The Edinburgh Social Cognition Test (ESCoT): A New Test of Theory of Mind and Social Norm Understanding

R. Asaad Baksh

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This thesis is dedicated to the many participants who made this research possible. Thank you.

List of acronyms

AD – Alzheimer’s disease

AQ – Autism Quotient

AS – Asperger's Syndrome

ASD – Autism Spectrum Disorders

AUC – Area Under the Curve

BAP – Broader Autism Phenotype

BMIPB - BIRT Memory and Information Processing Battery

bvFTD – behavioural–variant Frontotemporal dementia

dMPFC – Dorsomedial prefrontal cortex

DSM–5 – Diagnostic and Statistical Manual of Mental Disorders, 5th Edition

ECAS - Edinburgh Cognitive and Behavioural Amyotrophic Lateral Sclerosis Screen

ECog-DART - Edinburgh Cognitive Diagnosis Audit Research and Treatment Register

ESCoT – Edinburgh Social Cognition Test

ERP - Event-related potential

EQ – Empathy Quotient

FFA – Fusiform face area

FBI - Frontal Behaviour Inventory

FSCRT - Free and selective cued reminding test

FTD - Frontotemporal dementia

GeSoCS – Geneva Social Cognition Scale

HFA – High–Functioning Autism

IAPS - International Affective Picture System

JoP – Judgement of Preference

LSAS - Liebowitz Social Anxiety Scale

MA – Middle-aged adults

MAP - Medium autism phenotype

MASC – Movie for the Assessment of Social Cognition

MCI - Mild Cognitive Impairment

Msec – Milliseconds

NAP - Narrow autism phenotype

NC – Neurotypical controls

NPI - Neuropsychiatric Inventory

OA – Older adults

OFC – Orbitofrontal cortex

PAD - Pleasure, Arousal and Dominance

PFC – Prefrontal cortex

PRI – Perceptual Reasoning Index

RME – Reading the Mind in the Eyes

RMF – Reading the Mind in Films

ROC – Receiver Operator Characteristic

RT - Reaction time

SAD – Social Anxiety Disorder

SD – Standard Deviation

SNQ – Social Norms Questionnaire

SST – Social Scenarios Test

STS/STG – Superior temporal sulcus/gyrus

SQ – Systemizing Quotient

TASIT – Awareness of Social Inference Test

tDCS - Transcranial direct current stimulation

TMS – Transcranial magnetic stimulation

ToM – Theory of Mind

TOPF - Test of Premorbid Functioning

TPJ – Temporoparietal junction

TROG - Test for the Reception of Grammar

VCI – Verbal Comprehension Index

vMPFC – Ventromedial prefrontal cortex

WAIS–III – Wechsler Adult Intelligence Scale, Third Edition

WASI–II – Wechsler Abbreviated Scale of Intelligence, Second Edition

YA – Younger adults

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Abstract

Social cognitive abilities are needed to process and understand social information in order to respond appropriately in everyday social interactions. While there are a number of tests that have been developed to measure social cognition in the literature, many have important limitations such as only assessing one ability, performance being predicted by measures of intelligence and exhibiting low ecological validity. To address some of these limitations, I developed a new test called the Edinburgh Social Cognition Test (ESCoT). The ESCoT is an animated test that assesses four domains of social cognition: cognitive Theory of Mind (ToM) (What is X thinking?); affective ToM (How does X feel at the end of the animation?); interpersonal understanding of social norms (Did X behave as other people should behave?); and intrapersonal understanding of social norms (Would you have acted the same as X in the animation?). The aims of this thesis were to examine the validity of the ESCoT as a test of social cognition and to further investigate social cognitive processes in healthy and neurological populations.

The ESCoT was firstly administered to a healthy population of older, middle-aged and younger adults to examine the effects of ageing on social abilities. This study found that the ESCoT was sensitive to age; poorer performances on cognitive and affective ToM and also interpersonal but not intrapersonal understanding of social norms were predicted by older age. Furthermore unlike traditional tests used in the study, performance was not predicted by measures of intelligence. Instead, the sex of participants and autistic-like traits, in addition to age were found to be important for performance.

The ESCoT was then validated in a sample of adults with Autism Spectrum Disorder (ASD), and performance was compared to performance on established social cognition tests. Convergent validity was demonstrated in the study and the ESCoT

was sensitive to social cognitive difficulties found in ASD. This study also showed that the ESCoT was more effective than existing tests at differentiating ASD adults and neurotypical controls.

The interplay of social anxiety and empathy on ESCoT performance in addition to further exploring sex and autistic-like traits were then examined in a younger adult population. Social anxiety and empathy were not significant predictors of performance on the ESCoT. Similar to the results of the ageing study, this study found that women were better than men on affective ToM. However, unlike the ageing study, better cognitive ToM performance was predicted by older age. Better performance on interpersonal understanding of social norms and ESCoT total scores were predicted by more years of education.

The subsequent chapter then examined the clinical efficacy of the ESCoT in a patient population (Alzheimer's disease, behavioural-variant Frontotemporal dementia and amnestic mild cognitive impairment). Here performance on the ESCoT was compared between the patients and neurotypical controls. It was found that patients performed poorer than neurotypical controls on ESCoT total scores, affective ToM, inter-and intrapersonal understanding of social norms.

The final chapter returned to healthy ageing to more closely investigate the consequences of healthy ageing on social cognitive processes, by examining the positivity bias (preference for positive over negative stimuli) found in older adults using an attention paradigm. There was no evidence of the positivity bias in older, middle-aged and younger adults in regards to reaction time or accuracy. However, older and middle-aged adults differed in accuracy across stimuli type compared to younger adults.

This thesis offers novel insights into the social cognitive abilities of various populations. The ESCoT presents a new, informative and validated test of social cognition for researchers and clinicians to use, which has many advantages over established tests of social cognition.

The following chapters are under review for journal publication:

Chapter 3: Baksh, R.A., Abrahams, S., Auyeung, B., & MacPherson, S.E. (under review). The Edinburgh Social Cognition Test (ESCoT): Examining the effects of age on a new measure of theory of mind and social norm understanding. *PLoS One*.

Chapter 4: Baksh, R.A., Abrahams, S., Bertlich, M., Cameron, R., Jany, S., Dorrian, T., Baron-Cohen, S., Allison, C., Smith, P., MacPherson S.E., & Auyeung, B. (under review). Social cognition in adults with Autism Spectrum Disorders: Validation of the Edinburgh Social Cognition Test (ESCoT). *Autism Research.*

Lay summary

For us to interact with others, we rely on specific abilities to deal with social interactions. While there are many existing tests of our social abilities, some of these have disadvantages such as uncertainty in what they are assessing. Consequently, this limits their usefulness. This thesis aimed to develop a new test called the Edinburgh Social Cognition Test (ESCoT) to improve the way we measure social abilities. The ESCoT measures our ability to deduce what someone might be thinking and feeling in a particular situation. It also measures our understanding of how others should behave and how we should behave in public.

Through a series of studies the ESCoT was shown to be useful at identifying the changes that occur to our social abilities as we age. It was found to be helpful at identifying the social difficulties adults with Autism Spectrum Disorder experience better than traditional tests of social abilities. Furthermore, it showed that men and women differ in how well they can tell how someone else is feeling, and that our ability to identify how someone is thinking improves with age in young adults. The ESCoT was then used with patients with dementia to examine if it could be used in clinical settings. The results from this study showed that it is able to detect difficulties that dementia patients might experience in their social abilities. The final chapter looked at the way in which we handle emotional information as we age, but this study did not find support for improvements in dealing with emotional information with increasing age.

The present series of studies provides support for the ESCoT as a useful test that can be used to measure our social abilities in different groups of people, clinical and healthy alike.

Chapter 1: Introduction

Social cognitive abilities underlie our ability to process social information. This chapter gives an overview of two of the social cognitive abilities individuals use in social interactions (Theory of Mind and understanding of social norms), the tests of social cognition available for researchers to investigate social abilities and the current limitations of these assessments.

1. Introduction

1.1. What is social cognition?

The survival of an animal is dependent on social functioning; the ability to effectively interact with others in social situations (Amodio & Frith, 2006). Compared to other animal species, the social interactions in which humans engage are extremely complex (Amodio & Frith, 2006; Gallese, Keysers, & Rizzolatti, 2004). To process these complex interactions, humans have developed abilities to effectively interpret the social information within an interaction (Van Overwalle, 2009). These are our social cognitive abilities.

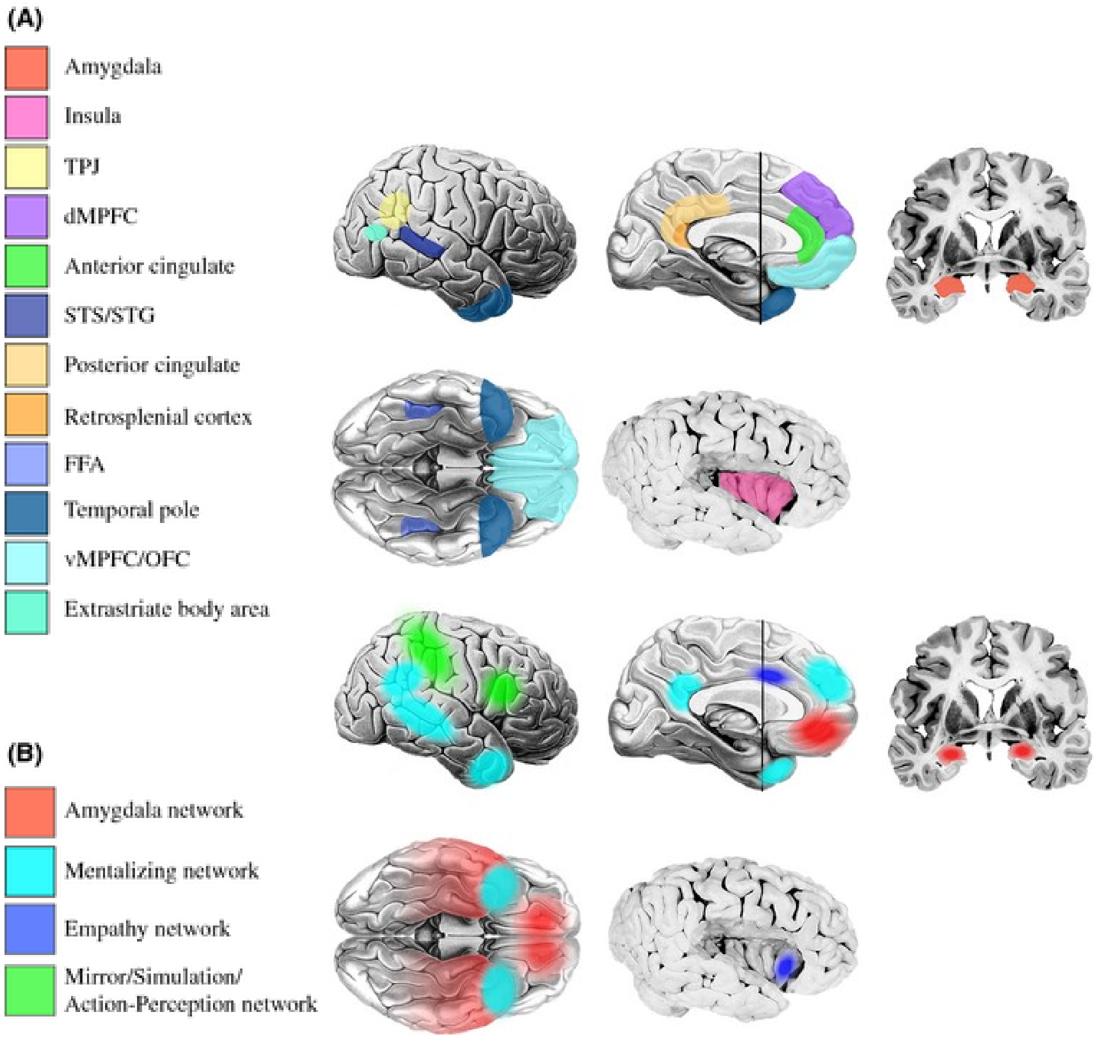
Social cognition has been studied from different theoretical and methodological perspectives, most notably in social psychology and social neuroscience (Amodio & Frith, 2006; Van Overwalle, 2009). Social psychologists have examined how an individual interacts with their constantly changing social world (Bargh, Chen, & Burrows, 1996), neuroscientists have examined the neural networks underlying social cognitive abilities (Sebastian et al., 2011) while neuropsychologists have studied patients to understand how difficulties in social cognition affect social functioning and interpersonal relationships (Henry, Phillips, & Von Hippel, 2014). These differing perspectives have converged in the domain of social cognitive neuroscience (Amodio & Frith, 2006).

While there are many varying definitions of social cognition, for this thesis social cognition was defined as the higher-order cognitive processes that allow individuals to interpret the behaviours of others (Adolphs, 2009). These abilities allow us to process and understand social information in order to respond appropriately in everyday interactions (Van Overwalle, 2009). Social cognition includes abilities such as theory of mind (ToM; i.e., the ability to recognise other people's mental states to understand and predict their behaviour), emotion recognition, empathy, moral judgments and the understanding of social norms (Baez, García, & Ibanez, 2016; Baez et al., 2013; Baez et al., 2012; Frith, 2008; Henry, Cowan, Lee, & Sachdev, 2015; Love, Ruff, & Geldmacher, 2015). The processing of social information has been shown to occur without conscious awareness (Adolphs, 2009; Bargh & Ferguson, 2000; Fiske & Taylor, 2013) and making social cognitive inferences is crucial for successful social interactions (Dziobek et al., 2006). This thesis will focus on ToM and understanding of social norms since these two social cognitive abilities are not typically explicitly examined together and it will draw from literature examining social cognitive abilities in healthy ageing adults and clinical populations, specifically adults with Autism Spectrum Disorders (ASD) and patients with dementia.

1.2. Neuropsychology of social cognition

Our understanding of social cognition has been informed by neuroimaging (Martory et al., 2015). As a consequence of such investigations, it has been shown that the processing of social stimuli typically engages certain brain regions specialized for social information (Adolphs, 2009; Kennedy & Adolphs, 2012; Poletti, Enrici, & Adenzato, 2012; Van Overwalle, 2009). In an early study by Brothers (1990), it was proposed that the amygdala, the orbitofrontal cortex, and the temporal poles are the regions activated during social interactions. As Figure 1 shows, understanding of social cognition has significantly progressed since the early nineties, and it is now evident that social cognitive abilities consist of a complex and interconnected neural system involving the temporoparietal junction; dorsomedial prefrontal cortex (PFC); superior temporal sulcus/gyrus, fusiform face area; ventromedial PFC/orbitofrontal cortex and amygdala (Kennedy & Adolphs, 2012).

1.2.1. Figure 1. The main structure and regions involved in social cognition in adults



Taken from: Kennedy and Adolphs (2012) in *Trends in Cognitive Sciences*, 16 (11).

