traits from faces implicitly. The Developmental Prosopagnosia sample showed similar performance to our non-clinical young adult sample in the Extraversion IAT. It also appears that there is possibly an impact of ethnicity in moderating implicit personality judgements for extraversion personality traits. Older adults were only able to make accurate implicit judgements of neuroticism (a negatively regarded trait) but failed to make accurate judgements for a positively regarded trait such as extraversion. As such our evidence suggests that there is the plausibility that the theoretical framework underpinning implicit personality judgements can vary for positive and negative trait judgements. However, the ability to form implicit personality judgements from faces, in general, appears to follow a unique automatic route in the cognitive system. This certainly adds to a novel theoretical framework suggesting that the ability to form personality inferences uses a unique route in the cognitive system and warrants further investigation in future.

The gold standard for accurate judgement is the prediction of behaviour from facial cues. Personality judgements play a critical part in everyday life, with the accuracy of these judgements having implications for both interpersonal and organizational effectiveness. This thesis has aimed to make significant contributions in the current theoretical frameworks and empirical literature involving implicit personality trait judgements. Observers routinely make accurate automatic inferences of personality traits from facial appearance. These inferences affect important social outcomes. The evidence that some personality traits are more accurately judged and independently processed suggests that this mechanism uses a novel pathway in the face processing and cognitive system that is not yet understood. If these findings are supported, it would significantly benefit the fields of psychopathology research and clinical practice.

References

Adams-Price, C. (1992). Eyewitness memory and aging: Predictors of accuracy in recall and person recognition. *Psychology and Aging*, *7*(4), 602.

Adams, R. B., Ambady, N., Macrae, C. N., & Kleck, R. E. (2006). Emotional expressions forecast approach-avoidance behavior. *Motivation and emotion*, *30*(2), 177-186.

Adolphs, R., Sears, L., & Piven, J. (2001). Abnormal processing of social information from faces in autism. *Journal of cognitive neuroscience*, *13*(2), 232-240.

Adolphs, R., Tranel, D., & Damasio, A. R. (1998). The human amygdala in social judgment. *Nature*, *393*(6684), 470-474.

Al Moubayed, N., Vazquez-Alvarez, Y., McKay, A., & Vinciarelli, A. (2014, November). Face-based automatic personality perception. In *Proceedings of the 22nd ACM international conference on Multimedia* (pp. 1153-1156).

Albright, L., Kenny, D. A., & Malloy, T. E. (1988). Consensus in personality judgments at zero acquaintance. *Journal of personality and social psychology*, *55*(3), 387.

Allport, F. H., & Allport, G. W. (1921). Personality Traits: Their Classification and Measurement. *The Journal of Abnormal Psychology and Social Psychology*, *16*(1), 6.

Ambady, N., Bernieri, F. J., & Richeson, J. A. (2000). Toward a histology of social behavior: Judgmental accuracy from thin slices of the behavioral stream. In *Advances in experimental social psychology* (Vol. 32, pp. 201-271). Academic Press.

American Psychiatric Association, (1994). Diagnostic and statistical manual of mental disorders (DSM-4). *American psychiatric association,* 143-7.

American Psychiatric Association. (2013). Diagnostic and statistical manual of mental disorders (5th edition) (Washington, DC, APA).

Ames, D. R., & Bianchi, E. C. (2008). The agreeableness asymmetry in first impressions: Perceivers' impulse to (mis) judge agreeableness and how it is moderated by power. *Personality and Social Psychology Bulletin*, *34*(12), 1719-1736.

Amodio, D. M., & Devine, P. G. (2006). Stereotyping and evaluation in implicit race bias: evidence for independent constructs and unique effects on behavior. *Journal of personality and social psychology*, *91*(4), 652.

Anastasi, J. S., & Rhodes, M. G. (2005). An own-age bias in face recognition for children and older adults. *Psychonomic bulletin & review*, *12*(6), 1043-1047.

Anastasi, J. S., & Rhodes, M. G. (2006). Evidence for an own-age bias in face recognition. *North American Journal of Psychology*, *8*(2).

Anwyl-Irvine, A. L., Massonnié, J., Flitton, A., Kirkham, N., & Evershed, J. K. (2020). Gorilla in our midst: An online behavioral experiment builder. *Behavior research methods*, *52*(1), 388-407.

Asendorpf, J. B., Banse, R., & Mücke, D. (2002). Double dissociation between implicit and explicit personality self-concept: The case of shy behavior. *Journal of personality and social psychology*, *83*(2), 380.

Ashwin, C., Chapman, E., Colle, L., & Baron-Cohen, S. (2006). Impaired recognition of negative basic emotions in autism: A test of the amygdala theory. *Social neuroscience*, *1*(3-4), 349-363.

Association Test D-Transformation for Psychological Assessment. Assessment. Advance online publication. http://dx.doi.org/10.1177/ 1073191114551382

Austin, E. J. (2005). Personality correlates of the broader autism phenotype as assessed by the Autism Spectrum Quotient (AQ). *Personality and Individual Differences*, *38*(2), 451-460.

Avidan, G., Tanzer, M., & Behrmann, M. (2011). Impaired holistic processing in congenital prosopagnosia. Neuropsychologia, 49(9), 2541-2552.

Back, M. D., Schmukle, S. C., & Egloff, B. (2009). Predicting actual behavior from the explicit and implicit self-concept of personality. *Journal of personality and social psychology*, *97*(3), 533.

Back, M. D., Stopfer, J. M., Vazire, S., Gaddis, S., Schmukle, S. C., Egloff, B., & Gosling, S. D. (2010). Facebook profiles reflect actual personality, not self-idealization. *Psychological science*, *21*(3), 372-374.

Bäckman, L. (1991). Recognition memory across the adult life span: The role of prior knowledge. *Memory & Cognition*, *19*(1), 63-71.

Bagby, M., Taylor, G. J., & Ryan, D. (1986). Toronto Alexithymia Scale: Relationship with personality and psychopathology measures. *Psychotherapy and Psychosomatics*, *45*(4), 207-215.

Bagby, R. M., & Taylor, G. J. (1997). Measurement and validation of the alexithymia construct. *Disorders of affect regulation: Alexithymia in medical and psychiatric illness*, 46-66.

Bailey, P. E., Szczap, P., McLennan, S. N., Slessor, G., Ruffman, T., & Rendell, P. G. (2016). Age-related similarities and differences in first impressions of trustworthiness. *Cognition and Emotion*, *30*(5), 1017-1026.

Bainbridge, W. A., Isola, P., & Oliva, A. (2013). The intrinsic memorability of face photographs. *Journal of Experimental Psychology: General*, *142*(4), 1323.

Ball, T., Derix, J., Wentlandt, J., Wieckhorst, B., Speck, O., Schulze-Bonhage, A., & Mutschler, I. (2009). Anatomical specificity of functional amygdala imaging of responses to stimuli with positive and negative emotional valence. *Journal of neuroscience methods*, *180*(1), 57-70.

Bar, M., Neta, M., & Linz, H. (2006). Very first impressions. *Emotion*, *6*(2), 269.

Barańczuk, U. (2019). The five-factor model of personality and alexithymia: A meta-analysis. *Journal of Research in Personality*, *78*, 227-248.

Barclay, P. (2008). Enhanced recognition of defectors depends on their rarity. *Cognition*, 107, 817–828.

Baron-Cohen, S. (1997). *Mindblindness: An essay on autism and theory of mind*. MIT press.

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism-spectrum quotient (AQ): Evidence from asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of autism and developmental disorders*, *31*(1), 5-17.

Baron-Cohen, S., Ring, H. A., Wheelwright, S., Bullmore, E. T., Brammer, M. J., Simmons, A., & Williams, S. C. (1999). Social intelligence in the normal and autistic brain: an fMRI study. *European journal of neuroscience*, *11*(6), 1891-1898.

Bartlett, J. C., & Leslie, J. E. (1986). Aging and memory for faces versus single views of faces. *Memory & cognition*, *14*(5), 371-381.

Bartlett, J. C., Hurry, S., & Thorley, W. (1984). Typicality and familiarity of faces. *Memory & Cognition*, *12*(3), 219-228.

Bate, S., & Bennetts, R. (2015). The independence of expression and identity in face-processing: evidence from neuropsychological case studies. *Frontiers in psychology*, *6*, 770.

Bate, S., Bennetts, R. J., Gregory, N., Tree, J. J., Murray, E., Adams, A., & Banissy, M. J. (2019). Objective Patterns of Face Recognition Deficits in 165 Adults with Self-Reported Developmental Prosopagnosia. *Brain sciences*, *9*(6), 133.

Bate, S., & Cook, S. J. (2012). Covert recognition relies on affective valence in developmental prosopagnosia: Evidence from the skin conductance response. *Neuropsychology*, *26*(5), 670.

Bate, S., Haslam, C., & Hodgson, T. L. (2009). Angry faces are special too: Evidence from the visual scanpath. *Neuropsychology*, *23*(5), 658.

Bate, S., Haslam, C., Jansari, A., & Hodgson, T. L. (2009). Covert face recognition relies on affective valence in congenital prosopagnosia. *Cognitive neuropsychology*, 26(4), 391- 411.

Bate, S., Haslam, C., Tree, J. J., & Hodgson, T. L. (2008). Evidence of an eye movement-based memory effect in congenital prosopagnosia. *Cortex*, *44*(7), 806-819.

Bate, S., & Tree, J. J. (2017). The definition and diagnosis of developmental prosopagnosia. *Quarterly Journal of Experimental Psychology*, *70*(2), 193-200.

Bayliss, A. P., & Tipper, S. P. (2006). Predictive gaze cues and personality judgments: Should eye trust you? Psychological Science, 17, 514–520.

Behrmann, M., & Avidan, G. (2005). Congenital prosopagnosia: face-blind from birth. *Trends in cognitive sciences*, *9*(4), 180-187.

Behrmann, M., Avidan, G., Marotta, J. J., & Kimchi, R. (2005). Detailed exploration of face-related processing in congenital prosopagnosia: 1. Behavioral findings. *Journal of cognitive neuroscience*, *17*(7), 1130-1149.

Bentin, S., DeGutis, J. M., D'Esposito, M., & Robertson, L. C. (2007). Too many trees to see the forest: performance, event-related potential, and functional magnetic resonance imaging manifestations of integrative congenital prosopagnosia. *Journal of Cognitive Neuroscience*, *19*(1), 132-146.

Bentin, S., Deouell, L. Y., & Soroker, N. (1999). Selective visual streaming in face recognition: Evidence from developmental prosopagnosia. *Neuroreport*, *10*(4), 823-827.

Berthoz, S., & Hill, E. L. (2005). The validity of using self-reports to assess emotion regulation abilities in adults with autism spectrum disorder. *European psychiatry*, *20*(3), 291-298.

Biotti, F., Gray, K. L., & Cook, R. (2019). Is developmental prosopagnosia best characterised as an apperceptive or mnemonic condition? *Neuropsychologia*, *124*, 285-298.

Bird, G., & Cook, R. (2013). Mixed emotions: the contribution of alexithymia to the emotional symptoms of autism. *Translational psychiatry*, *3*(7), e285-e285.

Bird, G., Silani, G., Brindley, R., White, S., Frith, U., & Singer, T. (2010). Empathic brain responses in insula are modulated by levels of alexithymia but not autism. *Brain*, *133*(5), 1515-1525.

Blair, I. V., & Banaji, M. R. (1996). Automatic and controlled processes in stereotype priming. *Journal of personality and social psychology*, *70*(6), 1142.

Blanton, H., & Mitchell, G. (2011). Reassessing the predictive validity of the IAT II: Reanalysis of Heider & Skowronski (2007). North American Journal of Psychology, 13, 99 106.

Blanton, H., Jaccard, J., Christie, C., & Gonzales, P. M. (2007). Plausible assumptions, questionable assumptions and post hoc rationalizations: Will the real IAT, please stand up? *Journal of Experimental Social Psychology*, *43*(3), 399-409.

Blanton, H., Jaccard, J., Strauts, E., Mitchell, G., & Tetlock, P. E. (2015). Toward a meaningful metric of implicit prejudice. Journal of Applied Psychology. Advance online publication. http://dx.doi.org/10.1037/a0038379

Bobak, A. K., Bennetts, R. J., Parris, B. A., Jansari, A., & Bate, S. (2016). An in-depth cognitive examination of individuals with superior face recognition skills. *Cortex*, *82*, 48-62.

Bobak, A. K., Pampoulov, P., & Bate, S. (2016). Detecting superior face recognition skills in a large sample of young British adults. *Frontiers in Psychology*, *7*, 1378.

Bobes, M. A., Martín, M., Olivares, E., & Valdés-Sosa, M. (2000). Different scalp topography of brain potentials related to expression and identity matching of faces. *Cognitive Brain Research*, *9*(3), 249-260.

Bonnefon, J. F., Hopfensitz, A., & De Neys, W. (2015). Face-ism and kernels of truth in facial inferences. *Trends in Cognitive Sciences*, *19*(8), 421-422.

Borkenau, P., & Liebler, A. (1992). Trait inferences: Sources of validity at zero acquaintance. *Journal of personality and social psychology*, *62*(4), 645.

Borkenau, P., & Ostendorf, F. (1990). Comparing exploratory and confirmatory factor analysis: A study on the 5-factor model of personality. *Personality and Individual differences*, *11*(5), 515-524.

Borkenau, P., Brecke, S., Möttig, C., & Paelecke, M. (2009). Extraversion is accurately perceived after a 50-ms exposure to a face. *Journal of research in personality*, *43*(4), 703-706.

Boshyan, J., Zebrowitz, L. A., Franklin Jr, R. G., McCormick, C. M., & Carré, J. M. (2014). Age similarities in recognizing threat from faces and diagnostic cues. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *69*(5), 710-718.

Bosson, J. K., Swann Jr, W. B., & Pennebaker, J. W. (2000). Stalking the perfect measure of implicit self-esteem: The blind men and the elephant revisited? *Journal of personality and social psychology*, *79*(4), 631.

Bothwell, R. K., Brigham, J. C., & Pigott, M. A. (1987). An exploratory study of personality differences in eyewitness memory. *Journal of Social Behavior and Personality, 2*, 335-343.

Bowles, D. C., McKone, E., Dawel, A., Duchaine, B., Palermo, R., Schmalzl, L., ... & Yovel, G. (2009). Diagnosing prosopagnosia: Effects of ageing, sex, and participant–stimulus ethnic match on the Cambridge Face Memory Test and Cambridge Face Perception Test. *Cognitive Neuropsychology*, *26*(5), 423-455.

Brady, T. F., Konkle, T., Alvarez, G. A., & Oliva, A. (2008). Visual long-term memory has a massive storage capacity for object details. *PNAS: Proceedings of the National Academy of Sciences, USA, 105,* 14325–14329. doi:10.1073/pnas.0803390105

Brewer, R., Bird, G., Gray, K. L., & Cook, R. (2019). Face perception in autism spectrum disorder: Modulation of holistic processing by facial emotion. *Cognition*, *193*, 104016.

Brewer, R., Collins, F., Cook, R., & Bird, G. (2015). Atypical trait inferences from facial cues in alexithymia. *Emotion*, *15*(5), 637.

Brigham, J. C., Maass, A., Martinez, D., & Whittenberger, G. (1983). The effect of arousal on facial recognition. *Basic and Applied Social Psychology, 4*, 279-293.

Briton, N. J., & Hall, J. A. (1995). Beliefs about female and male nonverbal communication. *Sex Roles*, *32*(1-2), 79-90.

Brown, R., & Hewstone, M. (2005). An integrative theory of intergroup contact. *Advances in experimental social psychology*, *37*(37), 255-343.

Bruce, V., & Young, A. (1986). Understanding face recognition. *British journal of psychology*, *77*(3), 305-327.

Bruner, J. S., & Tagiuri, R. (1954). The perception of people. In G.Lindzey (Ed.), *Handbook of social psychology (Vol. 2, pp. 634-654).* Reading, MA: Addison-Wesley.

Brunswik, E. (1956). *Perception and the representative design of psychological experiments*. Univ of California Press.

Buchner, A., Bell, R., Mehl, B., & Musch, J. (2009). No enhanced recognition memory, but better source memory for faces of cheaters. *Evolution and Human Behavior*, 30, 212–224.

Busigny, T., Van Belle, G., Jemel, B., Hosein, A., Joubert, S., & Rossion, B. (2014). Face-specific impairment in holistic perception following focal lesion of the right anterior temporal lobe. *Neuropsychologia*, *56*, 312-333.

Butcher, J. N., Perry, J. N., & Atlis, M. M. (2000). Validity and utility of computer-based test interpretation. *Psychological assessment*, *12*(1), 6.

Butler, E. E., Ward, R., Downing, P. E., & Ramsey, R. (2018). fMRI repetition suppression reveals no sensitivity to trait judgments from faces in face perception or theory-of-mind networks. *PloS one*, *13*(8), e0201237.

Caharel, S., Courtay, N., Bernard, C., Lalonde, R., & Rebaï, M. (2005). Familiarity and emotional expression influence an early stage of face processing: an electrophysiological study. *Brain and cognition*, *59*(1), 96-100.

Calder, A. J., & Young, A. W. (2005). Understanding the recognition of facial identity and facial expression. *Nature Reviews Neuroscience*, *6*(8), 641-651.

Calder, A. J., Keane, J., Manly, T., Sprengelmeyer, R., Scott, S., Nimmo-Smith, I., & Young, A. W. (2003). Facial expression recognition across the adult life span. *Neuropsychologia*, *41*(2), 195-202.

Calder, A. J., Lawrence, A. D., & Young, A. W. (2001). Neuropsychology of fear and loathing. *Nature reviews neuroscience*, *2*(5), 352-363.

Campbell, J., & Burke, D. (2009). Evidence that identity-dependent and identity-independent neural populations are recruited in the perception of five basic emotional facial expressions. *Vision research*, *49*(12), 1532-1540.

Canli, T., Zhao, Z., Desmond, J. E., Kang, E., Gross, J., & Gabrieli, J. D. (2001). An fMRI study of personality influences on brain reactivity to emotional stimuli. *Behavioral neuroscience*, *115*(1), 33.

Capps, L., Kasari, C., Yirmiya, N., & Sigman, M. (1993). Parental perception of emotional expressiveness in children with autism. *Journal of Consulting and Clinical Psychology*, *61*(3), 475.

Carbon, C. C., Grüter, T., Grüter, M., Weber, J. E., & Lueschow, A. (2010). Dissociation of facial attractiveness and distinctiveness processing in congenital prosopagnosia. *Visual Cognition*, *18*(5), 641-654.

Castelli, F. (2005). Understanding emotions from standardized facial expressions in autism and normal development. *Autism*, *9*(4), 428-449.

Castle, E., Eisenberger, N. I., Seeman, T. E., Moons, W. G., Boggero, I. A., Grinblatt, M. S., & Taylor, S. E. (2012). Neural and behavioral bases of age differences in perceptions of trust. *Proceedings of the National Academy of Sciences*, *109*(51), 20848-20852.

Caulfield, F., Ewing, L., Burton, N., Avard, E., & Rhodes, G. (2014). Facial trustworthiness judgments in children with ASD are modulated by happy and angry emotional cues. *PloS one*, *9*(5), e97644.

Charles, S. T., Mather, M., & Carstensen, L. L. (2003). Aging and emotional memory: the forgettable nature of negative images for older adults. *Journal of Experimental Psychology: General*, *132*(2), 310.

Childs, Michael Jeanne, Jones, Alex, Thwaites, Peter, Zdravkovic, Sunčica, Thorley, Craig, Suzuki, Atsunobu, Shen, Rachel, Ding, Qi, Burns, Edwin, Xu, Hong, and Tree, Jeremy J. (2021) *Do individual differences in face recognition ability moderate the other ethnicity effect?* Journal of Experimental Psychology: human perception and performance. (In Press)

Chiroro, P. M., Tredoux, C. G., Radaelli, S., & Meissner, C. A. (2008). Recognizing faces across continents: The effect of within-race variations on the own-race bias in face recognition. *Psychonomic Bulletin & Review*, *15*(6), 1089-1092.

Chiroro, P., & Valentine, T. (1995). An investigation of the contact hypothesis of the own-race bias in face recognition. *The Quarterly Journal of Experimental Psychology Section A*, *48*(4), 879-894.

Christiansen, N. D., Wolcott-Burnam, S., Janovics, J. E., Burns, G. N., & Quirk, S. W. (2005). The good judge revisited: Individual differences in the accuracy of personality judgments. *Human Performance*, *18*(2), 123-149.

Cloutier, J., Heatherton, T. F., Whalen, P. J., & Kelley, W. M. (2008). Gender differences in the neural substrates underlying the perception of facial attractiveness: Are attractive people rewarding. *Journal of Cognitive Neuroscience*, *20*(6), 941-951.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences. New York: Academic Press.

Cook, R., Brewer, R., Shah, P., & Bird, G. (2013). Alexithymia, not autism, predicts poor recognition of emotional facial expressions. *Psychological science*, *24*(5), 723-732.

Costa Jr, P. T., & McCrae, R. R. (1992). The five-factor model of personality and its relevance to personality disorders. *Journal of personality disorders*, *6*(4), 343-359.

Costa, P. T., & McCrae, R. R. (1980). Influence of extraversion and neuroticism on subjective well-being: happy and unhappy people. *Journal of personality and social psychology*, *38*(4), 668.

Couture, S. M., Penn, D. L., Losh, M., Adolphs, R., Hurley, R., & Piven, J. (2010). Comparison of social cognitive functioning in schizophrenia and high functioning autism: more convergence than divergence. *Psychological medicine*, *40*(4), 569.

Craig, B. M., Lipp, O. V., & Mallan, K. M. (2014). Emotional expressions preferentially elicit implicit evaluations of faces also varying in race or age. *Emotion*, *14*(5), 865.

Crookes, K., & McKone, E. (2009). Early maturity of face recognition: No childhood development of holistic processing, novel face encoding, or face- space. *Cognition*, 111(2), 219-247.

Curtin, F., & Schulz, P. (1998). Multiple correlations and Bonferroni's correction. *Biological psychiatry*, *44*(8), 775-777.

Dalrymple, K. A., Garrido, L., & Duchaine, B. (2014). Dissociation between face perception and face memory in adults, but not children, with developmental prosopagnosia. *Developmental Cognitive Neuroscience*, *10*, 10-20.

Damasio, A. R., Tranel, D., & Damasio, H. (1990). Face agnosia and the neural substrates of memory. *Annual review of neuroscience*, *13*(1), 89-109.

Darbyshire, D., Kirk, C., Wall, H. J., & Kaye, L. K. (2016). Don't Judge a (Face) Book by its Cover: Exploring judgement accuracy of others' personality on Facebook. *Computers in Human Behavior*, *58*, 380-387.

Darwin, C., & Prodger, P. (1998). *The expression of the emotions in man and animals*. Oxford University Press, USA.

Davies-Thompson, J., Pancaroglu, R., & Barton, J. (2014). Acquired prosopagnosia: structural basis and processing impairments. *Front Biosci (Elite Ed)*, *6*, 159-174.

Davis, J., McKone, E., Zirnsak, M., Moore, T., O'Kearney, R., Apthorp, D., & Palermo, R. (2017). Social and attention-to-detail subclusters of autistic traits differentially predict looking at eyes and face identity recognition ability. *British Journal of Psychology*, *108*(1), 191-219.

Dawson, G., Carver, L., Meltzoff, A. N., Panagiotides, H., McPartland, J., & Webb, S. J. (2002). Neural correlates of face and object recognition in young children with autism spectrum disorder, developmental delay, and typical development. *Child development*, *73*(3), 700-717.

Dawson, G., Webb, S. J., & McPartland, J. (2005). Understanding the nature of face processing impairment in autism: insights from behavioral and electrophysiological studies. *Developmental neuropsychology*, *27*(3), 403-424.

Deffenbacher, K. A., Johanson, J., Vetter, T., & O'Toole, A. J. (2000). The face typicality-recognizability relationship: encoding or retrieval locus?. *Memory & Cognition*, *28*(7), 1173-1182.

Delgado, M. R., Frank, R. H., & Phelps, E. A. (2005). Perceptions of moral character modulate the neural systems of reward during the trust game. *Nature neuroscience*, *8*(11), 1611-1618.

Dennett, H. W., McKone, E., Edwards, M., & Susilo, T. (2012). Face aftereffects predict individual differences in face recognition ability. *Psychological science*, *23*(11), 1279-1287.