1.3. ToM abilities

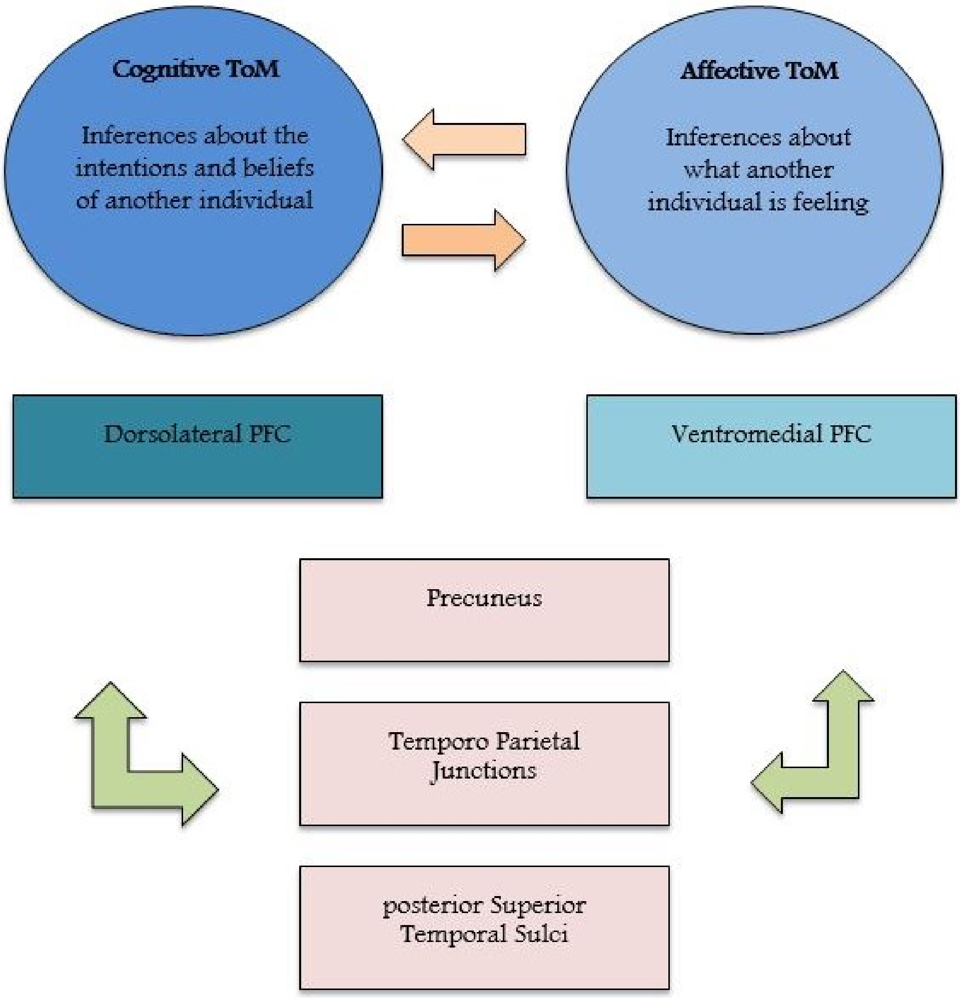
The notion of a 'theory of mind' was first introduced by Premack and Woodruff (1978) and popularised by Simon Baron Cohen in his work on children with ASD (Baron-Cohen, Leslie, & Frith, 1985). Since this seminal work showing that children with ASD perform poorer on ToM tasks compared to neurotypical controls (NC) or children with Down's syndrome, research on ToM has received an immense amount of attention. Consequently, until recently ToM was often used interchangeably with the term social cognition (Dziobek et al., 2006; Hutchins, Prelock, & Bonazinga, 2012; Hutchins et al., 2016). However, ToM is not the only ability that falls under this heading (Baez et al., 2013; Baez et al., 2012). ToM should be considered as one of several processes that form our social cognitive abilities.

Recent research from imaging and behavioural studies which used patients with lesions and clinical populations have shown a further breakdown of social cognitive abilities, such that ToM should not be considered a one-dimensional concept (Shamay-Tsoory & Aharon-Peretz, 2007; Shamay-Tsoory, Harari, Aharon-Peretz, & Levkovitz, 2010; Shamay-Tsoory et al., 2007; Shamay-Tsoory, Tibi-Elhanany, & Aharon-Peretz, 2006; Shamay-Tsoory, Tomer, Berger, Goldsher, & Aharon-Peretz, 2005), with processes differing based on whether they refer to cognitive or affective judgements (Shamay-Tsoory et al., 2010). Cognitive ToM is defined as the ability to make inferences about the intentions and beliefs of another individual. Affective ToM refers to the ability to make inferences about what another individual is feeling (Kalbe et al., 2010; Sebastian et al., 2011; Shamay-Tsoory et al., 2010). Numerous studies have investigated the role that various brain regions have in processing cognitive versus affective ToM by examining their activation in response to cognitive ToM tests such as perspective taking (Hynes, Baird, & Grafton, 2006) and affective ToM tests like the Faux Pas test (Stone, Baron-Cohen, & Knight, 1998).

On tests of cognitive and affective ToM, the performance of patients with localized lesions in the ventromedial regions was compared to patients with dorsolateral lesions, mixed prefrontal lesions, and posterior lesions and with NC. It was found that while NC performed better on affective ToM compared to cognitive ToM, patients exhibited a different patterns of findings. Affective ToM was impaired by ventromedial damage, while cognitive ToM was mostly impaired by extensive prefrontal damage (Shamay-Tsoory & Aharon-Peretz, 2007). These results were replicated using other tests of cognitive and affective ToM (false beliefs, false attribution, irony and lies) in a second lesion study. Again, patients with lesions localised to the ventromedial regions were significantly impaired on tests of affective ToM compared to cognitive ToM (Shamay-Tsoory et al., 2006). Moreover, Shamay-Tsoory et al. (2005) showed that lesions to the ventromedial but not dorsolateral PFC results in significant impairments to affective ToM but not cognitive ToM. In another study, performance of criminal offenders with psychopathic tendencies were compared to participants with localized lesions in the orbitofrontal or dorsolateral cortex, participants with non-frontal lesions, and NC. Individuals with psychopathy and those with orbitofrontal cortex lesions were impaired on the affective ToM inferences but not on cognitive ToM (Shamay-Tsoory et al., 2010). Moreover, individuals with schizophrenia have been found to be more impaired on affective ToM than cognitive ToM compared to NC (Shamay-Tsoory et al., 2007). Finally, using transcranial magnetic stimulation (TMS) in NC adults, Kalbe et al. (2010) found that stimulation over the dorsolateral PFC results in a selective effect on cognitive but not affective ToM. These findings suggest that cognitive and affective ToM abilities are partly dissociable (Shamay-Tsoory & Aharon-Peretz, 2007).

As Figure 2 shows, while both cognitive and affective ToM inferences involve the precuneus, temporo parietal junctions and posterior superior temporal sulci, cognitive ToM recruits the dorsolateral PFC while affective ToM inferences involves the ventromedial PFC (Hynes et al., 2006; Kalbe et al., 2010; Kipps & Hodges, 2006; Sebastian et al., 2011; Shamay-Tsoory & Aharon-Peretz, 2007; Shamay-Tsoory et al., 2010; Shamay-Tsoory et al., 2007; Shamay-Tsoory et al., 2006; Shamay-Tsoory et al., 2005; Sommer et al., 2007; Stone et al., 1998; Stuss, Gallup Jr, & Alexander, 2001).

1.3.1. Figure 2. Model of the shared but distinct neural systems for cognitive and affective ToM



Adapted from Poletti et al. (2012), Shamay-Tsoory et al. (2005, 2006) and Sebastian et al. (2012).

1.4. Understanding of social norms

One important aspect of social cognition that has not typically been assessed is the ability to understand social norms from interpersonal and intrapersonal perspectives. Interpersonal understanding of social norms is defined as the understanding of how another person should behave in a particular situation. Intrapersonal understanding of social norms is related to how you, yourself would behave in a social interaction.

While these abilities are rarely examined, they are particularly important because committing a social norm violation can be detrimental to existing relationships or opportunities to form new social relationships. Intrapersonal understanding of social norms has been explored in studies of dementia and adults with ASD. These studies have found that this social cognitive ability is impaired in behavioural-variant Frontotemporal dementia (bvFTD, see Chapter 6, section 6.1.1 for further review) (Carr et al., 2015) but is intact in adults with ASD (Baez et al., 2012, see Chapter 4, section 4.1 for further review). Interpersonal understanding of social norms has been examined in an ageing population. Halberstadt, Ruffman, Murray, Taumoepeau and Ryan (2011) found that older adults were poorer at discriminating between socially appropriate and inappropriate behaviours from short videos of social interactions compared to younger adults. Suggesting that with advancing age, our ability to understand how others should behave in social interactions is affected (see Chapter 3, section 3.1 for further review).

There is some neuroimaging data to suggest differential activation between other (interpersonal) –and–self (intrapersonal) inferences. These have been observed in the medial PFC and the ventromedial PFC which appear to be biased towards self-references, while the dorsomedial PFC is activated for other–inferences (D'Argembeau et al., 2007; Mitchell, Macrae, & Banaji, 2006). Moreover, using functional neuroimaging of NC adults, interpersonal understanding of social norms judgments has been shown to involve similar brain regions as cognitive and affective ToM including the medial frontal, temporal, lateral orbitofrontal and medial PFC (Berthoz, Armony, Blair, & Dolan, 2002). The orbitofrontal cortex has been found to be associated with antisocial behaviour in individuals with Borderline Personality Disorder, who exhibit impairments in both inter-and intrapersonal understanding of social norms (Blair, 2004).

1.5. Social cognition in clinical populations

Social cognition impairments are found in a number of clinical disorders including schizophrenia (Green, Horan, & Lee, 2015), social anxiety disorder (Hezel & McNally, 2014), depression (Wolkenstein, Schönenberg, Schirm, & Hautzinger, 2011), ASD (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001), Williams syndrome (Porter, Coltheart, & Langdon, 2008), bvFTD (Henry et al., 2014), Alzheimer's disease (AD) (Poletti et al., 2012), Amyotrophic lateral sclerosis (van der Hulst, Bak, & Abrahams, 2014) and traumatic brain injury (McDonald, Flanagan, Martin, & Saunders, 2004). These impairments are a major problem underlying difficulties in interpersonal relationships in several psychiatric populations (Patin & Hurlemann, 2015) and deficits in social functioning is a key diagnostic criterion for several clinical disorders (Kennedy & Adolphs, 2012) such as ASD and bvFTD (American Psychiatric Association, 2013). Additionally, the new DSM-5 has introduced social cognition as one of the six core functional components that can be affected by a clinical disorder (American Psychiatric Association, 2013; Happé & Conway, 2016). Deficits in core social abilities like ToM can be more incapacitating than traditionally assessed cognitive deficits (Henry et al., 2015) and impairments in social cognitive abilities are thought to be responsible for dysfunctional social interactions and social interaction difficulties seen in clinical populations (Bora, Walterfang, & Velakoulis, 2015; Hutchins et al., 2016).

Social cognitive abilities are important for facilitating societal integration and social support (Cohen, 2004; Silk, Alberts, & Altmann, 2003) and socially proficient individuals are more likely to be healthier and live longer (Cohen, 2004; Silk et al., 2003). ASD is the prototypical disorder to exemplify the importance of social cognitive abilities for effective social functioning (see Chapter 4, section 4.1 for further review). As a consequence of these difficulties in their social abilities, ASD adults experience social isolation (Orsmond, Krauss, & Seltzer, 2004; Orsmond, Shattuck, Cooper, Sterzing, & Anderson, 2013), superficial and less supportive friendships (Baron-Cohen & Wheelwright, 2003; Orsmond et al., 2013) and have difficulties maintaining meaningful relationships (Palmen, Didden, & Lang, 2012). These social difficulties occur despite adults with ASD having a desire for intimacy and social connectedness (Müller, Schuler, & Yates, 2008). Results from research involving individuals with ASD have suggested that social cognitive impairments are not the result of general cognitive dysfunction, as individuals with ASD perform well on controls tests, but are impaired on tests of ToM (Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997). In patients with dementia, Henry et al. (2014) found that patients with AD and bvFTD show impairments on ToM tests; bvFTD patients have significant and substantial difficulties in social abilities compared to AD patients (see Chapter 6, section 6.1.1 for further review). The findings above demonstrate that many different clinical groups exhibit social cognitive difficulties, and these impairments have significant real-world consequences.

1.6. Social cognition in healthy populations

In healthy populations, previous research has also shown that ToM plays a key role in communicating effectively during conversations (Krych-Appelbaum et al., 2007). People with better ToM abilities are more competent at social interactions. Woolley, Chabris, Pentland, Hashmi, and Malone (2010) found that adults with higher ToM scores perform better on group tasks such as those that involve resolving conflicts of points of view and brainstorming. Poor social skills present a major stumbling block for successful social integration (McDonald, Flanagan, Rollins, & Kinch, 2003). Without accurate social cognition individuals may respond to others in a manner that is ineffective, poorly timed, or frankly inappropriate (McDonald, 2012). Moreover, in NC adults social cognition abilities have been found to be important predictors of social competency (Henry et al., 2015), as they impact upon an individual's daily functioning, well-being and family quality of life (Love et al., 2015). Impairments are found as a consequence of healthy ageing (Henry, Phillips, Ruffman, & Bailey, 2013) with researchers showing that increasing age has a negative effect on an individual's cognitive ToM (Bailey & Henry, 2008; Bottiroli, Cavallini, Ceccato, Vecchi, & Lecce, 2016; Castelli et al., 2010; Duval, Piolino, Bejanin, Eustache, & Desgranges, 2011; Fischer, O'Rourke, & Thornton, 2016; German & Hehman, 2006; Moran, Jolly, & Mitchell, 2012; Saltzman, Strauss, Hunter, & Archibald, 2000) and affective ToM (Bailey & Henry, 2008; Bailey, Henry, & Von Hippel, 2008; Fischer et al., 2016; Pardini & Nichelli, 2009) (see Chapter 3, section 3.1 for further review). However, using different paradigms to measure the processing of emotional information, other researchers have suggested that older adults show a positivity bias in how they attend to positive and negative information, compared to younger adults (Mather & Carstensen, 2003). These results show that this is one aspect of processing emotional information that does not seem to show the same results as affective

ToM (see Chapter 7, section 7.1.2 for further review). Investigations into other NC populations have also shown that subclinical presentations of autistic-like traits (the Broader Autism Phenotype, BAP), empathy and social anxiety all impact on an individual's performance on tests of social cognition (Carroll & Chiew, 2006; Hezel & McNally, 2014; Wainer, Ingersoll, & Hopwood, 2011). Moreover, sex differences have also been found on our social abilities, specifically relating to affective ToM (Baron-Cohen et al., 2015). The impact of these traits on social cognition performance is reviewed in greater detail in Chapter 5 while the BAP and social cognition is discussed below.

1.7. The Broader Autism Phenotype (BAP)

There has been an increase in the prevalence of ASD diagnoses over recent years, due to increased awareness and improvement in assessment tools (Matson & Kozlowski, 2011; Williams, Mellis, & Peat, 2005). Moreover, genetic studies have shown that up to 56% of UK cases are genetically heritable (Colvert et al., 2015). Consequently, research into the genetic heritability of ASD has shifted to a dimensional approach to investigate the presence of autistic traits in first-degree relatives of individuals with ASD. Following a spectrum model of ASD, these studies have reported subclinical traits of ASD in these family members (Constantino et al., 2006; Grove, Baillie, Allison, Baron-Cohen, & Hoekstra, 2013; Piven, Palmer, Jacobi, Childress, & Arndt, 1997; Sucksmith, Allison, Baron-Cohen, Chakrabarti, & Hoekstra, 2013; Sucksmith, Roth, & Hoekstra, 2011).