Denrell, J. (2005). Why most people disapprove of me: Experience sampling in impression formation. *Psychological Review*, *112*, 951-978.

De Renzi, E., Faglioni, P., Grossi, D., & Nichelli, P. (1991). Apperceptive and associative forms of prosopagnosia. *Cortex*, *27*(2), 213-221.

Deruelle, C., Rondan, C., Gepner, B., & Tardif, C. (2004). Spatial frequency and face processing in children with autism and Asperger syndrome. *Journal of autism and developmental disorders*, *34*(2), 199-210.

Dienes, Z. (2014). Using Bayes to get the most out of non-significant results. *Frontiers in psychology*, *5*, 781.

Donnellan, M. B., & Lucas, R. E. (2008). Age differences in the big five across the life span: evidence from two national samples. *Psychology and aging*, *23*(3), 558.

Donnellan, M. B., Oswald, F. L., Baird, B. M., & Lucas, R. E. (2006). The mini-IPIP scales: tiny-yet-effective measures of the Big Five factors of personality. *Psychological assessment*, *18*(2), 192.

Duchaine, B., Germine, L., & Nakayama, K. (2007). Family resemblance: Ten family members with prosopagnosia and within-class object agnosia. *Cognitive neuropsychology*, *24*(4), 419-430.

Duchaine, B., Murray, H., Turner, M., White, S., & Garrido, L. (2009). Normal social cognition in developmental prosopagnosia. *Cognitive neuropsychology*, *26*(7), 620-634.

Duchaine, B. C., Parker, H., & Nakayama, K. (2003). Normal recognition of emotion in a prosopagnosic. *Perception*, *32*(7), 827-838.

Duchaine, B. C., & Nakayama, K. (2004). Developmental prosopagnosia and the Benton Facial Recognition test. *Neurology*, *62*(7), 1219-1220.

Duchaine, B., & Nakayama, K. (2006). The Cambridge Face Memory Test: Results for neurologically intact individuals and an investigation of its validity using inverted face stimuli and prosopagnosic participants. *Neuropsychologia*, *44*(4), 576-585.

Duchaine, B. C., & Nakayama, K. (2006). Developmental prosopagnosia: a window to content-specific face processing. *Current opinion in neurobiology*, *16*(2), 166-173.

Duchaine, B., Yovel, G., Butterworth, E., & Nakayama, K. (2006). Prosopagnosia as an impairment to face-specific mechanisms: elimination of the alternative hypotheses in a developmental case. *Cognitive Neuropsychology, 23(5),* 714-747.

Duchaine, B., Yovel, G., & Nakayama, K. (2007). No global processing deficit in the Navon task in 14 developmental prosopagnosics. *Social cognitive and affective neuroscience*, *2*(2), 104-113.

Dzhelyova, M. P., Ellison, A., & Atkinson, A. P. (2011). Event-related repetitive TMS reveals distinct, critical roles for right OFA and bilateral posterior STS in judging the sex and trustworthiness of faces. *Journal of cognitive neuroscience*, *23*(10), 2782-2796.

Ekman, P. (1993). Facial expression and emotion. *American psychologist*, *48*(4), 384.

Ekman, P., & Friesen, W. (1976). Pictures of facial affect. Palo Alto, CA: Consulting Psychologist's.

Elfenbein, H. A., & Ambady, N. (2002). On the universality and cultural specificity of emotion recognition: a meta-analysis. *Psychological bulletin*, *128*(2), 203.

Ellis, H. D. (1975). Recognizing faces. *British Journal of Psychology,* 66, 409-426.

Ellis, A. W., Young, A. W., & Flude, B. M. (1990). Repetition priming and face processing: Priming occurs within the system that responds to the identity of a face. *The Quarterly Journal of Experimental Psychology Section A*, *42*(3), 495-512.

Engell, A. D., & Haxby, J. V. (2007). Facial expression and gaze-direction in human superior temporal sulcus. *Neuropsychologia*, *45*(14), 3234-3241.

Engell, A. D., Haxby, J. V., & Todorov, A. (2007). Implicit trustworthiness decisions: automatic coding of face properties in the human amygdala. *Journal of cognitive neuroscience*, *19*(9), 1508-1519.

Engell, A. D., Todorov, A., & Haxby, J. V. (2010). Common neural mechanisms for the evaluation of facial trustworthiness and emotional expressions as revealed by behavioural adaptation. *Perception*, *39*(7), 931-941.

Engfors, L. M., Jeffery, L., Gignac, G. E., & Palermo, R. (2017). Individual differences in adaptive norm-based coding and holistic coding are associated yet each contributes uniquely to unfamiliar face recognition ability. *Journal of Experimental Psychology: Human Perception and Performance*, *43*(2), 281.

England, D. E., Descartes, L., & Collier-Meek, M. A. (2011). Gender role portrayal and the Disney princesses. *Sex roles*, *64*(7), 555-567.

Ewing, L., Caulfield, F., Read, A., & Rhodes, G. (2015). Appearance-based trust behaviour is reduced in children with autism spectrum disorder. *Autism*, *19*(8), 1002-1009.

Ewing, L., Caulfield, F., Read, A., & Rhodes, G. (2015a). Appearance-based trust behaviour is reduced in children with autism spectrum disorder. *Autism*, *19*(8), 1002–1009. http://dx.doi.org/10.1177/1362361314559431

Eysenckv, M. W. (1974). Age differences in incidental leaming. *Developmental Psychology,* 10, 936-941.

Falvello, V., Vinson, M., Ferrari, C., & Todorov, A. (2015). The robustness of learning about the trustworthiness of other people. *Social Cognition*, *33*(5), 368-386.

Farah, M. J. (2004). *Visual agnosia*. MIT press.

Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods*, *39*(2), 175-191.

Fazio, R. H., & Olson, M. A. (2003). Implicit measures in social cognition research: Their meaning and use. *Annual review of psychology*, *54*(1), 297-327.

Fazio, R. H., Jackson, J. R., Dunton, B. C., & Williams, C. J. (1995). Variability in automatic activation as an unobtrusive measure of racial attitudes: A bona fide pipeline? *Journal of personality and social psychology*, *69*(6), 1013.

Feinberg, M., Willer, R., & Schultz, M. (2014). Gossip and ostracism promote cooperation in groups. *Psychological science*, *25*(3), 656-664.

Finzi, R. D., Susilo, T., Barton, J. J., & Duchaine, B. C. (2016). The role of holistic face processing in acquired prosopagnosia: Evidence from the composite face effect. *Visual Cognition*, *24*(4), 304-320.

Frith, C. D., & Frith, U. (1999). Interacting minds--a biological basis. *Science*, *286*(5445), 1692-1695.

Fisher, K., Towler, J., & Eimer, M. (2017). Face identity matching is selectively impaired in developmental prosopagnosia. *cortex*, *89*, 11-27.

Fiske, S. T. (1998). Stereotyping, prejudice, and discrimination. *The handbook of social psychology*, *2*(4), 357-411.

Fleischhauer, M., Enge, S., Miller, R., Strobel, A., & Strobel, A. (2013). Neuroticism explains unwanted variance in Implicit Association Tests of personality: possible evidence for an affective valence confound. *Frontiers in psychology*, *4*, 672.

Fox, C. J., & Barton, J. J. (2007). What is adapted in face adaptation? The neural representations of expression in the human visual system. *Brain research*, *1127*, 80-89.

Fox, C. J., Hanif, H. M., Iaria, G., Duchaine, B. C., & Barton, J. J. (2011). Perceptual and anatomic patterns of selective deficits in facial identity and expression processing. *Neuropsychologia*, *49*(12), 3188-3200.

Fox, C. J., Moon, S. Y., Iaria, G., & Barton, J. J. (2009). The correlates of subjective perception of identity and expression in the face network: an fMRI adaptation study. *Neuroimage*, *44*(2), 569-580.

Fox, C. J., Oruç, I., & Barton, J. J. (2008). It doesn't matter how you feel. The facial identity aftereffect is invariant to changes in facial expression. *Journal of Vision*, *8*(3), 11-11.

Franklin Jr, R. G., & Adams Jr, R. B. (2010). What makes a face memorable? The relationship between face memory and emotional state reasoning. *Personality and Individual Differences*, *49*(1), 8-12.

Fridlund, A. J. (2014). *Human facial expression: An evolutionary view*. Academic Press.

Fulton, A., & Bartlett, J. C. (1991). Young and old faces in young and old heads: The factor of age in face recognition. *Psychology and aging*, *6*(4), 623.

Funder, D. C. (1995). On the accuracy of personality judgment: a realistic approach. *Psychological review*, *102*(4), 652.

Funder, D. C. (2012). Accurate personality judgment. *Current Directions in Psychological Science*, *21*(3), 177-182.

Funder, D. C. (Ed.). (1999). *Personality judgment: A realistic approach to person perception*. Elsevier.

Funder, D. C., & Dobroth, K. M. (1987). Differences between traits: Properties associated with inter-judge agreement. *Journal of Personality and Social Psychology*, *52*, 409-418.

Gallese, V. (2007). Before and below 'theory of mind': embodied simulation and the neural correlates of social cognition. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *362*(1480), 659-669.

Garwood, S. G., Cox, L., Kaplan, V., Wasserman, N., & Sulzer, J. L. (1980). Beauty is only "name" deep: The effect of first-name on ratings of physical attraction. *Journal of Applied Social Psychology*, *10*(5), 431-435.

Gobbini, M. I., & Haxby, J. V. (2007). Neural systems for recognition of familiar faces. *Neuropsychologia*, *45*(1), 32-41.

Gobbini, M. I., Leibenluft, E., Santiago, N., & Haxby, J. V. (2004). Social and emotional attachment in the neural representation of faces. *Neuroimage*, *22*(4), 1628-1635.

Goldberg, L. R. (1990). An alternative" description of personality": the big-five factor structure. *Journal of personality and social psychology*, *59*(6), 1216.

Goldberg, L. R. (1993). The structure of phenotypic personality traits. *American psychologist*, *48*(1), 26.

Gopie, N., Craik, F. I., & Hasher, L. (2011). A double dissociation of implicit and explicit memory in younger and older adults. *Psychological Science*, *22*(5), 634-640.

Gordon, R. A. (2015). *Regression analysis for the social sciences*. Routledge.

Gosling, S. D., Gaddis, S., & Vazire, S. (2007). Personality impressions based on facebook profiles. *Icwsm*, *7*, 1-4.

Grady, C. L., Randy McIntosh, A., Horwitz, B., & Rapoport, S. I. (2000). Age-related changes in the neural correlates of degraded and nondegraded face processing. *Cognitive Neuropsychology*, *17*(1-3), 165-186.

Graziano, W. G., & Tobin, R. M. (2009). Agreeableness. In M. R. Leary & R. H. Hoyle (Eds.), *Handbook of individual differences in social behavior (pp. 46–61).* New York: Guilford Press.

Greenwald, A. G. (1990). What cognitive representations underlie social attitudes? *Bulletin of the Psychonomic Society*, *28*(3), 254-260.

Greenwald, A. G., & Banaji, M. R. (1995). Implicit social cognition: attitudes, self-esteem, and stereotypes. *Psychological review*, *102*(1), 4.

Greenwald, A. G., Banaji, M. R., Rudman, L. A., Farnham, S. D., Nosek, B. A., & Mellott, D. S. (2002). A unified theory of implicit attitudes, stereotypes, self-esteem, and self-concept. *Psychological review*, *109*(1), 3.

Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. (1998). Measuring individual differences in implicit cognition: the implicit association test. *Journal of personality and social psychology*, *74*(6), 1464.

Grumm, M., & von Collani, G. (2007). Measuring Big-Five personality dimensions with the implicit association test–Implicit personality traits or self-esteem? *Personality and Individual Differences*, *43*(8), 2205-2217.

Hall, J. A., Andrzejewski, S. A., Murphy, N. A., Mast, M. S., & Feinstein, B. A. (2008). Accuracy of judging others' traits and states: Comparing mean levels across tests. *Journal of Research in Personality*, *42*(6), 1476-1489.

Halliday, D. W., MacDonald, S. W., Sherf, S. K., & Tanaka, J. W. (2014). A reciprocal model of face recognition and autistic traits: evidence from an individual differences perspective. *PLoS One*, *9*(5), e94013.

Hancock, K. J., & Rhodes, G. (2008). Contact, configural coding and the other-race effect in face recognition. *British Journal of Psychology*, *99*(1), 45-56.