The presentation of similar but less severe autistic-like traits is referred to as the Broader Autism Phenotype (BAP) (Bolton et al., 1994). More precisely, the BAP describes a group of subclinical social skills, communication traits and unusual personality features that are frequently found in the relatives of individuals with autism and which are believed to be milder manifestations of traits characteristic of clinically diagnosed ASD (Constantino et al., 2006; Rutter, 2000). There is evidence to suggest that subclinical autistic-like traits are not restricted to family members of individuals with ASD. Studies examining the BAP in neurotypical populations have found the presence of autistic-like traits in individuals with no known relatives with ASD (Constantino & Todd, 2003; Hoekstra, Bartels, Verweij, & Boomsma, 2007; Hurst, Mitchell, Kimbrel, Kwapil, & Nelson-Gray, 2007; Jobe & White, 2007; Stewart & Austin, 2009; Wainer et al., 2011). This suggests that subclinical autistic-like traits are a set of continuous and quantitative traits that are measurable in neurotypical individuals and distributed in the general population (Constantino et al., 2006; Constantino & Todd, 2005).

1.8. The BAP and social cognition

Individuals in the neurotypical population who exhibit more autistic-like traits report experiencing more social difficulties (Wainer et al., 2011). A number of studies have examined the relationship between the BAP and social cognition, but results have been variable. Parents of individuals with ASD have been shown to display difficulties in inferring affective states relative to age- and IQ-matched controls (Baron-Cohen & Hammer, 1997). Moreover, Losh and Piven (2007) and Losh et al. (2009) found that individuals who exhibited more autistic-like traits performed poorer than those with fewer traits on tests of affective ToM. However, other studies have found no relationship between autistic-like traits and affective ToM (Kunihira, Senju, Dairoku, Wakabayashi, & Hasegawa, 2006). In terms of cognitive ToM, Sasson, Nowlin, and Pinkham (2013) found no significant relationship between cognitive ToM and BAP traits using the Broad Autism Phenotype Questionnaire.

1.9. Tests used to measure social cognition

Tests that specifically assess social cognition are important because standard neuropsychological tests do not assess social abilities (Dodich et al., 2015; McDonald, 2012). Moreover social cognition tests are more sensitive than traditional neuropsychological tests of cognition at differentiating neurodegenerative diseases such as AD and bvFTD (Bora et al., 2015; Gregory et al., 2002). To measure social cognition, many researchers have developed various tests. Table 1 below gives a summary of the tests that have been designed to measure ToM and social norm understanding.

1.9.1. Table 1. A summary of tests used to assess ToM and understanding social norms

Test of social cognition	Authors	Social cognitive ability	Brief description of test	Advantages	Disadvantages
Reading the Mind in the Eyes (RME)	Baron-Cohen, Wheelwright, Hill, et al. (2001)	Primarily affective ToM	Nonverbal, static images of the eye region of faces.	Most common test of social cognition. Quick and easy; pencil and paper test.	Stimuli are static, limiting ecological validity. Monochrome images resulting in some not being very clear. Descriptor emotions are an interpretation from the authors and are advanced verbal concepts, so subject to verbal comprehension

					abilities. Cognitive aspects to some stimuli.
Awareness of Social Inference Test (TASIT)	McDonald et al. (2003)	Multimodal affective inferences and social inference	Dynamic excerpts of actors engaging in social interactions.	Clinically validated. Multiple versions to allow retesting.	Overdramatised (e.g. over acted/exaggerated) stimuli with limited context for interactions. Forced choice answers lowering ecological validity. Lengthy test with an administration time of 60-75 minutes.
Awkward Moments Test	Heavey, Phillips, Baron-Cohen, and	Affective ToM	Series of television commercials and 1	Open ended questions.	Uses television adverts of

	Rutter (2000)		series clip.		exaggerated interactions.
Empathic Accuracy Paradigm	Roeyers, Buysse, Ponnet, and Pichal (2001)	Cognitive and affective ToM	Secretly filmed conversations between subjects waiting to take part in an experiment.	Ecological validity. Open-ended questions.	Use of hidden filming limits the range of mental states to be inferred. No clear distinction between cognitive and affective ToM.
Faux Pas Task	Stone et al. (1998)	Affective ToM, Empathic understanding	Verbal, series of short written stories. Can be read to subject or they can read it themselves.	Extensive research base. Incorporates control stories.	Very subjective scoring. Measuring several social cognitive abilities without explicitly stating what they are. Limited ecological validity.

False-Belief tests, e.g. Sally–Anne test	Wimmer and Perner (1983) and various authors	Cognitive ToM	Written stories or storyboards of first and second order-(mistaken) beliefs between characters.	Extensive research use. Short and easy to administer.	Ceiling effects. Limited ecological validity with real world interactions. Large number of versions available limits inter-study comparisons.
Judgement of Preference (JoP)	Snowden et al. (2003)	Affective ToM (and Cognitive ToM in some versions)	Static, force choice self versus other preference test.	Sensitive to impairments in clinical populations. Brief and easy to administer.	Some ceiling effects. Limited ecological validity.
Movie for the Assessment of Social Cognition (MASC)	Dziobek et al. (2006)	Cognitive and affective ToM	Short film of four characters getting together for a dinner party.	Ecologically valid with contextual information.	Dubbed in English and limited validation of its use in English speaking

					populations. Force choice answers.
Reading the Mind in Films (RMF)	Golan, Baron-Cohen, Hill, and Golan (2006)	Affective ToM	Dynamic, short excerpts from feature films.	More ecologically valid than tests using static stimuli. Relatively short to administer.	Correlated with verbal comprehension. Force choice answers. Overdramatised interaction.
Social Norms Questionnaire (SNQ)	Rankin (2008)	Intrapersonal understanding of social norms	List of everyday social behaviours that individuals might engage in.	One of the few measures of intrapersonal understanding of social norms. Sensitive to impairments in clinical populations.	Self report with no objective component. Limited ecological validity.

Story-based Empathy Task	Dodich et al. (2015)	Cognitive and affective ToM	Nonverbal, static cartoon storyboards.	Short and easier to administer. Explicitly assesses cognitive and affective ToM.	Static stimuli limits ecological validity.
Strange Stories Test	Happé (1994)	Cognitive and affective ToM	Verbal, series of short written stories.	Incorporates control stories. Easy to administer.	No clear distinction between cognitive and affective ToM. Associated with verbal comprehension.
Geneva Social Cognition Scale (GeSoCS)	(Martory et al., 2015)	Cognitive and affective ToM	Combination of shortened versions of established tests of social cognition.	Variety of ToM tests. Clinical cut-offs to detect abnormal performance. Instructions and	A combination of previous tests such as the RME and Faux Pas, therefore suffers from their limitations. Long

				scoring methods are simple to use.	duration (40–60 minutes).
Strange Stories Film Test	Murray et al. (2017)	Cognitive and affective ToM	Short, acted scenarios of social interactions.	Better ecological validity than story based Strange Stories test. Explicitly assesses cognitive and affective ToM.	Interactions lack context.

*This table was modified and expanded upon based on Henry et al. (2015)

1.9.2. Current tests of ToM and social norms understanding

Within the field of social cognition, there are many tests that attempt to examine our social abilities, some experimental and other clinical tests. Table 1 gives a summary of the more popular tests that researchers have used to measure ToM and social norm understanding. False-belief tests were the first tests that researchers used to assess ToM and were the first to show that particular sample populations exhibit difficulties on social inferences. First-order false belief tests involve attributions about another individual's (mistaken) belief about an event. Second-order false-belief tests require the individual to attribute the false belief of one person based on the thoughts of another (Poletti et al., 2012; Premack & Woodruff, 1978; Wimmer & Perner, 1983).

Tests like the Faux Pas and RME have been extremely significant in developing our understanding of the abilities that we use to process complex social information. The Faux Pas test (Stone et al., 1998) consists of stories of an interaction in which a character unintentionally said something that was socially inappropriate and could potentially insult or hurt the feelings of the other character in the story. While the RME (Baron-Cohen, Wheelwright, Hill, et al., 2001) consists of 36 photographs of the ocular region of different human faces, and requires participants to make a force-choice response from four adjectives which best described what the individual in the image was thinking or feeling. Indeed, the RME is one of the most commonly used tests of social cognition in the literature (Henry et al., 2015) with adults with ASD (Baron-Cohen, Wheelwright, Hill, et al., 2001) and dementia patients (Gregory et al., 2002) both experiencing difficulties in inferring what another individual is thinking or feeling.

To improve ecological validity of tests, newer tests like the TASIT, MASC, RMF and Strange Stories Films test have been developed. The TASIT, MASC and Strange

Stories Films test all use excerpts of real-life actors engaging in various interactions (Dziobek et al., 2006; McDonald et al., 2003; Murray et al., 2017), while the RMF uses interactions from feature films (Golan et al., 2006). These tests are important because they have provided researchers with the capability to study social cognition using measures that more closely reflect how we use our social cognitive abilities in everyday interactions. The TASIT is predictive of real world functioning in clinical populations (McDonald et al., 2004). The Strange Stories Films test has recently been shown to have higher diagnostic accuracy compared to traditional tests like the RME in adults with ASD (Murray et al., 2017). Moreover, an advantage of both the TASIT and the GeSoCS are that they have been clinically validated. The TASIT has been validated in patients with Traumatic Brain Injury (McDonald et al., 2004), while the GeSoCS has been used in patients with stroke, epilepsy, trauma, tumour and dementia (Martory et al., 2015). This is extremely beneficial as they can be used in clinical settings to inform clinicians of social cognition deficits patients may be experiencing.

1.9.3. Limitations of current tests of social cognition

There are many important limitations to the current, existing tests of social cognition (see Table 1). One limitation of early false-belief tests is that they were designed for children and children as young as 6 or 7 years old can pass false-belief tests (Roeyers & Demurie, 2010). In addition, research has found that adults with ASD can perform as well as NC on these tests (Happé, 1994; Jolliffe & Baron-Cohen, 1999; White, Hill, Happé, & Frith, 2009) but still show marked problems in social interactions in everyday life (Dziobek et al., 2006; Palmen et al., 2012). This suggests that these tests may not be very sensitive in detecting social cognitive impairments in ASD adults.

Another limitation of many traditional tests of social cognition is that each is designed to assess a specific ability and they do not assess cognitive and affective ToM within the same test (Henry et al., 2013). This is an issue because it is difficult to compare cognitive and affective ToM if different tests are used. In the same study of AD, cognitive ToM was measured using first-order false belief, while affective ToM was measured using the RME (Cuerva et al., 2001).

This problem also exists in ageing research, for example Fischer et al. (2016) used the Strange Stories test (Happé, 1994) to assess cognitive ToM while the RME (Baron-Cohen, Wheelwright, Hill, et al., 2001) was used to assess affective ToM. Moreover, previous researchers have used visual-static stimuli such as Tom's taste test to assess affective ToM (Duval et al., 2011) and the RME (Pardini & Nichelli, 2009). While others have used verbal vignettes (Phillips et al., 2011) and visual-dynamic false belief story tests (Bailey & Henry, 2008) to measure our cognitive ToM abilities. The disadvantage of using different paradigms is that they use different stimuli, and may differ in level of difficulty. Researchers have suggested that stimuli type has an effect on performance (Henry et al., 2013) while tests that are unmatched in difficulty make direct comparisons problematic.

Some researchers have attempted to consider cognitive and affective ToM separately, but using existing tests. Bottiroli et al. (2016) attempted to measure cognitive and affective ToM using the Faux Pas test by reinterpreting the questions of the test into tapping specifically cognitive and affective ToM. They demonstrated that compared to younger adults, older adults performed poorer on cognitive ToM, but showed intact affective ToM abilities. Yet, some authors have argued that the Faux Pas imposes demands on both cognitive and affective ToM indiscriminately (Henry et al., 2013). This test was designed before researchers explicitly regarded ToM as a multidimensional process and so there is no clear distinction between cognitive and affective ToM. Moreover, it could be argued that the Faux Pas is a measure of affective ToM, as well as social norm understanding, since it primarily requires the participant to understand that a protagonist's feelings have been hurt by a social norm violation.

Another limitation of current tests of social cognition is their associations with intelligence, as performance on some social cognition tests are positively influenced by measures of intelligence (specifically verbal comprehension and perceptual reasoning) (Baker, Peterson, Pulos, & Kirkland, 2014; Charlton, Barrick, Markus, & Morris, 2009; Maylor, Moulson, Muncer, & Taylor, 2002; Sullivan & Ruffman, 2004). Consequently, Charlton et al. (2009) have argued that age-related difficulties in ToM are not independent of intelligence. They found that the association between age and ToM abilities as measured by the Strange Stories test was fully mediated by perceptual reasoning and partially mediated by verbal comprehension. Further studies have found correlations between ToM and verbal abilities (Maylor et al., 2002) and have shown that perceptual reasoning performance accounts for age-related differences, again on the Strange Stories test (Sullivan & Ruffman, 2004). These findings suggest that some tests may not be simply assessing our social cognitive abilities and this has important implications for interpretations of age-related differences in performance. Additionally, in research on adults with ASD, results have shown that verbal comprehension significantly influences performance on the RME (Baker et al., 2014), Strange Stories test (Kaland et al., 2002) and RMF (Golan et al., 2006), whereas perceptual reasoning also influences performance on the RME (Baker et al., 2014). On the TASIT, the authors report that up to 24% of variance in performance on social inferences scores was associated with verbal comprehension (McDonald et al., 2003). Such findings limit the interpretations from these tests and it would be beneficial for tests to assess social cognition independently of intelligence.

A recurrent drawback of many tests including the RME, RMF and Awkward Moments Test is the stimuli. These tests use stimuli that were created not for the purpose of assessment, for example advertisements, and then repurposed for a test of social cognition. The primary benefit of this approach is time the researchers save by not having to create the stimuli themselves. While this is undoubtedly a time effective approach, the stimuli are not designed to represent a specific inference about how the character is feeling or thinking. Tests like the RME, RMF and Awkward Moments Test also do not account for the large individual variability that accompanies an individual's interpretation of what another individual may be feeling or thinking. Moreover, RME and RMF are multiple-choice format tests and this limits their ability to measure everyday social abilities because we are not normally faced with social situations that give us an explicit choice of potential answers. Moreover, there is only a single correct answer on these tests, but inferring what another individual is feeling can have multiple interpretations.

Tests like the Faux Pas and Strange Stories test also lack ecological validity. They require participants to read factual or fictional information regarding multiple characters and process mental state information. However because of this methodology of using written stories, they do not capture specific abilities used in everyday social interactions (Frith, 2004; Klin, 2000; Lugnegård, Hallerbäck, Hjärthag, & Gillberg, 2013). Older adults are often impaired on these types of tests compared to their younger counterparts (Henry et al., 2013). However, due to the nature of the tests, poor performance could be a secondary consequence of broader cognitive difficulties (Eddy, Beck, Mitchell, Praamstra, & Pall, 2013). Additionally, false-belief tests lack ecological validity because in the real world we are not typically presented with situations similar to those in classic false-belief stories (e.g. B's belief about A's beliefs about the location of an object). There are other key limitations relating to ecological validity of established tests, for example the MASC is dubbed in English and important information about the interactions between the characters could be lost in translation. Moreover, the Awkward Moments Test uses television adverts of exaggerated interactions lowering the ecological validity of the test. The Empathic Accuracy Paradigm uses scenes from hidden filming that limits the range of mental states to be inferred.