Hassin, R., & Trope, Y. (2000). Facing faces: studies on the cognitive aspects of physiognomy. *Journal of personality and social psychology*, *78*(5), 837.

Hastie, R., & Kumar, P. A. (1979). Person memory: Personality traits as organizing principles in memory for behaviors. *Journal of Personality and Social Psychology*, *37*(1), 25.

Haxby, J. V., Hoffman, E. A., & Gobbini, M. I. (2000). The distributed human neural system for face perception. *Trends in cognitive sciences*, *4*(6), 223-233.

Hellström, Å., & Tekle, J. (1994). Person perception through facial photographs: Effects of glasses, hair, and beard on judgments of occupation and personal qualities. *European Journal of Social Psychology*, *24*(6), 693-705.

Hess, T. M., Hinson, J. T., & Statham, J. A. (2004). Explicit and implicit stereotype activation effects on memory: Do age and awareness moderate the impact of priming? *Psychology and aging*, *19*(3), 495.

Hirschmüller, S., Egloff, B., Nestler, S., & Back, M. D. (2013). The dual lens model: A comprehensive framework for understanding self–other agreement of personality judgments at zero acquaintance. *Journal of Personality and Social Psychology*, *104*(2), 335.

Hirschmüller, S., Egloff, B., Schmukle, S. C., Nestler, S., & Back, M. D. (2015). Accurate judgments of neuroticism at zero acquaintance: A question of relevance. *Journal of personality*, *83*(2), 221-228.

Hofmann, W., Gawronski, B., Gschwendner, T., Le, H., & Schmitt, M. (2005). A meta-analysis on the correlation between the Implicit Association Test and explicit self-report measures. *Personality and Social Psychology Bulletin*, *31*(10), 1369-1385.

Hofmann, W., Gschwendner, T., Nosek, B. A., & Schmitt, M. (2005). What moderates implicit—explicit consistency? *European review of social psychology*, *16*(1), 335-390.

Hooper, J. J., Sutherland, C. A., Ewing, L., Langdon, R., Caruana, N., Connaughton, E., ... & Rhodes, G. (2019). Should I trust you? Autistic traits predict reduced appearance-based trust decisions. *British Journal of Psychology*, *110*(4), 617-634.

Human, L. J., & Biesanz, J. C. (2013). Targeting the good target: An integrative review of the characteristics and consequences of being accurately perceived. *Personality and Social Psychology Review*, *17*(3), 248-272.

Hummert, M. L., Garstka, T. A., O'Brien, L. T., Greenwald, A. G., & Mellott, D. S. (2002). Using the implicit association test to measure age differences in implicit social cognitions. *Psychology and aging*, *17*(3), 482.

Humphreys, K., Avidan, G., & Behrmann, M. (2007). A detailed investigation of facial expression processing in congenital prosopagnosia as compared to acquired prosopagnosia. *Experimental Brain Research*, *176*(2), 356-373.

Ihme, K., Dannlowski, U., Lichev, V., Stuhrmann, A., Grotegerd, D., Rosenberg, N., ... & Suslow, T. (2013). Alexithymia is related to differences in gray matter volume: a voxel-based morphometry study. *Brain research*, *1491*, 60-67.

Isaacowitz, D. M., Löckenhoff, C. E., Lane, R. D., Wright, R., Sechrest, L., Riedel, R., & Costa, P. T. (2007). Age differences in recognition of emotion in lexical stimuli and facial expressions. *Psychology and aging*, *22*(1), 147.

Ivcevic, Z., & Ambady, N. (2012). Personality impressions from identity claims on Facebook. *Psychology of Popular Media Culture*, *1*(1), 38.

Jackson, M. C., Counter, P., & Tree, J. J. (2017). Face working memory deficits in developmental prosopagnosia: Tests of encoding limits and updating processes. *Neuropsychologia*, *106*, 60-70.

Jacoby, L. L., Lindsay, D. S., & Hessels, S. (2003). Item-specific control of automatic processes: Stroop process dissociations. *Psychonomic Bulletin & Review*, *10*(3), 638-644.

Jacoby, L. L., Lindsay, D. S., & Toth, J. P. (1992). Unconscious influences revealed: Attention, awareness, and control. *American psychologist*, *47*(6), 802.

Jenkins, R., White, D., Van Montfort, X., & Burton, A. M. (2011). Variability in photos of the same face. *Cognition*, *121*(3), 313-323.

Jessimer, M., & Markham, R. (1997). Alexithymia: a right hemisphere dysfunction specific to recognition of certain facial expressions?. *Brain and cognition*, *34*(2), 246-258.

John, O. P., & Robins, R. W. (1993). Determinants of interjudge agreement on personality traits: The Big Five domains, observ- ability, evaluativeness, and the unique perspective of the self. *Journal of Personality*, *61*, 521-551.

Jones, A. L., Kramer, R. S., & Ward, R. (2012). Signals of personality and health: The contributions of facial shape, skin texture, and viewing angle. *Journal of Experimental Psychology: Human Perception and Performance*, *38*(6), 1353.

Jones, A. L., Tree, J. J., & Ward, R. (2019). Personality in faces: Implicit associations between appearance and personality. *European Journal of Social Psychology*, *49*(3), 658-669.

Jongen, S., Axmacher, N., Kremers, N. A., Hoffmann, H., Limbrecht-Ecklundt, K., Traue, H. C., & Kessler, H. (2014). An investigation of facial emotion recognition impairments in alexithymia and its neural correlates. *Behavioural brain research*, *271*, 129-139.

Junior, J. C. S. J., Güçlütürk, Y., Pérez, M., Güçlü, U., Andujar, C., Baró, X., ... & Escalera, S. (2019). First impressions: A survey on vision-based apparent personality trait analysis. *IEEE Transactions on Affective Computing*.

Kanwisher, N., McDermott, J., & Chun, M. M. (1997). The fusiform face area: a module in human extrastriate cortex specialized for face perception. *Journal of neuroscience*, *17*(11), 4302-4311.

Keightley, M. L., Winocur, G., Burianova, H., Hongwanishkul, D., & Grady, C. L. (2006). Age effects on social cognition: faces tell a different story. *Psychology and Aging*, *21*(3), 558.

Ketcham, C. J., & Stelmach, G. E. (2001). Age-related declines in motor control. *Handbook of the psychology of aging*, *5*, 313-348.

Keysers, C., Gazzola, V., & Wagenmakers, E. J. (2020). Using Bayes factor hypothesis testing in neuroscience to establish evidence of absence. *Nature neuroscience*, *23*(7), 788-799.

Klamer, S., Schwarz, L., Krüger, O., Koch, K., Erb, M., Scheffler, K., & Ethofer, T. (2017). Association between neuroticism and emotional face processing. *Scientific reports*, *7*(1), 1-8.

Knutson, B. (1996). Facial expressions of emotion influence interpersonal trait inferences. *journal of Nonverbal Behavior*, *20*(3), 165-182.

Knutson, K. M., DeTucci, K. A., & Grafman, J. (2011). Implicit attitudes in prosopagnosia. *Neuropsychologia*, *49*(7), 1851-1862.

Kocsor, F., & Bereczkei, T. (2017). First impressions of strangers rely on generalization of behavioral traits associated with previously seen facial features. *Current Psychology*, *36*(3), 385-391.

Kotov, R., Gamez, W., Schmidt, F., & Watson, D. (2010). Linking "big" personality traits to anxiety, depressive, and substance use disorders: a meta-analysis. *Psychological bulletin*, *136*(5), 768.

Kramer, R. S., & Ward, R. (2010). Internal facial features are signals of personality and health. *The Quarterly Journal of Experimental Psychology*, *63*(11), 2273-2287.

Kuhbandner, C., Spachtholz, P., & Pastötter, B. (2016). Bad things come easier to the mind but harder to the body: Evidence from brain oscillations. *Cognitive, Affective, & Behavioral Neuroscience*, *16*(4), 768-778.

Lahey, B. B. (2009). Public health significance of neuroticism. *American Psychologist*, *64*(4), 241.

Lamont, A. C., Stewart-Williams, S., & Podd, J. (2005). Face recognition and aging: Effects of target age and memory load. *Memory & cognition*, *33*(6), 1017-1024.

Lander, K., & Butcher, N. (2015). Independence of face identity and expression processing: exploring the role of motion. *Frontiers in Psychology*, *6*, 255.

Lander, K., & Poyarekar, S. (2015). Famous face recognition, face matching, and extraversion. *Quarterly Journal of Experimental Psychology*, *68*(9), 1769-1776.

Lane, K. A., Banaji, M. R., Nosek, B. A., & Greenwald, A. G. (2007). Understanding and using the implicit association test: IV. *Implicit measures of attitudes*, 59-102.

Lane, R. D., Lee, S., Reidel, R., Weldon, V., Kaszniak, A., & Schwartz, G. E. (1996). Impaired verbal and nonverbal emotion recognition in alexithymia. *Psychosomatic medicine*, *58*(3), 203-210.

Lane, R. D., Sechrest, L., Riedel, R., Shapiro, D. E., & Kaszniak, A. W. (2000). Pervasive emotion recognition deficit common to alexithymia and the repressive coping style. *Psychosomatic medicine*, *62*(4), 492-501.

Latimier, A., Kovarski, K., Peyre, H., Fernandez, L. G., Gras, D., Leboyer, M., & Zalla, T. (2019). Trustworthiness and Dominance Personality Traits' Judgments in Adults with Autism Spectrum Disorder. *Journal of autism and developmental disorders*, *49*(11), 4535-4546.

Lebrecht, S., Pierce, L. J., Tarr, M. J., & Tanaka, J. W. (2009). Perceptual other-race training reduces implicit racial bias. *PloS one*, *4*(1), e4215.

Lee, M. D., & Wagenmakers, E. J. (2014). *Bayesian cognitive modeling: A practical course*. Cambridge university press.

Lee, Y., Duchaine, B., Wilson, H. R., & Nakayama, K. (2010). Three cases of developmental prosopagnosia from one family: detailed neuropsychological and psychophysical investigation of face processing. *Cortex, 46(8),* 949-964.

Letzring, T. D. (2008). The good judge of personality: Characteristics, behaviors, and observer accuracy. *Journal of research in personality*, *42*(4), 914-932.

Letzring, T. D., & Funder, D. C. (2019). The realistic accuracy model. *The Oxford handbook of accurate personality judgment. Oxford University Press and Oxford Handbooks Online. https://doi. org/10.1093/oxfordhb/9780190912529.013*, *2*.

Letzring, T. D., Colman, D. E., Krzyzaniak, S. L., & Roberts, B. W. (2020). Realistic Accuracy Model. *The Wiley Encyclopedia of Personality and Individual Differences: Models and Theories*, 341-349.

Letzring, T. D., Wells, S. M., & Funder, D. C. (2006). Information quantity and quality affect the realistic accuracy of personality judgment. *Journal of personality and social psychology*, *91*(1), 111.

Levin, D. T., & Angelone, B. L. (2001). Visual search for a socially defined feature: What causes the search asymmetry favoring cross-race faces?. *Perception & Psychophysics*, *63*(3), 423-435.

Lewis, G. J., Lefevre, C. E., & Young, A. W. (2016). Functional architecture of visual emotion recognition ability: A latent variable approach. *Journal of Experimental Psychology: General*, *145*(5), 589.

Lewis, G. J., Shakeshaft, N. G., & Plomin, R. (2018). Face identity recognition and the social difficulties component of the autism-like phenotype: Evidence for phenotypic and genetic links. *Journal of autism and developmental disorders*, *48*(8), 2758-2765.

Li, J., Tian, M., Fang, H., Xu, M., Li, H., & Liu, J. (2010). Extroversion predicts individual differences in face recognition. *Communication & Integrative Biology, 3*, 295-298.

Light, L. L., & Singh, A. (1987). Implicit and explicit memory in young and older adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *13*(4), 531.

Lin, T., Fischer, H., Johnson, M. K., & Ebner, N. C. (2019). The effects of face attractiveness on face memory depend on both age of perceiver and age of face. *Cognition and Emotion*, 1-15.

Linden, W., Wen, F., & Paulhus, D. L. (2014). Measuring alexithymia: Reliability, validity and prevalence. *Adv personal assessment*, *10*, 51-95.