Similarly, social interactions also occur within a context, and this context is key for processing social information and responding appropriately within the interaction (Chung, Mathews, & Barch, 2010; Love et al., 2015; Vermeulen, 2015). For example, when examining social cognition in ASD, some authors suggest utilizing context-sensitive tests involving real-world scenarios (Baez & Ibanez, 2014). Adults with ASD can pass forced-choice social cognition tests (Baez et al., 2012; Izuma, Matsumoto, Camerer, & Adolphs, 2011; Klin, 2000; Schilbach, Eickhoff, Cieslik, Kuzmanovic, & Vogeley, 2012), but have difficulties on tests which require spontaneous attributions of mental states (Senju, Southgate, White, & Frith, 2009). Unfortunately, the influence of context on social interactions is generally ignored in social cognition research (Bar, 2004; Maren, Phan, & Liberzon, 2013; Melloni, Lopez, & Ibanez, 2014). Specifically, tests like the TASIT and RMF lack contextual information. The TASIT uses excerpts from short interactions; consequently it lacks important information about the interaction. However, this missing information may be essential to the way in which the interaction is interpreted..

As social abilities are so vital for social interactions (Henry et al., 2015; Love et al., 2015), researchers have attempted to develop tests of social cognition for use in clinical settings (Martory et al., 2015; McDonald et al., 2003). However, as Table 1 shows, the tests that have been validated for clinical use are not appropriate for clinical environments (Dodich et al., 2015). For example, the TASIT is a long test with an administration time of 60-75 minutes, while the GeSoCS can take up to 60 minutes to complete. Since typical neuropsychological assessments are subject to time constraints, these two tests would be too lengthy for clinicians to use. There are other limitations of social cognition tests which restrict their usefulness in clinical settings. For example, popular tests like the RME (Baron-Cohen, Wheelwright, Hill, et al., 2001) lack validity as they do not correlate with other tests of social cognition in ASD (Spek, Scholte, & Van Berckelaer-Onnes, 2010) and have shown mixed results in terms of impaired performance of ASD compared to controls (Baron-Cohen, Wheelwright, Hill, et al., 2001; Couture et al., 2010; Roeyers et al., 2001). A concise, informative and validated test of social cognition for clinicians to use would be exceptionally beneficial in clinical settings.

It is evident that many existing tests assess only one social ability. However, social cognition consists of several different abilities that are simultaneously required during social interactions. To get a more realistic and comprehensive understanding of people's abilities, we need assessments that examine several aspects of social cognition. There are no tests which are currently available in the literature that allow clinicians and researchers to examine different aspects of social cognition such as cognitive and affective ToM, as well as the understanding of social norms within the same test. These are important abilities that would advance our understanding of our social cognitive abilities.

There are many important consequences to the limitations we have discussed. For example in the healthy ageing literature, there are inconsistencies in terms of what effects ageing has on our social cognitive abilities and this could be related to the way in which researchers assess ToM (Henry et al., 2013). These contradictions have resulted in an unclear picture of what happens to our social skills as we age. Traditional tests such as verbal text based tests can often overestimate social cognitive abilities. For instance, ASD individuals can pass the Strange Stories test but still exhibit difficulties in real-world social interactions (Scheeren, de Rosnay, Koot, & Begeer, 2013). The abstract nature of these tests limits their ecological validity because the relationship to real-world functioning is unclear (Mathersul, McDonald, & Rushby, 2013). Without suitable tests of social cognition, we are unable to accurately assess our social abilities.

1.10. Interim summary

To summarise, social cognition is concerned with the processes which we use to process social information and respond accurately in interpersonal interactions (Baez et al., 2016; Frith, 2008; Henry et al., 2015; Love et al., 2015). Two important social cognitive abilities have been discussed; the frequently researched ToM ability and understanding of social norms which is not commonly examined. The literature has shown that many clinical groups demonstrate social cognitive impairments. Equally, there are many tests which have been developed by previous researchers to examine our social abilities. While these tests have been beneficial to our understanding of social cognition, many of them are not without their disadvantages. These limitations provide opportunities to develop improved tests of social cognition.

1.11. Objectives and overall scope

More ecologically valid and informative tests that assess different social cognitive abilities in the same test are clearly needed, not only in research, but in clinical settings (Henry et al., 2015). Therefore, a new test called the Edinburgh Social Cognition Test (ESCoT) was developed based on previous work (Baksh, 2013). The ESCoT is an animated test that assesses four domains of social cognition. These are cognitive ToM (What is X thinking?), affective ToM (How does X feel at the end of the animation?), interpersonal understanding of social norms (Did X behave as other people should behave?) and intrapersonal understanding of social norms (Would you have acted the same as X in the animation?).

The aims of this thesis are to examine the validity of the ESCoT as a test of social cognition and to further investigate social cognitive processes in healthy and neurological populations. Firstly, Chapter 2 discusses the development of the ESCoT based on previous work. Chapter 3 (under review, PLoS ONE) then utilizes the ESCoT as a test of social cognition to examine the effects of healthy ageing on social cognitive abilities. Chapter 4 (under review, Autism Research) examines the validity of the ESCoT as a test of social cognition by comparing performance on the ESCoT with established tests of social cognition in ASD adults. Then the utility of the ESCoT as a research tool is examined by investigating the effects of sex, personality traits and self-reported levels of empathy on social cognition in younger adults in Chapter 5. Next, Chapter 6 investigates the use of the ESCoT as a clinical tool in dementia patients. Chapter 7 further explores the consequences of healthy ageing on social cognitive processes, by examining the positivity bias (preference for positive over negative stimuli) found in older adults using an attention paradigm. Finally, in Chapter 8 a summary of the results and a general discussion is provided.

Chapter 2: Development of the Edinburgh Social Cognition Test (ESCoT)

This chapter describes the development of the Edinburgh Social Cognition Test (ESCoT). During my MSc project supervised by Professor Abrahams and Dr MacPherson, I examined age effects on a test of social cognition called the Social Scenarios Test (SST), which was the precursor to the ESCoT. In this chapter, I will discuss the limitations of the SST and the stimuli development, scoring, and the pilot work carried out in the first ESCoT development phase of my PhD.

2.1. Introduction

The ESCoT was developed from a former test called the Social Scenarios Test (SST). The SST was developed by Professor Abrahams and Dr MacPherson and used in my MSc in Human Cognitive Neuropsychology dissertation project to examine the effects of healthy ageing on social cognition (Baksh, 2013).

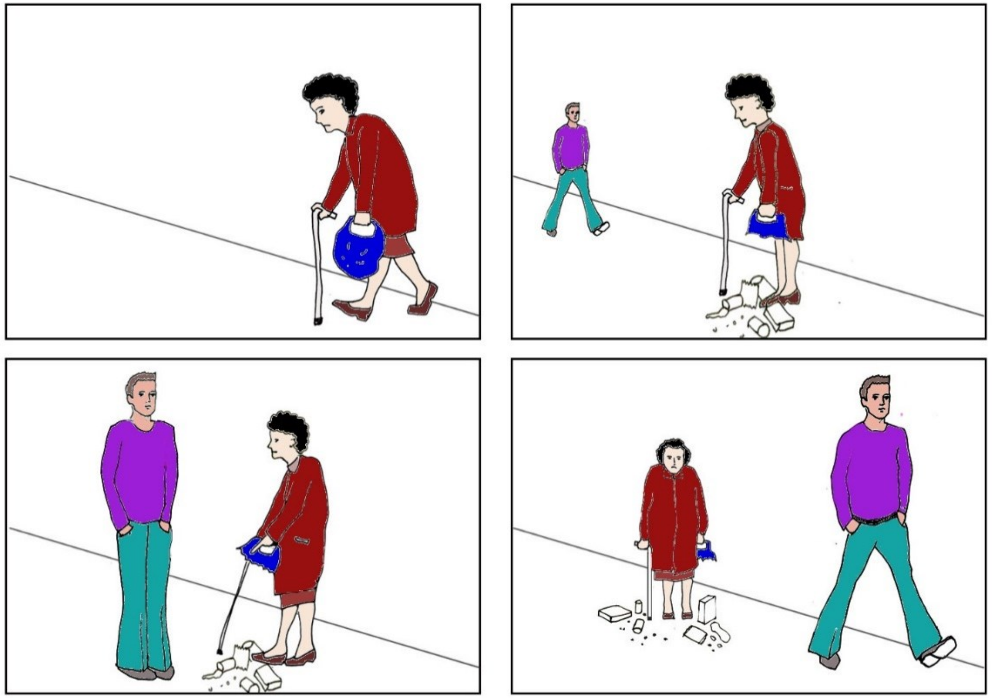
2.1.1. Social Scenarios Test: Precursor of the ESCoT

The SST was a static visual task that assessed ToM, emotional understanding and social norms. It consisted of 10 partially coloured storyboards showing different social interactions. Each storyboard consisted of 4 individual panels portraying a specific social interaction. Five of the interactions depicted 'everyday' interactions while the remaining 5 showed social interactions wherein one character committed a social norm violation. To focus participants' attention to the social situation, the key characters engaged in the interaction were depicted in colour while the remaining characters/background were in black and white.

Each storyboard was shown to the participant and 5 questions were asked about each social interaction: a general comprehension question (Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?), a ToM question (What did the X think that X wanted?), an emotional understanding question (How did X feel at the end of the story?), a social norm question (Did X in the animation behave as other people should behave?) and a self-reference question (Would you have acted the same as X in the story?). The ToM, emotional understanding and social norm questions were all scored while the self-reference question was not. Figure 3 below gives an example of the stimuli, questions and scoring scheme for the SST (taken from Baksh, 2013).

2.1.1.1. Figure 3. Storyboard and scoring scheme from the SST:

Scenario 1



Theory of Mind: What does the man think that the woman wants?
Prompt ONCE if needed: Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?

help with her shopping/her shopping to be picked up	2		
his assistance/help (follow with prompt)	1		
him to avoid stepping on her shopping/don't know	0		

Emotional Understanding: How does the woman feel at the end of the story?

angry/disappointed/sad/frustrated	2		
not happy (prompt)	1		
tired/unconcerned/happy	0		

Social Rule Knowledge/Understanding: Did the man in the cartoon behave as other people should behave?

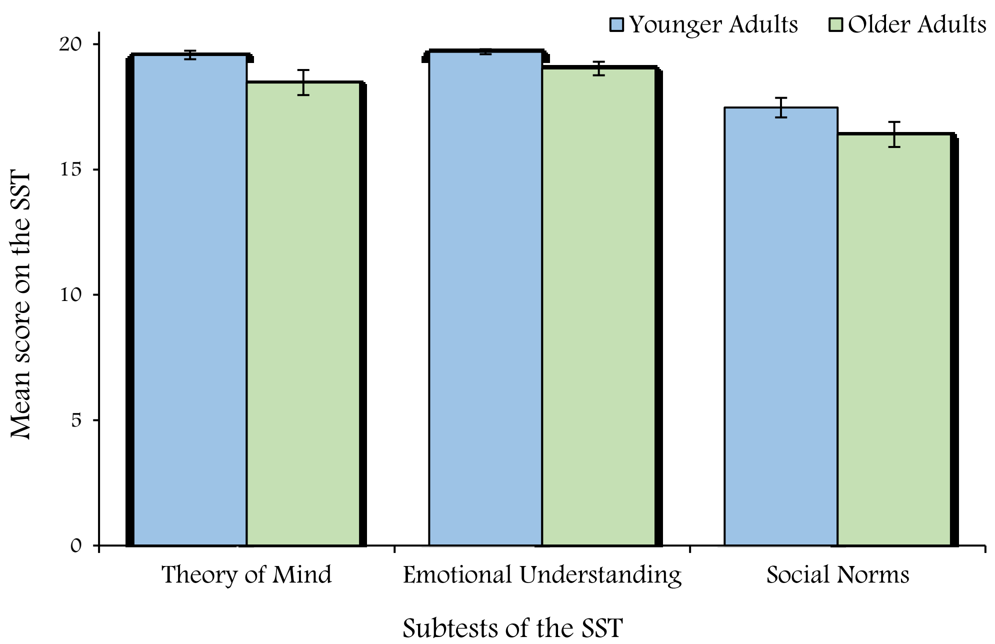
no - should have helped the old lady pick up her shopping as she obviously needed help/is frail/is old/has a stick	2		
no - should have helped her (prompt)	1		
yes - may have been in a rush and couldn't help/he didn't do anything wrong/he avoided her shopping as she requested/might not have noticed her pointing/don't know	0		

Would you have acted the same as the man in the cartoon?

yes	Reason:
no	

The primary aim of this project was to examine the effects of ageing on social cognition. There was no statistically significant difference between younger and older adults on the subtests. However, there was a significant difference in SST total scores between younger and older adults.

2.1.1.2. Figure 4. Performance of younger and older adults on each subtest (out of 20) of the SST (taken from Baksh, 2013)



Error bars = Standard error

2.1.2. Limitations of the SST

From Figure 4, it is evident that the main limitation of the SST as a test of social cognition was that the younger adults found the test too easy. This is based on the near ceiling performance of this group on the ToM and emotional understanding subtests. This would severely limit the application of the SST as a research and clinical test, due to limited variability in responses. Moreover, the ceiling effect made interpretation of the null age-related findings difficult since ceiling effects can result in erroneous conclusions of no effect when an age-related effect may have been present (Cramer & Howitt, 2004). Another limitation of the SST was that the self-reference question was not scored. This was an unexploited opportunity to explore intrapersonal understanding of social norms, an area that is extremely understudied in social cognition research. Moreover, the SST used static stimuli, but static tests are not very ecologically valid. There is recent evidence to suggest that video tests increase ecological validity, and as a consequence are more effective than other types of tests at differentiating between ASD and NC adults (Murray et al., 2017). Therefore, the SST might be improved if the static storyboards were turned into animations to increase the test's ecological validity. This modification could potentially increase the application of the SST as a test of social cognition.

To address the limitations highlighted in this earlier work, the first phase of my PhD was to redesign the SST. Firstly, the static storyboards became animations with summary storyboards at the end of each animation. New guidelines for scoring each question were created and a new guideline to score the self-reference question was introduced.

2.1.3. Development of the Edinburgh Social Cognition Test (ESCoT)

The animations for the ESCoT were based on the scenarios from the SST. One animation was taken out because there was ambiguity in regards to the nature of the interaction. These animations were each approximately 30 seconds long and were developed by a graphic designer. Attention was given to each animation to ensure that they contained the relevant information from the original stories (see Appendix 1.1 for each storyboard). In regards to administration of the ESCoT, participants watched the animation and they were asked questions relating to what they had observed while a static storyboard summary remained onscreen.

The structure of the scoring scheme was based on the SST; participants were asked a general comprehension question to describe what occurred in the interaction, this was done to ensure participants understood each animation (again, this was not scored). They were then asked 4 questions aimed at assessing different social cognitive abilities. Firstly, the names of the questions were changed to more accurately exemplify the specific social cognitive ability they were intended to measure.

Following Simone Shamay-Tsoory and colleagues' model of ToM (Shamay-Tsoory & Aharon-Peretz, 2007; Shamay-Tsoory et al., 2010; Shamay-Tsoory et al., 2007; Shamay-Tsoory et al., 2006; Shamay-Tsoory et al., 2005), the ToM question of the SST was renamed cognitive ToM and the emotional understanding question was renamed affective ToM. The questions for both ToM abilities were kept the same. Moreover, social norm understanding was subdivided into self- versus other-inferences. The social norms question was renamed interpersonal understanding of social norms (inferences about how another individual should behave) and the self-reference question was renamed intrapersonal understanding of social norms (inferences about how the participant themselves would have behaved compared to the character in the animation). Finally, to differentiate this new test from the SST, I changed the name of the test to the Edinburgh Social Cognition Test (ESCoT).

Secondly, in an attempt to increase the variability in responses, the total points that could be awarded for each question was increased from 0 – 2 points to 0 – 3 points for each of the subtests (see Appendix 1.2 for full scoring scheme). Each response was scored based on the quality of the answer, with maximum points awarded for responses that successfully extracted and integrated the relevant information from the interaction and articulated this response in a contextually specific manner. Importantly, response length was not related to quality; participants could score maximum points with a minimal response that provided the appropriate information. For the scoring of the intrapersonal understanding of social norms subtest, responses that considered the social nuances of the interaction were scored more highly than responses that highlighted personal attributes of the participant. Participants could score a maximum of 30 points for each subtest and a maximum score of 120 points on the overall test (see Figure 5 below for an example of this scoring scheme). To examine the validity of the ESCoT, 2 pilot studies were conducted, these are detailed below.

2.1.3.1. Figure 5. The scoring scheme of the ESCoT (scenario 1, see Appendix 1.2 for full scoring scheme)

Question 1: Cognitive Theory of Mind: **What did the man think that the elderly woman wanted?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the elderly woman needs help with a specific activity and a contextual reason why she needs assistance. For example *help with her shopping because she looks like she is unable to pick it up herself/she has a walking stick so obviously has mobility issues*	3		
An answer that recognises that the elderly woman needs help with a specific activity. For example, *help with her shopping/her shopping to be picked.* No more than two points can be gained if the consequences of her age or situation is not explained **(prompt)**	2		
An answer that recognises that the elderly woman needs help. For example *his assistance/help* **(prompt)**	1		
An answer that does not recognise that the elderly woman needs help. For example *him to avoid stepping on her shopping* **OR** *don't know*	0		

Question 2: Affective Theory of Mind: **How did the elderly woman feel at the end of the animation?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that provides a specific negative emotion with a contextual reason. For example *angry/disappointed/sad/frustrated because the man walked straight pass her without offering to help pick up her spilled shopping when it is evident that she needs help*	3		
An answer that gives a specific negative emotion. For example *angry/disappointed/sad/frustrated* **(prompt)**	2		
An answer that provides a generic negative emotion. For example *not happy* **(prompt)**	1		
An answer that provides a neutral emotion. For example *tired/unconcerned* **OR** provides a positive emotion for example, *happy* **OR** *don't know*	0		

Question 3: Interpersonal understanding of Social Norms: **Did the man in the animation behave as other people should behave?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the man acted in a socially unacceptable way and a contextual reason why she needed help. For example, *no - should have helped the elderly woman pick up her shopping as she obviously needed help/is frail/is old/has a stick*	3		
An answer that recognises that the man acted in a socially unacceptable manner. For example *no - should have helped her* **(prompt)**	2		
An answer that does not recognise that the man acted in a socially unacceptable manner but provides a reasonable justification. For example *yes - may have been in a rush and couldn't help/he didn't do anything wrong/he avoided her shopping as she requested/might not have noticed her pointing*	1		
Don't know/irrelevant explanation	0		

Question 4: Intrapersonal understanding of social norms (Section 2): **Would you have acted the same as the man in the animation?**

Prompt ONCE if needed: *Can you tell me why?*

		Reason (**prompt if not provided**)	Social context	Personal attributes
YES				
NO				

2.2. The ESCoT: Pilot 1

2.2.1. Methods

2.2.1.1. Participants

With the new dynamic animations, summary storyboards and new scoring guidelines, the ESCoT was piloted on 10 younger adults (8 females, *M* age = 25.60 years, *SD* = 3.24, range = 22–32). Participants were recruited using online advertisement. Informed consent was obtained from all individuals and the study was approved by the School of Philosophy, Psychology and Language Sciences (Psychology) Ethics committee.

2.2.1.2. Materials and Procedure

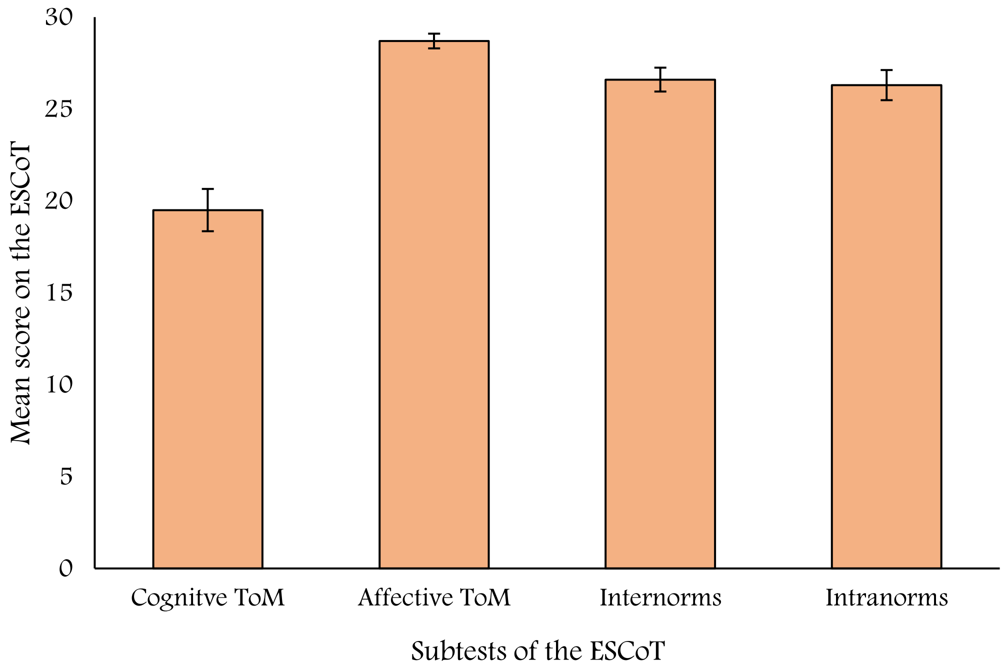
Participants completed the ESCoT in a quiet room. Here they watched each animation and answered questions relating to what they saw. The ESCoT consisted of 10 dynamic, cartoon-style animations depicting social interactions. Five interactions involved a social norm violation and 5 portrayed everyday interactions that did not involve social norm violations. Participants answered 5 questions following each animation (see Appendix 1.2 for the full scoring scheme) and could score a maximum of 120 points (see Chapter 3, section 3.2.2.3 for a more detailed description of the ESCoT).

2.2.1.3. Analysis

Participants' performance was graphically represented using histograms. Secondly, a content analysis was done by first transcribing the responses of participants for each scenario and then the frequency of particular ways of answering the questions were investigated (Hsieh & Shannon, 2005).

2.2.2. Results

2.2.2.1. Figure 6. Performance of participants (n = 10) on the ESCoT



Error bars = Standard error

As Figure 6 shows, there were still issues with the scoring scheme of the ESCoT. For example, there was larger variation in performance for cognitive ToM compared to the other subtests. Additionally, there was near-ceiling performance on affective ToM, with little variation in scores.

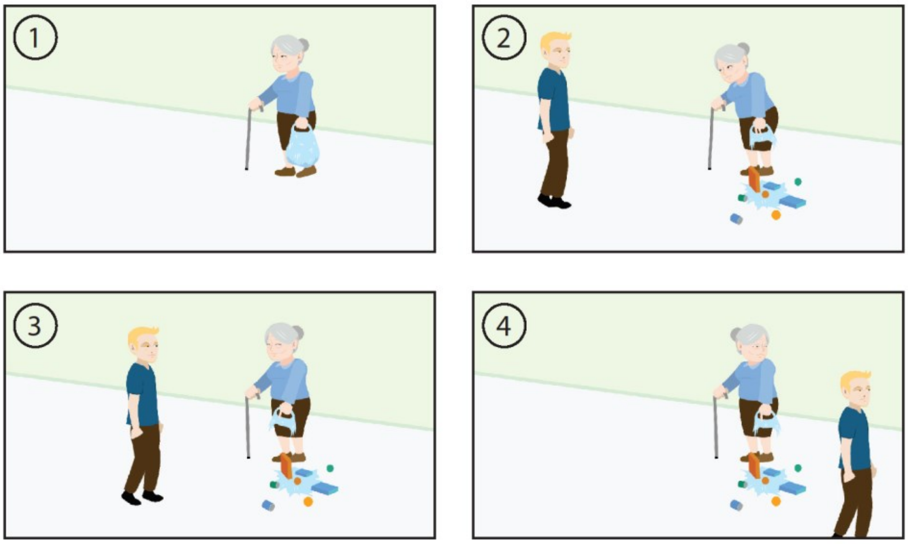
To understand these issues in greater detail and to investigate reasons behind the different kinds of responses to the questions, a content analysis was performed on the responses of the 10 participants.

2.2.2.2. Content analysis of Pilot 1: Cognitive ToM

Firstly, the analysis focused on the cognitive ToM subtest to understand why there was more variation in scores and poorer performance on this subtest in comparison to the other subtests. The most evident observation from the data was that participants had difficulties with the second-order nature of the question: 'what did X think that X wanted?' Specifically, responses were often vague and unclear in regards to which perspective participants were referring. The examples and Figure 7 below illustrates this.

Scenario 1 & 7 – Examples of responses in which the perspective was ambiguous:

Scenario 1

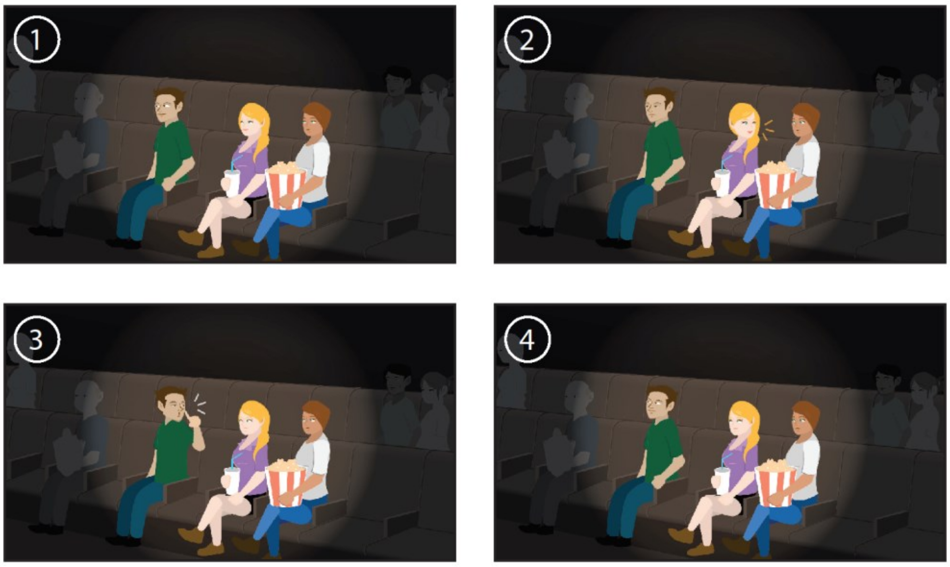


Question: What did the man think that the elderly woman wanted?

First response: A hand to pick up her groceries.

Following prompt: I don't know really. Just a hand to get them back up. She's not got a bag now so…

Scenario 7



Question: What did the women think that the man wanted?

First response: Wanted them to be quiet (in relation to Scenario 7).

Following prompt: Because they were talking in the cinema and he couldn't hear, so he was like shh…

As the examples above demonstrate, it was unclear whether the response that the participants gave were a first order (they thought that…) or second order ToM (they thought that he thought…) answer. Interestingly, in Scenario 1, 70% of participants gave a vague answer in terms of perspective where it was unclear which character's perspective the participant was referring to. The type of error dropped to 50% in Scenario 2. For some participants, they frequently gave answers in which the perspective was vague. For example, participant no. 4 gave vague answers in 100% of their responses and participant no. 7 did the same in 90% of their responses. Moreover, frequency of vague answers in terms of perspective decreased substantially after the first two scenarios and participants gave second-orders more frequently.

2.2.2.2.1. Figure 7. Percentage of times participants gave ambiguously vague answers in relation to perspective-taking

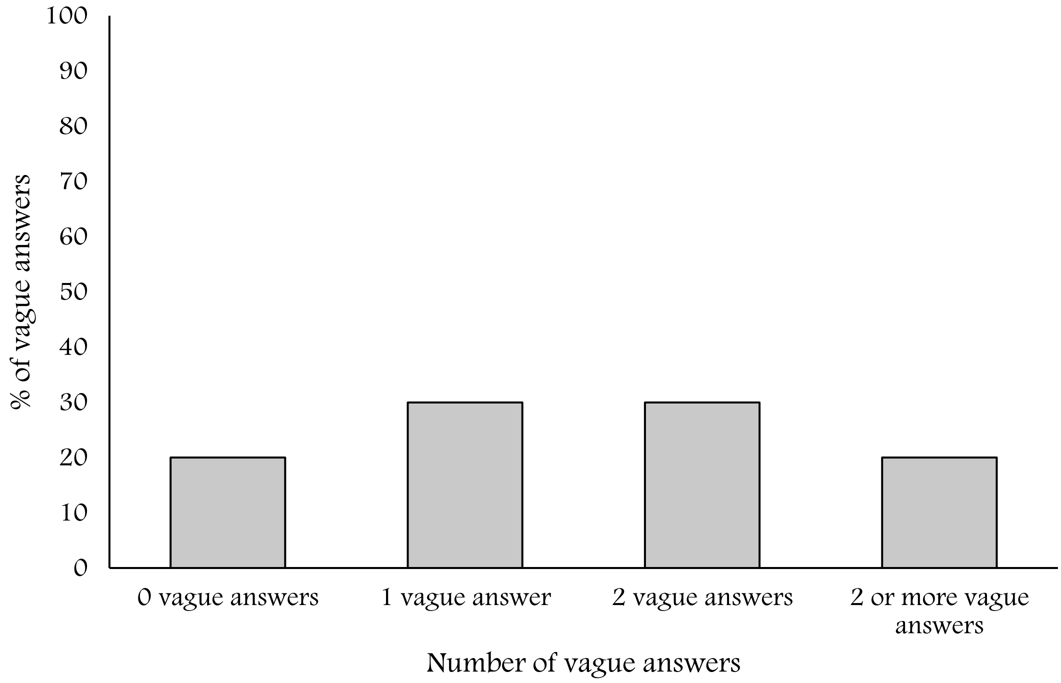
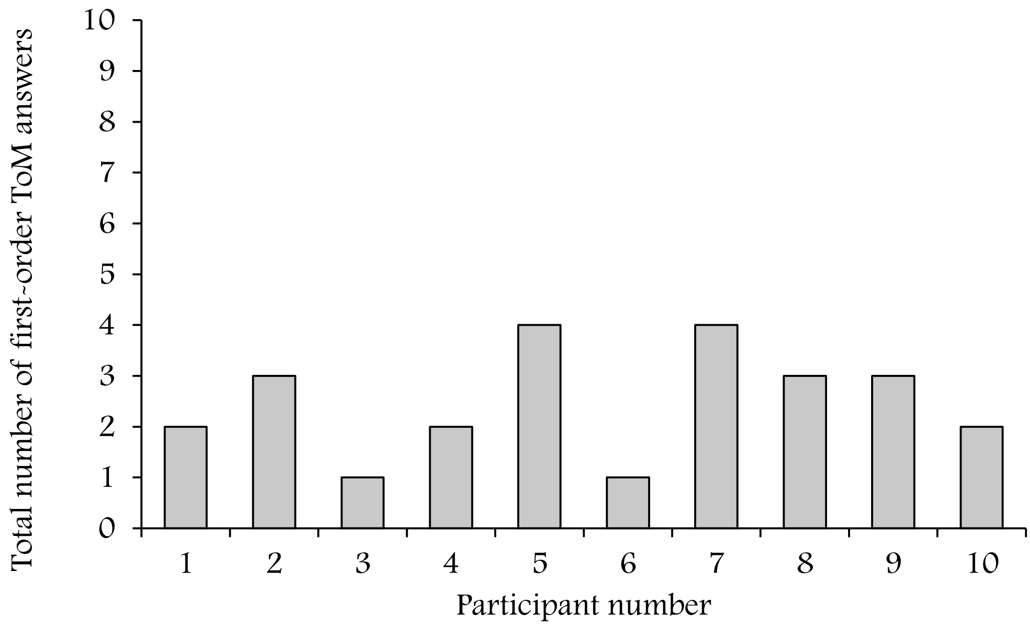


Figure 7 illustrates, that participants often gave responses in which it was unclear which character in the interaction they were referring to. They frequently gave at least one answer in which the perspective was ambiguous. Eighty per cent of participants did not answer the cognitive ToM question correctly.