Lindholm, T. (2005). Own-age biases in verbal person memory. *Memory*, *13*(1), 21-30.

Liss, M., Mailloux, J., & Erchull, M. J. (2008). The relationships between sensory processing sensitivity, alexithymia, autism, depression, and anxiety. *Personality and individual differences*, *45*(3), 255-259.

Little, A. C., & Perrett, D. I. (2007). Using composite images to assess accuracy in personality attribution to faces. *British Journal of Psychology*, *98*(1), 111-126.

Little, A. C., Burt, D. M., & Perrett, D. I. (2006). What is good is beautiful: Face preference reflects desired personality. *Personality and Individual Differences*, *41*(6), 1107-1118.

Lombardo, M. V., Barnes, J. L., Wheelwright, S. J., & Baron-Cohen, S. (2007). Self-referential cognition and empathy in autism. *PloS one*, *2*(9), e883.

Luminet, O., Bagby, R. M., Wagner, H., Taylor, G. J., & Parker, J. D. (1999). Relation between alexithymia and the five-factor model of personality: A facet-level analysis. *Journal of personality assessment*, *73*(3), 345-358.

Luminet, O., Grynberg, D., Ruzette, N., & Mikolajczak, M. (2011). Personality-dependent effects of oxytocin: greater social benefits for high alexithymia scorers. *Biological psychology*, *87*(3), 401-406.

Lundqvist, D., Flykt, A., & Ohman, A. (1998). *The Karolinska Directed Emotional Faces*. Stockholm, Sweden: Karolinska Institute, Psychology Section, Department of Clinical Neuroscience.

Lyvers, M., Boileau, M., & Thorberg, F. A. (2019). Personality and Alcohol-Related Risk: Neuroticism, Extraversion, and Alexithymia. *The American Journal of Psychology*, *132*(4), 451-465.

MacLeod, C., & Rutherford, E. M. (1992). Anxiety and the selective processing of emotional information: Mediating roles of awareness, trait and state variables, and personal relevance of stimulus materials. *Behaviour Research and Therapy*, *30*(5), 479-491.

Mann, L. S., Wise, T. N., Trinidad, A., & Kohanski, R. (1994). Alexithymia, affect recognition, and the five-factor model of personality in normal subjects. *Psychological reports*, *74*(2), 563-567.

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation. *Psychological review*, *98*(2), 224.

Marsh, A. A., Ambady, N., & Kleck, R. E. (2005). The effects of fear and anger facial expressions on approach-and avoidance-related behaviors. *Emotion*, *5*(1), 119.

Mather, M., & Carstensen, L. L. (2003). Aging and attentional biases for emotional faces. *Psychological science*, *14*(5), 409-415.

Mathersul, D., McDonald, S., & Rushby, J. A. (2013). Psychophysiological correlates of social judgement in high-functioning adults with autism spectrum disorder. *International Journal of Psychophysiology*, *87*(1), 88-94.

McArthur, L. (1982). Judging a book by its cover: A cognitive analysis of the relationship between physical appearance and stereotyping. In A. Hastorf & A. Isen (Eds.), *Cognitive social psychology* (pp.149–211). New York: Elsevier/North-Holland.

McArthur, L. Z., & Baron, R. M. (1983). Toward an ecological theory of social perception. *Psychological review*, *90*(3), 215.

McCarthy, G., Puce, A., Gore, J. C., & Allison, T. (1997). Face-specific processing in the human fusiform gyrus. *Journal of cognitive neuroscience*, *9*(5), 605-610.

McCrae, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of personality*, *60*(2), 175-215.

McDonald, P. W., & Prkachin, K. M. (1990). The expression and perception of facial emotion in alexithymia: a pilot study. *Psychosomatic medicine*.

Mealey, L., Daood, C., & Krage, M. (1996). Enhanced memory for faces of cheaters. Ethology and Sociobiology, 17, 119–128.

Megreya, A. M. & Burton, A. M. (2006). Unfamiliar faces are not faces: Evidence from a matching task. *Memory & Cognition, 34*, 865-876.

Megreya, A. M., & Bindemann, M. (2013). Individual differences in personality and face identification. *Journal of Cognitive Psychology*, *25*(1), 30-37.

Meissner, C. A., & Brigham, J. C. (2001). Thirty years of investigating the own-race bias in memory for faces: A meta-analytic review. *Psychology, Public Policy, and Law*, *7*(1), 3.

Meissner, C. A., Brigham, J. C., & Butz, D. A. (2005). Memory for own-and other-race faces: A dual-process approach. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, *19*(5), 545-567.

Minio-Paluello, I., Porciello, G., Pascual-Leone, A., & Baron-Cohen, S. (2020). Face individual identity recognition: a potential endophenotype in autism. *Molecular Autism*, *11*(1), 1-16.

Mogg, K., & Bradley, B. P. (1998). A cognitive-motivational analysis of anxiety. *Behaviour research and therapy*, *36*(9), 809-848.

Montebarocci, O., Surcinelli, P., Rossi, N., & Baldaro, B. (2011). Alexithymia, verbal ability and emotion recognition. *Psychiatric Quarterly*, *82*(3), 245-252.

Montepare, J. M., & Dobish, H. (2003). The contribution of emotion perceptions and their overgeneralizations to trait impressions. *Journal of Nonverbal behavior*, *27*(4), 237-254.

Montepare, J. M., & Dobish, H. (2003). The contribution of emotion perceptions and their overgeneralizations to trait impressions. *Journal of Nonverbal behavior*, *27*(4), 237-254.

Mueller, J. H., & Thompson, W. B. (1988). Individual differences in face memory. In *Practical aspects of memory: Current research and issues* (Vol. 1, pp. 71-76). John Wiley & Sons Oxford England.

Mueller, J. H., Bailis, K. L., & Goldstein, A. G. (1979). Depth of processing and anxiety in facial recognition. *British Journal of Psychology, 70,* 511-515.

Mueller, J. H., Keller, T., & Dandoy, A. (1989). Face memory and spontaneous personality processing. *Bulletin of the Psychonomic Society*, *27*(2), 103-106.

Müller, J., Bühner, M., & Ellgring, H. (2004). The assessment of alexithymia: psychometric properties and validity of the Bermond–Vorst alexithymia questionnaire. *Personality and Individual Differences*, *37*(2), 373-391.

Murphy, M., Bolton, P. F., Pickles, A., Fombonne, E., Piven, J., & Rutter, M. (2000). Personality traits of the relatives of autistic probands. *Psychological medicine*, *30*(6), 1411-1424.

Na, J., & Kitayama, S. (2011). Spontaneous trait inference is culture-specific: Behavioral and neural evidence. *Psychological science*, *22*(8), 1025-1032.

Nakagawa, S. (2004). A farewell to Bonferroni: the problems of low statistical power and publication bias. *Behavioral ecology*, *15*(6), 1044-1045.

Naumann, L. P., Vazire, S., Rentfrow, P. J., & Gosling, S. D. (2009). Personality judgments based on physical appearance. *Personality and social psychology bulletin*, *35*(12), 1661-1671.

Nemiah, J. C. (1970). Affect and fantasy in patients with psychosomatic disorders. *Modern trends in psychosomatic medicine*, *2*, 26-34.

Nemiah, J. C., & Sifneos, P. E. (1970). Psychosomatic illness: A problem in communication. *Psychotherapy and Psychosomatics, 18*(1-6), 154 160. https://doi.org/10.1159/000286074

Nemiah, J. C., Freyberger, H. J., & Sifneos, P. E. (1976). In O. W. Hill (Ed.), *Alexithymia: A view of the psychosomatic process* (pp. 430 – 439). London, England: Butterworths.

Nestler, S., & Back, M. D. (2013). Applications and extensions of the lens model to understand interpersonal judgments at zero acquaintance. *Current Directions in Psychological Science*, *22*(5), 374-379.

Niedenthal, P. M. (2007). Embodying emotion. *science*, *316*(5827), 1002-1005.

Nosek, B. A., Greenwald, A. G., & Banaji, M. R. (2005). Understanding and using the Implicit Association Test: II. Method variables and construct validity. *Personality and Social Psychology Bulletin*, *31*(2), 166-180.

Nosek, B. A., Greenwald, A. G., & Banaji, M. R. (2007). The Implicit Association Test at age 7: A methodological and conceptual review. *Automatic processes in social thinking and behavior*, *4*, 265-292.

Nosek, B. A., Smyth, F. L., Hansen, J. J., Devos, T., Lindner, N. M., Ranganath, K. A., ... & Banaji, M. R. (2007). Pervasiveness and correlates of implicit attitudes and stereotypes. *European Review of Social Psychology*, *18*(1), 36-88.

Nowicki, S., Winograd, E., & Millard, B. A. (1979). Memory for faces: A social learning analysis. *Journal of Research in Personality, 13*, 460-468.

O'brien, R. M. (2007). A caution regarding rules of thumb for variance inflation factors. *Quality & quantity*, *41*(5), 673-690.

Oosterhof, N. N., & Todorov, A. (2008). The functional basis of face evaluation. *PNAS: Proceedings of the National Academy of Sciences of the United States of America, 105,* 11087–11092. http://dx.doi.org/ 10.1073/pnas.0805664105

Ormel, J., Bastiaansen, A., Riese, H., Bos, E. H., Servaas, M., Ellenbogen, M., ... & Aleman, A. (2013). The biological and psychological basis of neuroticism: current status and future directions. *Neuroscience & Biobehavioral Reviews*, *37*(1), 59-72.

Oswald, F. L., Mitchell, G., Blanton, H., Jaccard, J., & Tetlock, P. E. (2015). Using the IAT to predict ethnic and racial discrimination: small effect sizes of unknown societal significance.

Over, H., & Cook, R. (2018). Where do spontaneous first impressions of faces come from? *Cognition*, *170*, 190-200.

Ozonoff, S., Pennington, B. F., & Rogers, S. J. (1991). Executive function deficits in high-functioning autistic individuals: relationship to theory of mind.Journal of child Psychology and Psychiatry, 32(7), 1081-1105.

Palermo, R., Jeffery, L., Lewandowsky, J., Fiorentini, C., Irons, J. L., Dawel, A., & Rhodes, G. (2018). Adaptive face coding contributes to individual differences in facial expression recognition independently of affective factors. *Journal of Experimental Psychology: Human Perception and Performance*, *44*(4), 503.

Palermo, R., O'Connor, K. B., Davis, J. M., Irons, J., & McKone, E. (2013). New tests to measure individual differences in matching and labelling facial expressions of emotion, and their association with ability to recognise vocal emotions and facial identity. *PloS one*, *8*(6), e68126.

Palermo, R., Rossion, B., Rhodes, G., Laguesse, R., Tez, T., Hall, B., ... & Al-Janabi, S. (2017). Do people have insight into their face recognition abilities? *Quarterly Journal of Experimental Psychology*, *70*(2), 218-233.

Palermo, R., Willis, M. L., Rivolta, D., McKone, E., Wilson, C. E., & Calder, A. J. (2011). Impaired holistic coding of facial expression and facial identity in congenital prosopagnosia. *Neuropsychologia*, *49*(5), 1226-1235.

Pandey, R., & Mandal, M. K. (1997). Processing of facial expressions of emotion and alexithymia. *British Journal of Clinical Psychology*, *36*(4), 631-633.

Parikh, D., Torralba, A., Oliva, A., & Isola, P. (2012). Understanding the intrinsic memorability of images. *Journal of Vision,* 12(9), 1082.

Park, J. H., & Schaller, M. (2009). Parasites, minds and cultures. *The Psychologist* 22(11), 942-945.

Parker, J., Taylor, G., & Bagby, M. (1993). Alexithymia and the processing of emotional stimuli: An experimental study. *New Trends in Experimental and Clinical Psychiatry*, *9*, 9-9.

Parker, P. D., Prkachin, K. M., & Prkachin, G. C. (2005). Processing of facial expressions of negative emotion in alexithymia: the influence of temporal constraint. *Journal of personality*, *73*(4), 1087-1107.

Penton-Voak, I. S., Pound, N., Little, A. C., & Perrett, D. I. (2006). Personality judgments from natural and composite facial images: More evidence for a "kernel of truth" in social perception. *Social cognition*, *24*(5), 607-640.

Perdue, C. W., Dovidio, J. F., Gurtman, M. B., & Tyler, R. B. (1990). Us and them: social categorization and the process of intergroup bias. *Journal of personality and social psychology*, *59*(3), 475.