To further understand the difficulties with the cognitive ToM question, the occurrence of first-order responses to the second-order ToM question was examined next.

2.2.2.2.2. Figure 8. Number of first-order answers to the cognitive ToM question



The results in Figure 8 are based on participants' full response to the questions (their initial responses and the follow-up prompt, 'Can you explain that in more detail?') It is evident that 100% of participants answered the cognitive ToM question from the wrong perspective at least once. Participants gave an average of 2.5 out of 10 first-order ToM answers when asked the second-order cognitive ToM question.

Another important trend that emerged from the data was that participants frequently gave a response in which the perspective was vague but would then follow this up with a first-order rather than the correct second-order explanation. Additionally, participants occasionally switched from a second-order, to a first-order answer.

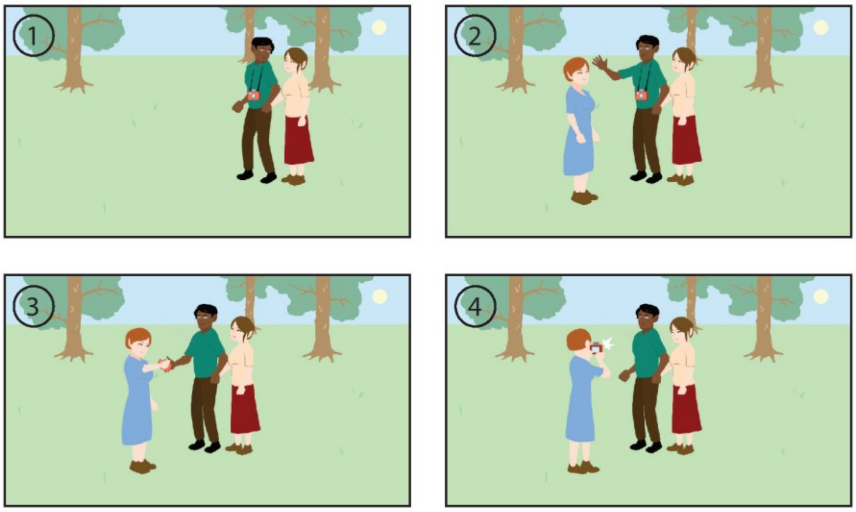
Scenario 1 – Example of ambiguously vague perspective taking with first order responses:

Question: What did the man think that the elderly woman wanted?

First response: To pick up her stuff and help her…

Following prompt: She thought he should pick up her shopping. Help her take them home.

Scenario 10 – Example of participants switching from a second-order response to a first order response:



Question: What did the woman think that the couple wanted?

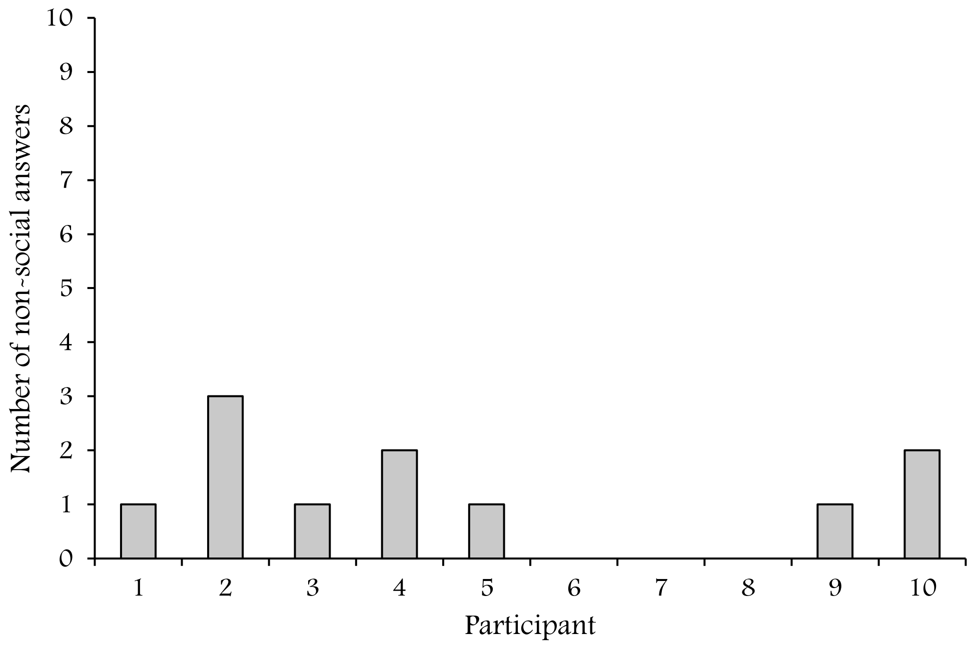
First response: The woman thought that the couple wanted a memory and a photo to be taken of them.

Following prompt: The couple wanted her to help them and provide a, do them a favour.

All participants made these errors at least once. They either gave a vague response which turned out to be a first-order answer or gave a second-order response that became a first-order answer following prompting.

Finally, the occurrence of social and non-social answers was examined. Social answers were defined as responses that mentioned both of the characters in the interaction and non-social answers as those that only mentioned one of the characters in the interaction.

2.2.2.2.3. Figure 9. Number of non-social answers to cognitive ToM questions



As Figure 9 shows, out of the 10 occasions, 70% of participants gave at least one non-social response. This suggests that participants sometimes failed to incorporate both characters in the interaction in their answers to the cognitive ToM question.

2.2.2.3. Interim summary

As the results above have shown, there are several factors that may have contributed to poor performance on the cognitive ToM subtest. These include providing responses from an unclear perspective, producing first-order answers to the second-order ToM question, difficulties maintaining a second-order perspective and, on occasion, providing non-social answers.

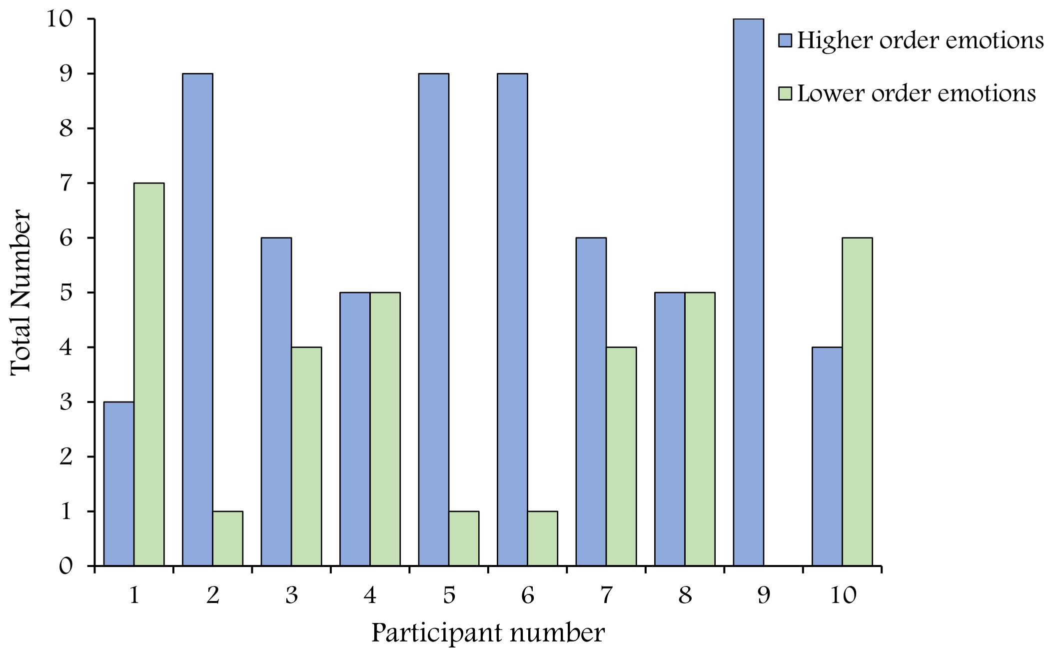
2.2.2.4. Content analysis of Pilot 1 data: Affective ToM

As previously mentioned, the performance on the affective ToM subtest was near ceiling, indicating that participants found this subtest relatively easy. To understand the kind of responses participants gave, their answers were dichotomised into two groups: responses that exhibited a lower order emotional understanding and those that demonstrated a higher order emotional understanding. This was carried out because all types of contextual emotions were regarded as correct answers and there was no differentiation between the types of emotions described.

A response was categorised as a lower order emotional response if they included happiness, sadness, disgusted, fear, surprised and angry. This was based on the facial expression work by Paul Ekman (Ekman, 1973; Ekman, Sorenson, & Friesen, 1969). Responses such as fine, ok, upset and not happy were included as lower order emotional responses as they are contextually vague and are ambiguous.

A higher order emotional response was defined as a complex, contextually specific emotions. For example, disappointed, rude, abandoned, vulnerable, helpless, unlucky, disrespected, irritated, "pissed off" are all complex and contextually specific emotions because they related specifically to the interaction.

2.2.2.4.1. Figure 10. The number of lower and higher order emotional responses of participants



As Figure 10 illustrates, most participants gave a mixture of responses containing lower and higher order emotions, with the exception of participant no. 9 who gave higher order emotional responses for all 10 scenarios.

2.2.2.5. Redesigned scoring scheme for the ESCoT

Based on the results above, the scoring scheme was redesigned for the cognitive and affective ToM subtest. This was also the case for the interpersonal understanding of social norms scoring scheme based on the results from the cognitive ToM question analysis, to incorporate the social and non-social distinction in responses and for consistency in the scoring scheme.

Below is the new scoring scheme with examples from scenario 1.

1. Cognitive ToM: What is the elderly lady thinking?

This question was changed to a first-order ToM question, as the content analysis showed that participants were finding the second-order nature of the question difficult. Moreover, it was altered for consistency across the test items since the other 3 subtest questions were all first-order.

A social and non-social aspect was added to the responses to differentiate a 1-point and 2-point answer. To achieve 3 points on this question, participants were now required to include both characters in the interaction and provide a contextual reason for the inference about what the character is thinking. Social and non-social answers were added to examine participants' inclusion of all characters in the interaction into their responses.

Finally, to clearly differentiate cognitive and affective ToM, any cognitive ToM responses that included an affective state limited the maximum mark to 2 points, as the question is assessing inferences about thinking and not emotional states.

2.2.2.5.1. Figure 11. New cognitive ToM scoring instructions: What is the elderly lady thinking?

Prompt ONCE if needed: Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?

			Additional notes
A social answer that recognises that the elderly lady required assistance, and provides a contextual reason of why she needed assistance. For example, she is thinking she wants him/the young man to help her pick up the shopping/she wants his help because her bag has split/she has a stick so she cannot do it herself. Mention of affective state limits mark to 2 points	3		
A social answer that recognises that the elderly lady required assistance. No more than 2 points can be gained if a contextual reason is not given. For example, she is thinking she wants him/the young man to help her pick up the shopping/she wants his help (prompt)	2		
A non-social answer that recognises that the elderly lady required assistance. No more than 1 point can be gained if there is no mention of the other person from the interaction in the response, even with a contextual reason. For example, she wants assistance/she is thinking she wants help/help to pick up her shopping (prompt)	1		
Don't know/irrelevant answer	0		

2. Affective ToM: How does the elderly lady feel at the end of the animation?

Based on the content analysis, I separated responses into lower and higher order emotional answers. To achieve more than 1 point, participants were now required to give a contextual reason for the specific emotion.

2.2.2.5.2. Figure 12. New affective ToM scoring instructions

Prompt ONCE if needed: Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?

			Additional notes
An answer that demonstrates a higher order emotional understanding, with a contextual reason. For example, she feels abandoned/vulnerable/helpless because the man just ignored her and she is going to have to pick up her shopping on her own, which will be difficult as she has mobility issues (prompt)	3		
An answer that demonstrates a lower order emotional understanding, with a contextual reason. For example, she feels angry/she is upset/not happy because the man just ignored her and she is going to have to pick up her shopping on her own, which will be difficult as she has mobility issues (prompt)	2		
An answer that demonstrates a lower order emotional understanding. For example, she feels angry/she is upset/not happy (prompt)	1		
Don't know/irrelevant answer	0		

3. Interpersonal understanding of social norms: Did the man in the animation behave as other people should behave?

In line with the cognitive ToM question, I added a social and non-social aspect to the interpersonal understanding of social norms. To differentiate a 2- and 3-point answer, participants were now required to provide a contextual reason to achieve 3 points.

2.2.2.5.3. Figure 13. New interpersonal understanding of social norms scoring instructions

Prompt ONCE if needed: Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?

			Additional notes
A social answer that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner, and provides a contextual explanation of why she needed help. For example, no - he should have helped her/the elderly woman pick up her shopping because she obviously needed help/is frail/is old/has a stick	3		
A social answer that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner. No more than 2 points can be gained if a contextual explanation is not given. For example, no - he should have helped her/the elderly woman pick up her shopping (prompt)	2		
A non-social answer that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner. For example, no - he should have helped/picked up the shopping (prompt) OR yes – he may have been in a rush and could not help/he did not do anything wrong/he avoided her shopping as she requested/might not have noticed her pointing	1		
Don't know/irrelevant answer	0		

4. Intrapersonal understanding of social norms: Would you have acted the same as the man in the animation?

As highlighted by Figure 6, participants' performance did not indicate that this question required modification.

2.2.2.5.4. Figure 14. New intrapersonal understanding of social norms scoring instructions

Prompt ONCE if needed: Can you tell me why?

		Reason (prompt if not provided)	Social context (2)	Personal attributes (1)
YES (0)				
NO (1)				

5. Additional changes made to the scoring scheme based on the content analysis

The cognitive and affective ToM questions were counter-balanced in terms of administration order and I introduced a practice scenario so participants were familiar with the nature of the questions, and to clarify any questions they might have about the test (see Appendix 1.3 for this new animation). Finally, participants could now score a maximum of 30 on each subtest with a maximum score of 120.

2.3. The ESCoT: Pilot 2

2.3.1. Methods

2.3.1.1. Participants

To evaluate this new scoring scheme, a short pilot on 5 participants was conducted. Unfortunately, demographic information for these participants was not collected.

2.3.1.2. Materials and Procedure

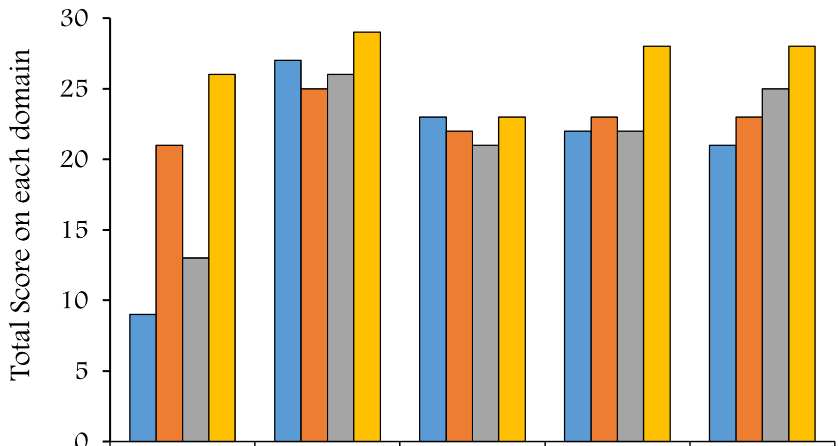
Similar to Pilot 1, participants completed the ESCoT in a quiet room and answered each question after watching the animation. In this pilot, their answers were scored using the new scoring scheme detailed above (see Appendix 1.4 for the full scoring scheme).

2.3.1.3. Analysis

Participants' performance was graphically represented using a histogram. Secondly, a shorter content analysis was performed on one participant who exhibited poorer performance on the ESCoT compared to the other participants.

2.3.2. Results

2.3.2.1. Figure 15. Individual performance of participants with the new scoring scheme (each subtest is scored out of 30)



	1	2	3	4	5
Cognitive ToM	9	27	23	22	21
Affective ToM	21	25	22	23	23
Interpersonal understanding social norms	13	26	21	22	25
Intrapersonal understanding social norms	26	29	23	28	28

As Figure 15 demonstrates, performance was more consistent across the subtests with the new scoring scheme, with the exception of participant no. 1. Mean performance on each of the subtests (without participant no. 1) was cognitive ToM = 23.25, affective ToM = 23.25, interpersonal understanding of social norms = 23.50 and intrapersonal understanding of social norms = 27.

2.3.2.2. Case study of participant no. 1: Pilot 2

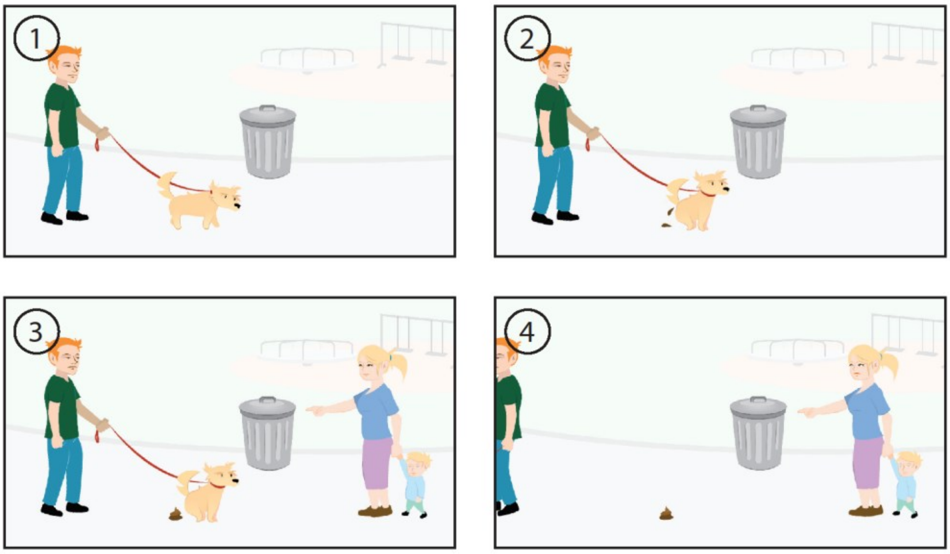
To understand the atypical performance of participant no. 1, a short content analysis was performed on their performance to illustrate some of the errors noted in their answers.

Participant no. 1 was a neurotypical 28-year-old male student who was studying for his MSc in Philosophy. Noteworthy, he took 52 minutes to complete the ESCoT which is substantially longer than the 20 – 25 minutes of the other participants.

Typical errors of Participant no. 1:

1. He gave an emotional response for cognitive ToM questions, but he showed an advanced affective ToM understanding. For example:

Scenario 4:



E: What is the woman with the child thinking?

S: You know it's a playground and like that so it's unhygienic, so it has bacteria and if kids play in this area, it makes it dangerous for them. So she might be really annoyed because voluntarily or not this guy is putting her kids health at risk so she might be, you know quite annoyed, I would understand it.

E: Can you explain that in a little bit more detail?

S: Well, I would not say that she would be angry, just for the sake. If it's a playground or any area that kids play, especially, then it would be a hazard or dangerous. There could of course be a different objection. You know, it's not right to just, this guy could not just care about the consequences. The others should care and take care of the problem.

E: How does the woman with the child feel at the end of the animation?

S: Annoyed.

E: Can you explain that in a little bit more detail?

S: To put myself in her situation, what would I. Yeah annoyed, feeling a bit like why her reasonable request was ignored by this guy.

2. Some vague emotional responses, but an advanced understanding of social rules. For example:

E: How does the woman feel at the end of the animation? (Disobey parking regulations)

S: Again, I don’t really know. But I could presume she’s a bit like oh well, I did what I could.

E: Can you explain that in a little bit more detail?

S: Difficult to say, I think this, generally speaking, in the scheme of things; she has other stuff to do that just…I don’t know. And at the end of the day, it’s a no parking zone. You can’t really complain because it’s quite visible.

As the example responses above demonstrated, participant no. 1 showed specific difficulties in responding to the subtest questions of the ESCoT. Such difficulties are common in conditions like ASD, in which individuals have difficulties inferring what another individual is thinking but have a good understanding of social norms (Zalla, Sav, Stopin, Ahade, & Leboyer, 2009).

While he was recruited as a neurotypical participant, it was possible he had a diagnosis of a clinical or developmental disorder that was not disclosed and could have affected his performance on the ESCoT. Moreover, he could have exhibited subclinical traits of a clinical disorder that too could have affected his performance. Unfortunately, background information such as diagnosis of clinical disorders was not collected, nor was subclinical presentations of developmental disorders such as ASD assessed. Consequently, given this participant's responses to the subtests of the ESCoT, he was excluded.

2.4. Overall summary and conclusions

The principles of the SST as a test of social cognition were good, but the SST suffered from important limitations. The ESCoT was developed to address these limitations and produce a test that was more ecologically valid, to assess different domains of social cognition within a single test. Results from the pilot data suggest that the ESCoT is an improvement from the SST and the next stage would be to examine ESCoT performance in a larger group of individuals.

Chapter 3: The Effect of Age, the Broader Autism Phenotype and Intelligence on Performance of the ESCoT

To explore the validity of the ESCoT as a test of social cognition, I first examined the effects of healthy ageing on our social abilities. Moreover, in the forthcoming chapter I examined the psychometric properties of the ESCoT by investigating the effect of the Broader Autism Phenotype (BAP) and intelligence on performance of this new test of social cognition.

Data in this chapter were collected by myself.

[1]This chapter has been submitted in its complete form as a journal paper and is currently under review for publication in PLoS One.

Baksh, R.A., Abrahams, S., Auyeung, B., & MacPherson, S.E. (under review). The Edinburgh Social Cognition Test (ESCoT): Examining the effects of age on a new measure of theory of mind and social norm understanding. *PLoS One*.

[1] The section numbering has been changed to fit in with the thesis structure although the format is consistent with the journal

3.1. Introduction

The study of social cognition is concerned with the higher-order cognitive processes that allow individuals to interpret the behaviours of others (Adolphs, 2009). These abilities allow us to process and understand social information in order to respond appropriately in everyday interactions (Baez et al., 2016; Frith, 2008; Henry et al., 2015; Love et al., 2015). Social cognition includes abilities such as theory of mind (ToM; i.e., the ability to recognise other people's mental states to understand and predict their behaviour), emotion recognition, empathy, moral judgments and the understanding of social norms (Baez et al., 2013; Baez et al., 2012).

Healthy aging is associated with reliable improvement in emotional well-being (Scheibe & Carstensen, 2010) and social functioning (Luong, Charles, & Fingerman, 2010). Although social network size decreases with age, older adults' social interactions with individuals who remain within their social networks are rated as being more satisfying (English & Carstensen, 2014). Life experience is thought to influence how people process and respond to social information (e.g., (Blanchard-Fields, 2007)). For example, older adults are thought to be more receptive to emotional cues when making social judgements compared to younger adults (see (Hess, 2005)). Yet, some studies examining individuals' ability to understand and evaluate relevant social information have reported poorer performance in healthy older adults compared to younger adults (Henry et al., 2013; Kemp, Després, Sellal, & Dufour, 2012).

One of the most extensively studied aspects of social cognition in healthy aging is ToM (Kemp et al., 2012). More recently, it has been argued that ToM is not a one-dimensional concept, but processes differ based on whether they refer to cognitive or affective judgements (Shamay-Tsoory et al., 2010). Cognitive ToM is defined as the ability to make inferences about the thoughts, intentions and beliefs of another individual. Affective ToM refers to the ability to make inferences about what another individual is feeling (Kalbe et al., 2010; Sebastian et al., 2011; Shamay-Tsoory et al., 2010). Age-related differences have been found where older adults perform more poorly compared to their younger counterparts on tests such as Reading the Mind in the Eyes (RME) (Baron-Cohen, Wheelwright, Hill, et al., 2001), Faux Pas stories (Stone et al., 1998) and Happé's Strange Stories, among others (Bailey & Henry, 2008; Bailey et al., 2008; Bottiroli et al., 2016; Duval et al., 2011; Happé, Winner, & Brownell, 1998; Maylor et al., 2002; McKinnon & Moscovitch, 2007; Moran et al., 2012; Rakoczy, Harder-Kasten, & Sturm, 2012; Sullivan & Ruffman, 2004). Yet, other studies have found age-related improvements in favour of older adults such as Happé et al. (1998) or equivalent performance between younger and older adults (Castelli et al., 2010; Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006; Li et al., 2013; MacPherson, Phillips, & Della Sala, 2002; McKinnon & Moscovitch, 2007; Phillips, MacLean, & Allen, 2002; Wang & Su, 2006). Potentially, age-related differences may be related to one aspect of ToM but not the other, for example cognitive ToM but not affective ToM. However, research into possible dissociations between cognitive and affective ToM has yielded mixed findings. In perspective taking tests that assess cognitive ToM, older adults perform more poorly than younger adults (Bailey & Henry, 2008; Bottiroli et al., 2016; Castelli et al., 2010; Duval et al., 2011; Fischer et al., 2016; German & Hehman, 2006; Moran et al., 2012; Saltzman et al., 2000). Nonetheless, other authors have failed to find age-related differences in cognitive ToM (Castelli et al., 2010; Keightley et al., 2006). Affective ToM has been examined using tests such as the RME (Baron-Cohen, Wheelwright, Hill, et al., 2001) where individuals are required to make inferences from the eye region of photographs. Older adults have been found to perform significantly more poorly than younger adults (Bailey & Henry, 2008; Bailey et al., 2008; Fischer et al., 2016; Pardini & Nichelli, 2009; Slessor, Phillips, & Bull, 2007). Video based ToM tests have also shown that older adults perform significantly more poorly than younger adults (Slessor et al., 2007; Sullivan & Ruffman, 2004). However, Castelli et al. (2010) and Li et al. (2013) have both reported comparable performance between younger and older adults on the RME. Moreover, story-based affective ToM tests such as the Faux Pas test (Stone et al., 1998) have less consistently reported age-related differences with some studies reporting poorer performance with age (Wang & Su, 2006) but others not reporting age-related differences (MacPherson et al., 2002). Overall, it is unclear how social cognitive abilities, specifically cognitive and affective ToM abilities are affected by aging when the performance of older adults is compared to younger adults. A possible reason for the inconsistencies in the literature could be related to the way in which researchers assess ToM (Henry et al., 2013).

The aging literature has tended to assess the influence of age on the distinct components of ToM using different tests (e.g., Fischer et al., 2016) and these paradigms vary in both their stimuli type and level of difficulty. For example, affective ToM has been examined using tests involving visual-static stimuli such as Tom's taste test (Duval et al., 2011) and the RME (Pardini & Nichelli, 2009). In contrast, cognitive ToM has been examined using verbal vignettes (Phillips et al., 2011) and visual-dynamic false belief story tests (Bailey & Henry, 2008). Existing tests of social cognition have been criticised as they require participants to read factual or fictional information regarding multiple characters and process mental state information. Poor performance could be a secondary consequence of broader cognitive difficulties (Eddy et al., 2013). Moreover, few aging studies have compared affective and cognitive ToM within the same test, making it difficult to contrast the influence of age on tests that are not directly comparable. Recently, Bottiroli et al. (2016) attempted to measure cognitive and affective ToM using the Faux Pas test. They demonstrated that compared to younger adults, older adults performed poorer on cognitive ToM, but showed intact affective ToM abilities. Yet, some authors have argued that the Faux Pas imposes demands on both cognitive and affective ToM (Henry et al., 2013). This test was designed before researchers explicitly regarded ToM as a multidimensional process and so there is no clear distinction between cognitive and affective ToM. Moreover, we would argue that the Faux Pas is a measure of affective ToM, as well as social norm understanding, since it primarily requires the participant to understand that a protagonist's feelings have been hurt by a social norm violation.

One important aspect of social cognition which has not typically been assessed in the aging literature is the ability to understand social norms from interpersonal and intrapersonal perspectives. While intrapersonal understanding of social norms has been explored in studies of dementia (Carr et al., 2015), adults with Autism Spectrum Disorders (ASD) (Baez et al., 2012) and patients with schizophrenia and bipolar disorder (Baez et al., 2013), few studies have examined this ability in healthy aging. In one of the only studies exploring interpersonal understanding of social norms in healthy aging, Halberstadt, Ruffman, Murray, Taumoepeau and Ryan (2011) found that older adults were poorer at discriminating between socially appropriate and inappropriate behaviours from short videos of social interactions compared to younger adults.

Performance on social cognition tests have been shown to be influenced by variables such as personality traits and measures of intelligence (e.g., verbal comprehension and perceptual reasoning). Charlton et al. (2009) have argued that age-related difficulties in ToM are not independent of measures of intelligence. They found that the association between age and ToM abilities as measured by

Happé's Strange Stories test was fully mediated by perceptual reasoning and partially mediated by verbal comprehension. Further studies have found correlations between ToM and verbal abilities (Maylor et al., 2002) and have shown that perceptual reasoning performance accounts for age-related differences, again on Happé's Strange Stories test (Sullivan & Ruffman, 2004). These findings suggest that some tests may not be simply assessing our social cognitive abilities and this has important implications for interpretations of age-related differences in performance.

A hallmark characteristic of ASD is pronounced impairments in social cognition (American Psychiatric Association, 2013). Moreover, research has shown that difficulties in social cognition are responsible for social functioning impairment in ASD (Klin, Jones, Schultz, Volkmar, & Cohen, 2002), suggesting that social cognitive abilities are important contributions to the quality of an individual's social interactions. This finding is relevant for the present study since characteristics typically found in adults with ASD are continuously distributed within the general population (Sasson et al., 2013; Wainer, Block, Donnellan, & Ingersoll, 2013; Wainer et al., 2011). Indeed, subclinical autistic-like traits referred to as the Broad Autism Phenotype (BAP) (Piven et al., 1997) within the general population are related to reductions in social cognitive ability (Sasson et al., 2013). Individuals who exhibit more BAP traits report experiencing more social and interpersonal problems (Losh & Piven, 2007; Wainer et al., 2011). Additionally, recent evidence suggests that BAP traits in older adults are associated with lower levels of social support, and increased self-reported levels of depression and anxiety (Wallace, Budgett, & Charlton, 2016). Given the findings discussed above, it would be of interest to examine the relationship between the ESCoT, measures of intelligence and the BAP, and compare these to the findings of established tests.