Perfect, T. J., & Harris, L. J. (2003). Adult age differences in unconscious transference: Source confusion or identity blending? *Memory & cognition*, *31*(4), 570-580.

Perfect, T. J., & Moon, H. (2005). The own-age effect in face recognition. *Measuring the mind: Speed, control, and age*, 317-340.

Perneger, T. V. (1998). What's wrong with Bonferroni adjustments. *Bmj*, *316*(7139), 1236-1238.

Perrett, D. I., Harris, M. H., Mistlin, A. J., Hietanen, J. K., Benson, P. J., Bevan, R., ... & Brierly, K. (1990). Social Signals Analyzed at the Single Cell Level: Someone is Looking at Me, Something Moved! *International Journal of Comparative Psychology*, *4*(1).

Petrican, R., Todorov, A., & Grady, C. (2014). Personality at face value: Facial appearance predicts self and other personality judgments among strangers and spouses. *Journal of nonverbal behavior*, *38*(2), 259-277.

Pitcher, D., Walsh, V., & Duchaine, B. (2011). The role of the occipital face area in the cortical face perception network. *Experimental brain research*, *209*(4), 481-493.

Piven, J., Palmer, P., Landa, R., Santangelo, S., Jacobi, D., & Childress, D. (1997). Personality and language characteristics in parents from multiple-incidence autism families. *American Journal of Medical Genetics*, *74*(4), 398-411.

Poljac, E., Poljac, E., & Wagemans, J. (2013). Reduced accuracy and sensitivity in the perception of emotional facial expressions in individuals with high autism spectrum traits. *Autism*, *17*(6), 668-680.

Prkachin, G. C., Casey, C., & Prkachin, K. M. (2009). Alexithymia and perception of facial expressions of emotion. *Personality and Individual Differences*, *46*(4), 412-417.

Quadflieg, S., Todorov, A., Laguesse, R., & Rossion, B. (2012). Normal face-based judgements of social characteristics despite severely impaired holistic face processing. *Visual cognition*, *20*(8), 865-882.

Qualter, P., Quinton, S. J., Wagner, H., & Brown, S. (2009). Loneliness, interpersonal distrust, and alexithymia in university students 1. *Journal of Applied Social Psychology*, *39*(6), 1461-1479.

Quintana, D. S., & Williams, D. R. (2018). Bayesian alternatives for common null-hypothesis significance tests in psychiatry: a non-technical guide using JASP. *BMC psychiatry*, *18*(1), 1-8.

Rezlescu, C., Susilo, T., Barton, J. J., & Duchaine, B. (2014). Normal social evaluations of faces in acquired prosopagnosia. *cortex*, *50*, 200-203.

Rhodes, G. (2006). The evolutionary psychology of facial beauty. *Annu. Rev. Psychol.*, *57*, 199-226.

Rhodes, G. (2017). Adaptive coding and face recognition. *Current Directions in Psychological Science*, *26*(3), 218-224.

Rhodes, G., & Leopold, D. A. (2011). Adaptive norm-based coding of face identity. *The Oxford handbook of face perception*, 263-286.

Rhodes, G., Jeffery, L., Taylor, L., & Ewing, L. (2013). Autistic traits are linked to reduced adaptive coding of face identity and selectively poorer face recognition in men but not women. *Neuropsychologia*, *51*(13), 2702-2708.

Rhodes, G., Jeffery, L., Taylor, L., Hayward, W. G., & Ewing, L. (2014). Individual differences in adaptive coding of face identity are linked to individual differences in face recognition ability. *Journal of Experimental Psychology: Human Perception and Performance*, *40*(3), 897.

Rhodes, G., Locke, V., Ewing, L., & Evangelista, E. (2009). Race coding and the other-race effect in face recognition. *Perception*, *38*(2), 232-241.

Rhodes, M. G., & Anastasi, J. S. (2012). The own-age bias in face recognition: a meta-analytic and theoretical review. *Psychological bulletin*, *138*(1), 146.

Riby, D. M., Doherty-Sneddon, G., & Bruce, V. (2009). The eyes or the mouth? Feature salience and unfamiliar face processing in Williams syndrome and autism. *Quarterly journal of experimental psychology*, *62*(1), 189-203.

Richler, J. J., Cheung, O. S., & Gauthier, I. (2011). Holistic processing predicts face recognition. Psychological Science.

Rivolta, D., Schmalzl, L., Coltheart, M., & Palermo, R. (2010). Semantic information can facilitate covert face recognition in congenital prosopagnosia. *Journal of Clinical and Experimental Neuropsychology*, 32(9), 1002-1016.

Robinson, E. B., Munir, K., Munafò, M. R., Hughes, M., McCormick, M. C., & Koenen, K. C. (2011). Stability of autistic traits in the general population: further evidence for a continuum of impairment. *Journal of the American Academy of Child & Adolescent Psychiatry*, *50*(4), 376-384.

Rosenberg, N., Rufer, M., Lichev, V., Ihme, K., Grabe, H. J., Kugel, H., ... & Suslow, T. (2016). Observer-rated alexithymia and its relationship with the five-factor-model of personality. *Psychologica Belgica*, *56*(2), 118.

Rosenthal, R., & Rosnow, R. L. (2008). *Essentials of behavioral research: Methods and data analysis*.

Rosenthal, R., Hall, J. A., DiMatteo, M. R., Rogers, P. L., & Archer, D. (1979). Sensitivity to nonverbal communication: The PONS test. Baltimore: The Johns Hopkins University Press.

Rossion, B., Caldara, R., Seghier, M., Schuller, A. M., Lazeyras, F., & Mayer, E. (2003). A network of occipito-temporal face-sensitive areas besides the right middle fusiform gyrus is necessary for normal face processing. *Brain*, *126*(11), 2381-2395.

Rothermund, K., & Wentura, D. (2001). Figure-ground asymmetries in the Implicit Association Test (IAT). *Zeitschrift für experimentelle Psychologie*, *48*(2), 94-106.

Ruffman, T., Henry, J. D., Livingstone, V., & Phillips, L. H. (2008). A meta-analytic review of emotion recognition and aging: Implications for neuropsychological models of aging. *Neuroscience & Biobehavioral Reviews*, *32*(4), 863-881.

Ruffman, T., Sullivan, S., & Edge, N. (2006). Differences in the way older and younger adults rate threat in faces but not situations. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *61*(4), P187-P194.

Rule, N. O., Ambady, N., & Adams Jr, R. B. (2009). Personality in perspective: Judgmental consistency across orientations of the face. *Perception*, *38*(11), 1688-1699.

Rule, N. O., Ambady, N., Adams Jr, R. B., Ozono, H., Nakashima, S., Yoshikawa, S., & Watabe, M. (2010). Polling the face: prediction and consensus across cultures. *Journal of personality and social psychology*, *98*(1), 1.

Rule, N. O., Krendl, A. C., Ivcevic, Z., & Ambady, N. (2013). Accuracy and consensus in judgments of trustworthiness from faces: Behavioral and neural correlates. *Journal of*

Personality and Social Psychology, *104*(3), 409–426. https://doi.org/10.1037/a0031050

Rule, N. O., Slepian, M. L., & Ambady, N. (2012). A memory advantage for untrustworthy faces. *Cognition*, *125*(2), 207-218.

Russell, J. A. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological bulletin*, *115*(1), 102.

Ruzich, E., Allison, C., Smith, P., Watson, P., Auyeung, B., Ring, H., & Baron-Cohen, S. (2015). Measuring autistic traits in the general population: a systematic review of the Autism-Spectrum Quotient (AQ) in a nonclinical population sample of 6,900 typical adult males and females. *Molecular autism*, *6*(1), 2.

Sacco, D. F., & Brown, M. (2018). Preferences for facially communicated big five personality traits and their relation to self-reported big five personality. *Personality and Individual Differences*, *134*, 195-200.

Said, C. P., Haxby, J. V., & Todorov, A. (2011). Brain systems for assessing the affective value of faces. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *366*(1571), 1660-1670.

Said, C. P., Moore, C. D., Engell, A. D., Todorov, A., & Haxby, J. V. (2010). Distributed representations of dynamic facial expressions in the superior temporal sulcus. *Journal of vision*, *10*(5), 11-11.

Sasson, N. J., Nowlin, R. B., & Pinkham, A. E. (2013). Social cognition, social skill, and the broad autism phenotype. *Autism*, *17*(6), 655-667.

Satchell, L. P., Davis, J. P., Julle-Danière, E., Tupper, N., & Marshman, P. (2019). Recognising faces but not traits: Accurate personality judgment from faces is unrelated to superior face memory. *Journal of Research in Personality*, *79*, 49-58.

Satchell, L. P., Davis, J. P., Julle-Danière, E., Tupper, N., & Marshman, P. (2019). Recognising faces but not traits: Accurate personality judgment from faces is unrelated to superior face memory. *Journal of Research in Personality*, *79*, 49-58.

Schneider, D. J. (1973). Implicit personality theory: A review. *Psychological bulletin*, *79*(5), 294.

Schönbrodt, F. D., & Wagenmakers, E. J. (2018). Bayes factor design analysis: Planning for compelling evidence. *Psychonomic bulletin & review*, *25*(1), 128-142.

Schriber, R. A., Robins, R. W., & Solomon, M. (2014). Personality and self-insight in individuals with autism spectrum disorder. *Journal of Personality and Social Psychology*, *106*(1), 112.

Scott, N. J., Kramer, R. S. S., Jones, A. L., & Ward, R. (2013). Facial cues to depressive symptoms and their associated personality attributions. *Psychiatry Research*, *208*(1), 47-53.

Searcy, J. H., Bartlett, J. C., Memon, A., & Swanson, K. (2001). Aging and lineup performance at long retention intervals: Effects of metamemory and context reinstatement. *Journal of Applied Psychology*, *86*(2), 207.

Searcy, J., Bartlett, J. C., & Memon, A. (2000). Influence of post-event narratives, line-up conditions and individual differences on false identification by young and older eyewitnesses. *Legal and Criminological Psychology*, *5*(2), 219-235.

Secord, P. F. (1958). Facial features and inference processes in interpersonal perception. *Person perception and interpersonal behavior*, 300-315.

Shah, P., Gaule, A., Sowden, S., Bird, G., & Cook, R. (2015). The 20-item prosopagnosia index (PI20): a self-report instrument for identifying developmental prosopagnosia. *Royal Society Open Science*, *2*(6), 140343.

Shah, P., Hall, R., Catmur, C., & Bird, G. (2016). Alexithymia, not autism, is associated with impaired interoception. *cortex*, *81*, 215-220.

Shakeshaft, N. G., & Plomin, R. (2015). Genetic specificity of face recognition. *Proceedings of the National Academy of Sciences*, *112*(41), 12887-12892.

Shear, B. R., & Zumbo, B. D. (2013). False positives in multiple regression: Unanticipated consequences of measurement error in the predictor variables. *Educational and Psychological Measurement*, *73*(5), 733-756.

Shepherd, J. W., & Ellis, H. D. (1973). The effect of attractiveness on recognition memory for faces. *The American journal of psychology*, 627-633.

Sherman, J. W., Gawronski, B., Gonsalkorale, K., Hugenberg, K., Allen, T. J., & Groom, C. J. (2008). The self-regulation of automatic associations and behavioral impulses. *Psychological review*, *115*(2), 314.

Shevlin, M., Walker, S., Davies, M. N., Banyard, P., & Lewis, C. A. (2003). Can you judge a book by its cover? Evidence of self–stranger agreement on personality at zero acquaintance. *Personality and Individual Differences*, *35*(6), 1373-1383.

Slepian, M. L., Young, S. G., Rule, N. O., Weisbuch, M., & Ambady, N. (2012). Embodied impression formation: Social judgments and motor cues to approach and avoidance. *Social Cognition,* 30, 232–240.

Smailes, H. L., Humphries, J. E., Ryder, H., Klatt, T., Maltby, J., Pearmain, A. M., & Flowe, H. D. (2018). Age-related differences in spontaneous trait judgments from facial appearance. *Psychiatry, Psychology and Law*, *25*(5), 759-768.

Smith–McLallen, A., Johnson, B. T., Dovidio, J. F., & Pearson, A. R. (2006). Black and white: The role of color bias in implicit race bias. *Social Cognition*, *24*(1), 46-73.

Sperber, D., & Hirschfeld, L. A. (2004). The cognitive foundations of cultural stability and diversity. *Trends in cognitive sciences*, *8*(1), 40-46.

Sporer, S. L. (1999, July). *The own-race bias in Germany: Testing the contact hypothesis with Turks and Germans.* Paper presented at the 4th European Conference on Psychology and Law of the U.S. Psychology–Law Association and the European Psychology–Law Association, Dublin.

Sporer, S. L. (2001). Recognizing faces of other ethnic groups: An integration of theories. *Psychology, Public Policy, and Law*, *7*(1), 36.

Sprengelmeyer, R., Young, A. W., Baldas, E. M., Ratheiser, I., Sutherland, C. A., Müller, H. P., Grön, G., Süssmuth, S. D., Landwehrmeyer, G. B., & Orth, M. (2016). The neuropsychology of first impressions: Evidence from Huntington's disease. *Cortex*, *85*, 100-115.

Steffens, M. C., & Schulze König, S. (2006). Predicting spontaneous big five behaviour with implicit association tests. *European Journal of Psychological Assessment*, *22*(1), 13-20.

Stumps, A., Saad, E., Rothlein, D., Verfaellie, M., & DeGutis, J. (2020). Characterizing developmental prosopagnosia beyond face perception: Impaired recollection but intact familiarity recognition. *Cortex*.

Sucksmith, E., Roth, I., & Hoekstra, R. A. (2011). Autistic traits below the clinical threshold: re-examining the broader autism phenotype in the 21st century. *Neuropsychology review*, *21*(4), 360-389.

Sullivan, S., & Ruffman, T. (2004). Emotion recognition deficits in the elderly. *International Journal of Neuroscience*, *114*(3), 403-432.

Sullivan, S., Campbell, A., Hutton, S. B., & Ruffman, T. (2017). What's good for the goose is not good for the gander: Age and gender differences in scanning emotion faces. *The Journals of Gerontology: Series B*, *72*(3), 441-447.

Sutherland, C. A. M., Liu, X., Zhang, L., Chu, Y., Oldmeadow, J. A., & Young, A. W. (2018). Facial First Impressions Across Culture: Data-Driven Modeling of Chinese and British Perceivers' Unconstrained Facial Impressions. Personality and Social Psychology Bulletin, 44(4), 521–537. https://doi.org/10.1177/0146167217744194

Sutherland, C. A., Oldmeadow, J. A., & Young, A. W. (2016). Integrating social and facial models of person perception: Converging and diverging dimensions. *Cognition*, *157*, 257-267.

Sutherland, C. A., Oldmeadow, J. A., Santos, I. M., Towler, J., Burt, D. M., & Young, A. W. (2013). Social inferences from faces: Ambient images generate a three-dimensional model. *Cognition*, *127*(1), 105-118.

Sutherland, C. A., Rowley, L. E., Amoaku, U. T., Daguzan, E., Kidd-Rossiter, K. A., Maceviciute, U., & Young, A. W. (2015). Personality judgments from everyday images of faces. *Frontiers in Psychology*, *6*, 1616.

Suzuki, A., & Suga, S. (2010). Enhanced memory for the wolf in sheep's clothing: Facial trustworthiness modulates face-trait associative memory. *Cognition*, 117, 224–229.

Swart, M., Kortekaas, R., & Aleman, A. (2009). Dealing with feelings: characterization of trait alexithymia on emotion regulation strategies and cognitive-emotional processing. *PloS one*, *4*(6), e5751.

Sze, J. A., Goodkind, M. S., Gyurak, A., & Levenson, R. W. (2012). Aging and Emotion Recognition: Not Just a Losing Matter. *Psychology and aging*, *27*(4), 940.

Taylor, G. J., Bagby, R. M., & Parker, J. D. (2003). The 20-Item Toronto Alexithymia Scale: IV. Reliability and factorial validity in different languages and cultures. *Journal of psychosomatic research*, *55*(3), 277-283.

Thompson, W. B. & Mueller, J. H. (1984). Face Memory and Hemispheric Preference: Emotionality and extroversion. *Brain and Cognition, 3*, 239-248.

Todorov, A. (2008). Evaluating faces on trustworthiness: An extension of systems for recognition of emotions signalling approach/avoidance behaviours. *Annals of the New York Academy of Sciences*, *1124*(1), 208-224.

Todorov, A. T., Said, C. C., & Verosky, S. C. (2012). Personality impressions from facial appearance. In *Oxford Handbook of Face Perception*. Oxford University Press.

Todorov, A., & Bargh, J. A. (2002). Automatic sources of aggression. *Aggression and violent behavior*, *7*(1), 53-68.

Todorov, A., & Duchaine, B. (2008). Reading trustworthiness in faces without recognizing faces. *Cognitive Neuropsychology*, *25*(3), 395-410.

Todorov, A., & Uleman, J. S. (2003). The efficiency of binding spontaneous trait inferences to actors' faces. *Journal of Experimental Social Psychology*, *39*(6), 549-562.

Todorov, A., Baron, S. G., & Oosterhof, N. N. (2008). Evaluating face trustworthiness: a model based approach. *Social cognitive and affective neuroscience*, *3*(2), 119-127.

Todorov, A., Gobbini, M. I., Evans, K. K., & Haxby, J. V. (2007). Spontaneous retrieval of affective person knowledge in face perception. *Neuropsychologia*, *45*(1), 163-173.

Todorov, A., Mandisodza, A. N., Goren, A., & Hall, C. C. (2005). Inferences of competence from faces predict election outcomes. *Science*, *308*(5728), 1623-1626.

Todorov, A., Olivola, C. Y., Dotsch, R., & Mende-Siedlecki, P. (2015). Social attributions from faces: Determinants, consequences, accuracy, and functional significance. *Annual review of psychology*, *66*.

Todorov, A., Pakrashi, M., & Oosterhof, N. N. (2009). Evaluating faces on trustworthiness after minimal time exposure. *Social Cognition*, *27*(6), 813-833.

Todorov, A., Said, C. P., Engell, A. D., & Oosterhof, N. N. (2008). Understanding evaluation of faces on social dimensions. *Trends in cognitive sciences*, *12*(12), 455-460.

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

Uhlmann, E. L., Poehlman, T. A., & Nosek, B. A. (2012). Automatic associations: Personal attitudes or cultural knowledge. *Ideology, psychology, and law*, 228-260.

Uhlmann, E., & Swanson, J. (2004). Exposure to violent video games increases automatic aggressiveness. *Journal of adolescence*, *27*(1), 41-52.

Valentine, T. (1991). A unified account of the effects of distinctiveness, inversion, and race in face recognition. *The Quarterly Journal of Experimental Psychology Section A*, *43*(2), 161-204.

van Doorn, J., van den Bergh, D., Bohm, U., Dablander, F., Derks, K., Draws, T., & Ly, A. (2019). The JASP guidelines for conducting and reporting a Bayesian analysis.

Van Leeuwen, M. L., & Neil Macrae, C. (2004). Is beautiful always good? Implicit benefits of facial attractiveness. *Social cognition*, *22*(6), 637-649.

Verosky, S. C., & Todorov, A. (2010). Generalization of affective learning about faces to perceptually similar faces. *Psychological Science*, *21*(6), 779-785.

Visser, M. (2020). Emotion Recognition and Aging. Comparing a Labeling Task With a Categorization Task Using Facial Representations. *Frontiers in psychology*, *11*.

Vogt, S., & Magnussen, S. (2007). Long-term memory for 400 pictures on a common theme. *Experimental psychology*, *54*(4), 298.

Vokey, J. R., & Read, J. D. (1992). Familiarity, memorability, and the effect of typicality on the recognition of faces. *Memory & Cognition*, *20*(3), 291-302.

Vorst, H. C., & Bermond, B. (2001). Validity and reliability of the Bermond–Vorst alexithymia questionnaire. *Personality and individual differences*, *30*(3), 413-434.

Wada, Y., & Yamamoto, T. (2001). Selective impairment of facial recognition due to a haematoma restricted to the right fusiform and lateral occipital region. *Journal of Neurology, Neurosurgery & Psychiatry*, *71*(2), 254-257.

Wakabayashi, A., Baron-Cohen, S., & Wheelwright, S. (2006). Are autistic traits an independent personality dimension? A study of the Autism-Spectrum Quotient (AQ) and the NEO-PI-R. *Personality and individual differences*, *41*(5), 873-883.

Walker, M., & Vetter, T. (2016). Changing the personality of a face: Perceived Big Two and Big Five personality factors modeled in real photographs. *Journal of personality and social psychology*, *110*(4), 609.

Walker, M., Jiang, F., Vetter, T., & Sczesny, S. (2011). Universals and cultural differences in forming personality trait judgments from faces. *Social Psychological and Personality Science*, *2*(6), 609-617.

Walker, P. M., & Hewstone, M. (2006). A perceptual discrimination investigation of the own-race effect and intergroup experience. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, *20*(4), 461-475.

Walker, P. M., Silvert, L., Hewstone, M., & Nobre, A. C. (2008). Social contact and other-race face processing in the human brain. *Social Cognitive and Affective Neuroscience*, *3*(1), 16-25.

Wall, H. J., Taylor, P. J., & Campbell, C. (2016). Getting the balance right? A mismatch in interaction demands between target and judge impacts on judgement accuracy for some traits but not others. *Personality and Individual Differences*, *88*, 66-72.

Wang, R., Li, J., Fang, H., Tian, M., & Liu, J. (2012). Individual differences in holistic processing predict face recognition ability. *Psychological science*, *23*(2), 169-177.

Webb, S. J., Neuhaus, E., & Faja, S. (2017). Face perception and learning in autism spectrum disorders. *Quarterly journal of experimental psychology*, *70*(5), 970-986.

Weigelt, S., Koldewyn, K., & Kanwisher, N. (2012). Face identity recognition in autism spectrum disorders: a review of behavioral studies. *Neuroscience & Biobehavioral Reviews*, *36*(3), 1060-1084.

White, S. W., Oswald, D., Ollendick, T., & Scahill, L. (2009). Anxiety in children and adolescents with autism spectrum disorders. *Clinical psychology review*, *29*(3), 216-229.

White, S., Hill, E., Winston, J., & Frith, U. (2006). An islet of social ability in Asperger Syndrome: judging social attributes from faces. *Brain and cognition*, *61*(1), 69-77.

Wiese, H., Altmann, C. S., & Schweinberger, S. R. (2014). Effects of attractiveness on face memory separated from distinctiveness: Evidence from event-related brain potentials. *Neuropsychologia*, *56*, 26-36.

Willis, J., & Todorov, A. (2006). First impressions: Making up your mind after a 100-ms exposure to a face. *Psychological science*, *17*(7), 592-598.

Wilmer, J. B., Germine, L., Chabris, C. F., Chatterjee, G., Williams, M., Loken, E., ... & Duchaine, B. (2010). Human face recognition ability is specific and highly heritable. Proceedings of the National Academy of sciences, 107(11), 5238-5241.

Wilson, T. D., Lindsey, S., & Schooler, T. Y. (2000). A model of dual attitudes. *Psychological review*, *107*(1), 101.

Winston, J. S., Henson, R. N. A., Fine-Goulden, M. R., & Dolan, R. J. (2004). fMRI-adaptation reveals dissociable neural representations of identity and expression in face perception. *Journal of neurophysiology*, *92*(3), 1830-1839.

Winston, J. S., O'Doherty, J., Kilner, J. M., Perrett, D. I., & Dolan, R. J. (2007). Brain systems for assessing facial attractiveness. *Neuropsychologia*, *45*(1), 195-206.

Winston, J. S., Strange, B. A., O'Doherty, J., & Dolan, R. J. (2002). Automatic and intentional brain responses during evaluation of trustworthiness of faces. *Nature neuroscience*, *5*(3), 277-283.

Wong, H. K., Stephen, I. D., & Keeble, D. R. (2020). The Own-Race Bias for Face Recognition in a Multiracial Society. *Frontiers in Psychology*, *11*, 208.

Woodhead, M. M. & Baddeley, A. D. (1981). Individual differences and memory for faces, pictures, and words. *Memory & Cognition, 9*, 368-370.

Wright, D. B., & Stroud, J. N. (2002). Age differences in line-up identification accuracy: People are better with their own age. *Law and human behavior*, *26*(6), 641-654.

Wright, D. B., Boyd, C. E., & Tredoux, C. G. (2003). Inter-racial contact and the own-race bias for face recognition in South Africa and England. *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition*, *17*(3), 365-373.

Young, S. G., Hugenberg, K., Bernstein, M. J., & Sacco, D. F. (2012). Perception and motivation in face recognition: A critical review of theories of the cross-race effect. *Personality and Social Psychology Review*, *16*(2), 116-142.

Young, R. K., Kennedy, A. H., Newhouse, A., Browne, P., & Thiessen, D. (1993). The effects of names on perception of intelligence, popularity, and competence. *Journal of Applied Social Psychology*, *23*(21), 1770-1788.

Young, A. W., McWeeny, K. H., Hay, D. C., & Ellis, A. W. (1986). Matching familiar and unfamiliar faces on identity and expression. *Psychological research*, *48*(2), 63-68.

Zebrowitz, L. A. (1997). Reading faces: Window to the soul? Boulder, CO: Westview Press.

Zebrowitz, L. A. (2017). First impressions from faces. *Current directions in psychological science*, *26*(3), 237-242.

Zebrowitz, L. A., & Collins, M. A. (1997). Accurate social perception at zero acquaintance: The affordances of a Gibsonian approach. *Personality & Social Psychology Review*, *1*, 204-223.

Zebrowitz, L. A., & McDonald, S. M. (1991). The impact of litigants' baby-facedness and attractiveness on adjudications in small claims courts. *Law and human behavior*, *15*(6), 603-623.

Zebrowitz, L. A., Montepare, J. M., & Lee, H. K. (1993). They don't all look alike: Individual impressions of other racial groups. *Journal of personality and social psychology*, *65*(1), 85.

Zebrowitz, L. A., & Montepare, J. (2006). The Ecological Approach to Person Perception: Evolutionary Roots and Contemporary Offshoots.

Zebrowitz, L. A., & Montepare, J. M. (2008). Social psychological face perception: Why appearance matters. *Social and personality psychology compass*, *2*(3), 1497-1517.

Zebrowitz, L. A., & Zhang, Y. (2011). Origins of impression formation in animal and infant

Zebrowitz, L. A., Bronstad, P. M., & Montepare, J. M. (2011). An ecological theory of face perception. *The Science of Social Vision: The Science of Social Vision*, *7*(1).

Zebrowitz, L. A., Franklin Jr, R. G., Hillman, S., & Boc, H. (2013). Older and younger adults' first impressions from faces: Similar in agreement but different in positivity. *Psychology and aging*, *28*(1), 202.

Zhu, Q., Song, Y., Hu, S., Li, X., Tian, M., Zhen, Z., & Liu, J. (2010). Heritability of the specific cognitive ability of face perception. *Current Biology*, *20*(2), 137-142.

Appendix

Appendix A

Extraversion young adults: Performances on non-clinical young adults excluding participants scoring high on the AQ scale (AQ>32), TAS-20 (>61) and 2SDs below the mean for CFMT and emotion task.

One participant scored 2SD below the mean on the CFMT, four participants scored 2SD below the mean on the emotion matching task. Seven participants scored high on the AQ scale, and twenty-seven participants scored high on the TAS20 scale. These participants were removed. A total sample of 82 individuals are presented below. A one-sample t-test revealed that the young adults (after excluding participants) were still able to make accurate implicit extraversion personality trait judgements from faces, *IAT D* = .14 (*SD* =.35), *t* (81) = 3.54, *p*<.001, d = .391. Consistent with the findings reported in Chapter 5 (pg.97), the regression analysis revealed that the ability to identify personality from faces implicitly was unrelated to autism traits, alexithymia traits, face memory and emotion expression perception (F (4,77) = .926, p = .45, R^2 = .05

Appendix B

Developmental prosopagnosia scores on neuropsychological test battery (Including individuals scoring high on the AQ scale).

DP Case	Age	Gender	PI20	CFMT	CFPT	FFT%correct
DP1	31	Male	78	28	30	45.76
DP2	18	Female	86	26	24.66	52.94
DP3	81	Female	87	38	26.67	15.79
DP4	58	Female	85	38	26	32.61
DP5	39	Female	82	30	26	51.67
DP6	72	Female	80	37	34	30.91
DP7	54	Female	87	27	32	37.50
DP8	45	Female	77	32	28.34	61.67
DP9	60	Female	88	27	24	17.24
DP10	67	Male	91	33	28.67	15.79
DP11	67	Female	86	33	28.67	38.00

DP12	63	Female	70	34	33.33	43.40
DP13	67	Female	90	34	26.67	25.86
DP14	76	Male	80	29	28.66	37.50
DP15	58	Male	81	32	22.67	35.00
DP16	32	Female	81	38	36	61.40
DP17	60	Male	89	32	26.67	35.42
DP18	57	Female	73	24	22	48.98
DP19	36	Female	76	42	21.33	60.34
DP20	69	Female	89	37	28.34	32.00
DP21	41	Male	79	36	30	45.76
DP22	50	Female	96	27	31.34	1.69
DP23	62	Female	82	34	34	68.33
DP24	50	Female	85	34	28.67	39.29
DP25	39	Female	74	37	33.34	58.33
DP26	43	Female	84	33	33.34	56.25
DP27	54	Female	90	30	30.67	33.96
DP28	35	Female	92	29	28.34	15.38
DP29	31	Female	75	32	29.33	62.26
DP30	40	Female	89	26	29.34	4.55
DP31	76	Male	81	37	20.67	41.14
DP32	46	Female	68	35	28	59.32
DP33	48	Female	73	28	26.67	50.98
DP34	63	Female	84	38	36.67	29.73
DP35	54	Female	78	43	28.34	41.14
DP36	61	Female	87	31	28.67	44.00
DP37	71	Male	68	36	29.33	44.83
DP38	51	Female	83	28	31.33	29.31
DP39	69	Male	83	38	28.34	36.21
DP40	70	Female	97	28	20.67	41.14
DP41	68	Male	90	34	29.34	30.00

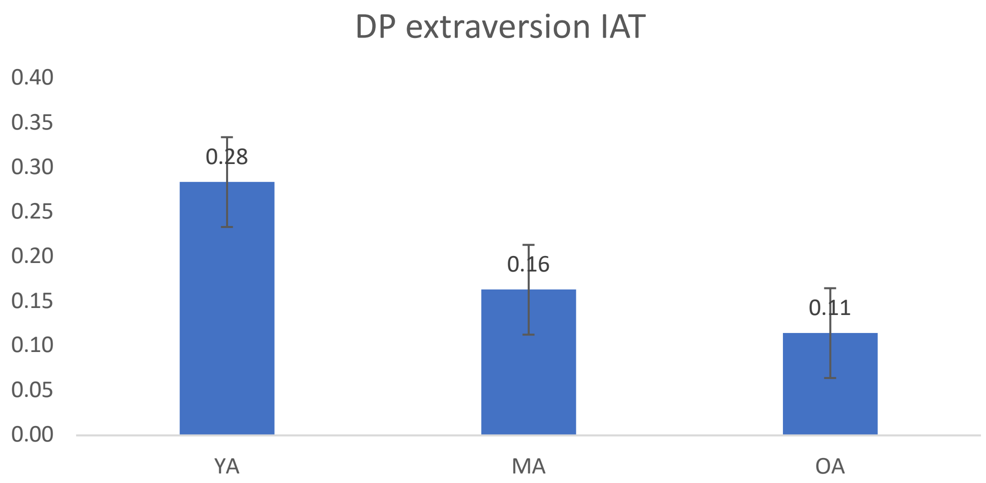
DP42	47	Female	89	37	30	43.86
DP43	43	Female	73	30	28.34	46.43
DP44	56	Male	71	37	30	64.81
DP45	54	Female	94	27	28.34	22.03
DP46	58	Male	85	38	28	59.32
DP47	42	Female	75	32	24.67	58.49
DP48	68	Male	61	26	21.33	15.38
DP49	35	Male	88	27	26.67	70.00
DP50	65	Female	87	34	28.66	51.67
DP51	49	Female	76	24	28.34	52.54

PI20 (Prosopagnosia Index-20; Shah et al., 2015); CFMT (Cambridge Face Memory Task; Duchaine & Nakayama, 2006b); CFPT (Cambridge Face Perception Task; Duchaine et al., 2007); FFT (Famous Faces Test; young version – 18-34 age group, old version – 35+ age group; Bate et al., 2019; Duchaine & Nakayama, 2005).

Appendix C

There were non-significant within-group differences for DP IAT extraversion performances (p > .05; See figure below). There were 5 young adults (age range 18-35), 13 middle age (age range (36- 55), 18 older age (55 above) participants.

DP performance in extraversion IAT differences within group age



Note: YA = young adults, MA = middle age, OA = older adults

Appendix D

Accuracy breakdown by word/image presentation in congruent and incongruent blocks for the IAT

Task	N	Congruent Word	Congruent Image	Incongruent Word	Incongruent Image
Young Extraversion	*118*	*M*= 94.68 *SD* = *6.10*	*M*= 93.86 *SD* = 7.26	*M*= 92.99 *SD* = *8.13*	*M*= 93.24 *SD* = 7.87
DP - Ext	*36*	*M*= 97.29 *SD* = *4.03*	*M*= *83.33* *SD* = *18.25*	*M*= 95.83 *SD* = *6.32*	*M*= *81.81* *SD* = 17.42
Agreeableness	*89*	*M*= 92.67 *SD* = 8.96	*M*= 89.27 *SD* = 11.93	*M*= 92.53 *SD* = 10.41	*M*= 89.69 *SD* = 11.22
Young Neuroticism	*120*	*M*= 90.69 *SD* = 11.34	*M*= 90.25 *SD* = 11.86	*M*= 86.67 *SD* = 12.21	*M*= 88.23 *SD* = 14.53
Old extraversion	*62*	*M*= 94.64 *SD* = 9.58	*M*= 83.67 *SD* = 16.77	*M*= 95.08 *SD* = 7.57	*M*= 78.95 *SD* = 20.36
Old neuroticism	*50*	*M*= 93.05 *SD* = 12.04	*M*= 85.65 *SD* = 16.65	*M*= 90.9 *SD* = 12.73	*M*= 82.2 *SD* = 19.08
Other-ethnicity	*60*	*M*= 92.17 *SD* = 13.42	*M*= 91.21 *SD* = 14.07	*M*= 91.04 *SD* = 16.22	*M*= 91.58 *SD* = 15.20

Note. Accuracy was calculated for each correct response in the first attempt for words and images. For procedure refer Chapter 4, pg. 67.

Appendix E

Agreeableness- Performances of young adults excluding participants scoring high on the AQ scale (AQ>32), TAS-20 (>61) and 2SDs below the mean for CFMT and emotion task.

One participant scored 2SD below the mean on the CFMT, three participants scored 2SD below the mean on the emotion matching task. Seven participants scored high on the AQ scale, and seven participants scored high on the TAS20 scale. These participants were removed. A total sample of 76 individuals are presented below. A one-sample t-test revealed that the young adults (after excluding participants) were still able to make accurate implicit agreeableness personality trait judgements from faces, *IAT D* = -.101 (*SD* =.32), *t* (75) = -2.73, *p*=.008, d = -.31. Consistent with the findings reported in Chapter 6 (pg.128), the regression analysis revealed that the ability to identify personality from faces implicitly was unrelated to autism traits, alexithymia traits, face memory and emotion expression perception (F (4,71) = .07, p = .99, R^2 = -.05.

Appendix F

Neuroticism - Performances of young adults excluding participants scoring high on the AQ scale (AQ>32), TAS-20 (>61) and 2SDs below the mean for CFMT and emotion task.

Three participants scored 2SD below the mean on the CFMT, three participants scored 2SD below the mean on the emotion matching task. Eight participants scored high on the AQ scale, and Nineteen participants scored high on the TAS20 scale. These participants were removed. A total sample of 95 individuals are presented below. A one-sample t-test revealed that the young adults (after excluding participants) were still able to make accurate implicit neuroticism personality trait judgements from faces, *IAT D = .152* (*SD* =.37), *t* (94) = 4.02, *p*<.001, d = .41. Consistent with the findings reported in Chapter 7 (pg.143), the regression analysis revealed that the ability to identify personality from faces implicitly was unrelated to autism traits, alexithymia traits, self-perception neuroticism, face memory and emotion expression perception (F (5,89) = 1.01, p = .42, R^2 = -.05.