To our knowledge, no tests are currently available in the literature that allow clinicians and researchers to examine different aspects of social cognition such as cognitive and affective ToM and understanding of social norms within the same test. Yet, some authors have argued that reliable assessments of a given construct should have multiple measures and these should differ in modality (Devine & Hughes, 2013). This could possibly be the reason for contradictory findings in the aging literature (Henry et al., 2013). Moreover, while tests like the Movie for the Assessment of Social Cognition (MASC) (Dziobek et al., 2006), the Awareness of Social Inference Test (TASIT) (McDonald et al., 2003), the Awkward Moments Test (Heavey et al., 2000) and the Empathic Accuracy Paradigm (Roeyers et al., 2001) already exist and are all useful indices of social cognitive functioning, they are not without their limitations. For instance, the TASIT (McDonald et al., 2003) uses excerpts from short interactions so lacks important contextual information, the MASC (Dziobek et al., 2006) is dubbed in English, the Awkward Moments Test (Heavey et al., 2000) uses television adverts of exaggerated interactions and the Empathic Accuracy Paradigm (Roeyers et al., 2001) uses scenes from hidden filming which limits the range of mental states to be inferred.

We attempted to address these issues using a novel test of social cognition called the Edinburgh Social Cognition Test (ESCoT). We devised the ESCoT to explicitly measure both cognitive and affective ToM in the same test. The ESCoT also provides a much-needed measure of interpersonal and intrapersonal social norm understanding. Few tests measure more than one social cognitive ability in a single test, but the ESCoT provides four distinct and potentially informative insights into social cognitive abilities.

The aims of this study were to investigate the relationship between the ESCoT and a) age, b) measures of intelligence and c) the BAP in comparison to established tests. Additionally, we sought to examine convergent validity between the ESCoT and other measures of social cognition. By closely examining different social cognitive abilities in a systemic manner using the ESCoT, this study sought to shed new light on the consequences of aging on social cognitive abilities in younger, middle-aged and older adults.

3.2. Methods

3.2.1. Participants

A total of 91 healthy participants were recruited for this study: 30 aged between 18 and 35 years (15 male, 15 female), 30 aged between 45 and 60 years (15 male, 15 female) and 31 aged between 65 and 85 years (14 male, 17 female). The participants' demographic information is reported in Table 2. None of the participants had any self-reported history of neurological or psychiatric disorders based on the Wechsler Adult Intelligence Scale (WAIS-III) exclusion criteria (Wechsler, 1997). Participants were recruited from online advertisement, through a Psychology Department volunteer panel, and were reimbursed for their time. The study was approved by the School of Philosophy, Psychology and Language Sciences (Psychology) Ethics committee at the University of Edinburgh.

3.2.2. Measures

3.2.2.1. Assessment of Intelligence

The Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II) (Wechsler, 2011b) was administered as a measure of verbal comprehension and perceptual reasoning. Participants completed four subtests: Vocabulary; Similarities; Block Design; and Matrix Reasoning. Scores from each of the four subtests were converted to age-adjusted standardised scores. The Vocabulary and

Similarities subsets provided a Verbal Comprehension Index (VCI) and Block Design and Matrix Reasoning provide a Perceptual Reasoning Index (PRI) (McCrimmon & Smith, 2013; Wechsler, 2011b).

3.2.2.2. Measures of the Broader Autism Phenotype (BAP)

The Autism Quotient (AQ) (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001) was administered to assess traits related to the autism spectrum.

The Empathy Quotient (EQ) (Baron-Cohen & Wheelwright, 2004) was administered to measure the ability to identify and understand the thoughts and feelings of others and to respond to these with appropriate emotions.

The Systemizing Quotient (SQ) (Baron-Cohen, Richler, Bisarya, Gurunathan, & Wheelwright, 2003) assessed the drive to analyse or construct systems such as mechanical systems. All questionnaires were self-report and participants completed them electronically.

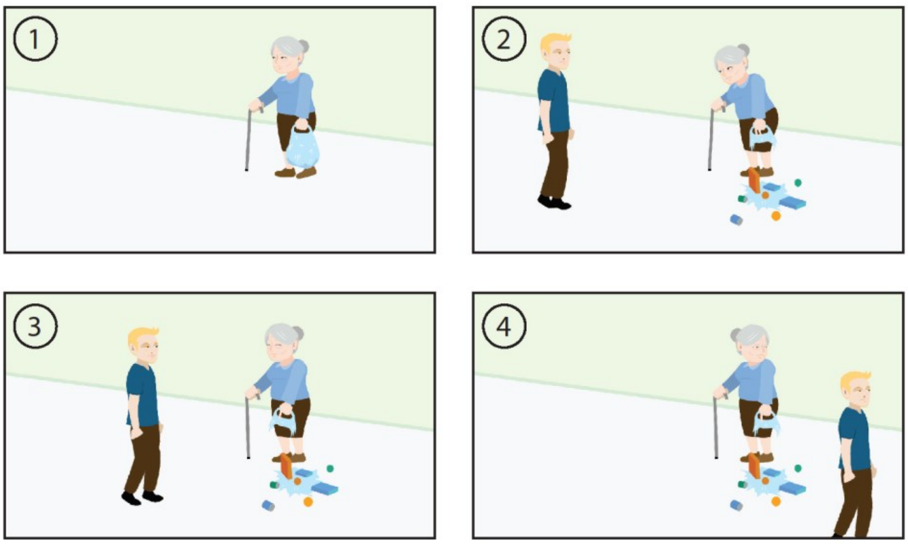
For the AQ (maximum score = 50), the higher the score, the more autistic-like characteristics the individual possessed. For the EQ (maximum score = 80), higher scores suggested higher levels of empathy. For the SQ (maximum score = 150), higher scores suggested stronger interest systems, for example the drive to construct systems or to understand the underlying rules that govern a system.

3.2.2.3. Measures of Social Cognition

The Edinburgh Social Cognition Test (ESCoT). The Edinburgh Social Cognition Test (ESCoT) measured four social cognitive abilities: cognitive ToM; affective ToM; interpersonal understanding of social norms and intrapersonal understanding of social norms.

The ESCoT consisted of 11 dynamic, cartoon-style social interactions (each approximately 30 seconds long): 1 practice interaction, 5 interactions involved a social norm violation and 5 portrayed everyday interactions that did not involve social norm violations. Each animation had a different context and specific questions relating to that context. The animation was presented in the middle of a computer screen and at the end of each animation, a static storyboard depicting a summarised version of the interaction was presented (see Figure 16). The storyboard remained on the screen for the duration of the trial.

Figure 16. Example interaction from the ESCoT



General comprehension question: Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?

Cognitive ToM: What is the elderly lady thinking?

Affective ToM: How does the elderly lady feel at the end of the animation?

Interpersonal Understanding of Social Norms: Did the man in the animation behave as other people should behave?

Intrapersonal Understanding of Social Norms: Would you have acted the same as the man in the animation?

Participants were asked to describe what had occurred in the interaction. Then participants were asked one question to assess each of the four subtests of social cognition (see Figure 16). To allow participants to give their optimal interpretation of each interaction and capture the quality of their response, they were prompted if they gave a limited response or their response lacked important information from the interaction. They were prompted with the question, 'Can you tell me more about what you mean by that?' or 'Can you explain that in a little bit more detail?'. Each participant was prompted only once for each question.

Each response was scored based on the quality of the answer with maximum points awarded for responses that successfully extracted and integrated the relevant information from the interaction and articulated this response in a contextually specific manner. Importantly, response length was not related to quality; participants could score maximum points with a minimal response. For scoring of the intrapersonal understanding of social norms subtest, responses that considered the social nuances of the interaction were scored more highly than responses that highlighted personal attributes of the participant. Each question was awarded a maximum of 3 points, resulting in a score of 12 points for each social interaction. The total maximum score for the test was 120 points.

Reading the Mind in the Eyes (RME) (Baron-Cohen, Wheelwright, Hill, et al., 2001). The RME was administered to assess affective ToM. Participants were presented with photographs of the ocular region of different human faces and were required to make a force-choice response from four adjectives (one target and three foils) which best described what the individual was thinking or feeling. Prior to performing the test, participants were provided with a glossary of the adjectives to clarify what each word meant, if they are unsure or unfamiliar with the word. Reponses were recorded verbally and 1 point was awarded for each correct answer, giving a total score of 36.

Reading the Mind in Films (RMF) (Golan et al., 2006). The RMF was administered to assess affective ToM. Participants viewed short scenes from feature films and were instructed to make a forced-choice response from four adjectives (one target and three foils) that best described what the protagonist was thinking or feeling at the end of the scene. Similar to the RME, participants were provided with a glossary of the adjectives for clarification and responded verbally. A correct response was awarded 1 point, giving a total score of 22.

Judgement of Preference (JoP) (Girardi, MacPherson, & Abrahams, 2011). The JoP assessed a participant's ability to make affective ToM judgements of a character while inhibiting their own preferences. This version consisted of a pre-experimental condition and two experimental conditions, each comprising of twelve trials each. In the pre-experimental condition, participants were instructed to choose the item that they liked the most out of 4 items. Following this, participants were presented with a small circular face in the middle of a computer screen with 4 objects in the four corners. In the affective condition, participants were told to choose the item the face in the middle of the screen liked. In the physical condition, participants were asked to identify the item that the face was looking at. Participants touched the item in the correct position on the screen of a touch-screen computer. Each participant was instructed to respond as quickly but as accurately as possible. The affective and physical conditions were counterbalanced. A correct response was given 1 point with a maximum score of 12 per condition.

Social Norms Questionnaire (SNQ) (Rankin, 2008). The SNQ examined intrapersonal understanding of social norms. It was originally developed to screen patients for potential behaviour changes and is administered to examine how well participants understand the social standards that govern their behaviour in mainstream culture. Participants were given a list of behaviours (e.g., tell a stranger you don't like their hairstyle?) and asked to indicate whether or not each of the behaviours was socially acceptable to perform in the presence of a stranger or acquaintance, not a close friend or family member. A total score (maximum score = 22) was calculated, with higher scores reflecting better performance.

3.2.3. Procedure

Participants completed all six tasks in a single session, which took approximately two hours to complete. The order of the tasks was kept the same for each participant.

3.2.4. Statistical Analyses

The effects of age, intelligence (verbal comprehension and perceptual reasoning) and the BAP (AQ, EQ and SQ) on the ESCoT and established tests of social cognition were investigated using hierarchical multiple regression analysis. In the first stage, the background predictors (age, gender, years of education, measures of IQ) which showed a correlation with the outcome variables (subtests of the ESCoT, ESCoT total scores and established social cognition tests) at a pre-specified significance level of $p < 0.20$ was entered into the analysis (Altman, 1991) using the enter method. While some researchers have suggested that all relevant variables should be included in the regression model regardless of their significance, this approach can result in numerically unstable estimates and large standard errors (Bursac, Gauss, Williams, & Hosmer, 2008). We chose a significance level of $p < 0.20$ over more traditional levels such as $p < 0.05$ because $p < 0.05$ can fail in identifying variables known to be important, and simulation studies have shown that a cut-off of $p < 0.20$ yields better outcomes than a cut-off of $p < 0.05$ (Bursac et al., 2008; Lee, 2014). The scores of VCI and PRI were entered into the first stage independently along with the other background predictor variables in separate regression models. In the second stage, AQ, EQ and SQ scores were entered using the stepwise method (entry criterion $p < 0.05$, removal criterion $p > 0.10$) to examine their effect on performance. Furthermore, adjusted scores based on the regression analyses were calculated. These age adjustments were calculated using the unstandardized β coefficients from the regression analysis and the mean age of the sample, the calculations for these can be found in the supplementary materials (Appendix 1.5). To investigate the relationship between the ESCoT and standard tests of social cognition, correlational analyses were conducted to validate the ESCoT against established tests.

3.3. Results

Table 3 demonstrates the preliminary correlational analyses between cognitive ToM, affective ToM, inter- and intrapersonal understanding of social norms with VCI scores, PRI scores, age, years of education and gender. Variables with correlations that were significant at the $p < 0.20$ level were included in the regression analysis. Tables 4 shows a summary of the regression analyses for the subtests of the ESCoT.

3.3.1. Table 2. Summary of demographic information

	Age group				
	Younger adults (*n* = 30)	Middle-aged adults (*n* = 30)	Older adults (*n* = 31)	Sig*	ηp² (*d*)
Age (*SD*)	26.20 (5.21)	50.60 (5.77)	72.45 (6.05)	-	-
Males:Females	15:15	15:15	14:17	0.409	-
Years of full-time education	17.03 (2.82)	15.53 (2.86)	14.58 (2.88)	O < Y	0.12 (0.74)

Y = Younger adults; M = Middle-aged adults, O = Older adults. *Analyses were conducted using one-way ANOVAs, post hoc testing were conducted using Gabriel's procedure for multiple comparisons. All $p<.05$.

3.3.2. Table 3. Correlational analysis between the background predictors and measures of the ESCoT

Outcome variable	Age	Years of education	Gender	VCI	PRI
Cognitive ToM	–0.32*	0.18*	0.01	0.12	0.04
Affective ToM	–0.17*	0.09	0.23*	0.15*	0.18*
Interpersonal understanding of social norms	–0.38*	0.12	0.06	–0.08	–0.09
Intrapersonal understanding of social norms	–0.16*	–0.09	–0.13	–0.09	–0.11

*$p < 0.20$. Predictor variables which correlated with the outcome variable at the $p < 0.20$ level met criteria for inclusion in the regression model. Predictor variables with correlations $p > 0.20$ did not meet criteria for inclusion in the regression model. Results of the regression analyses that included the correlated variables can be seen in Table 3. VCI = Verbal Comprehension Index; PRI = Perceptual Reasoning Index.

3.3.3. Table 4. Regression analyses for the subtests of the ESCoT with VCI and PRI scores

	Model 1 summary	Significant predictors in Model 1	Excluded predictors in Model 2	F–change & ΔR^2	Significant predictors in Model 2
Cognitive ToM	$R = 0.33$, $R^2 = 0.11$, $F(2, 87) = 5.28$, $p = 0.007$	Age ($p = 0.006$)	AQ, EQ & SQ	–	–
Interpersonal Understanding of Social Norms	$R = 0.38$, $R^2 = 0.14$, $F(1, 88) = 14.43$, $p = 0.000267$	Age ($p = 0.000267$)	EQ & SQ	F–change = 10.55, $p = 0.002$, $\Delta R^2 = 0.09$	Age ($p = 0.000069$) & AQ ($p = 0.002$)
Intrapersonal Understanding of Social Norms	$R = 0.16$, $R^2 = 0.03$, $F(1, 88) = 2.28$, $p = 0.134$	–	EQ & SQ	F–change = 7.27, $p = 0.008$, $\Delta R^2 = 0.08$	AQ ($p = 0.008$)
VCI Affective ToM	$R = 0.35$, $R^2 = 0.13$, $F(3, 80) = 3.80$, $p = 0.013$	Age ($p = 0.014$) & Gender ($p = 0.048$)	AQ, EQ & SQ	–	–

PRI Affective ToM	R = 0.35, R^2 = 0.12, F(3, 80) = 3.61, p = 0.017	Age (p = 0.026) & Gender (p = 0.037)	AQ, EQ & SQ	–	–

ESCoT total scores and IQ scores. The ESCoT total scores correlated with age ($r = -0.42$, $p < 0.001$). Years of education ($r = 0.13$, $p = 0.229$), gender (males = 1, females = 2, $r = 0.09$, $p = 0.397$), VCI scores ($r = 0.11$, $p = 0.300$) and PRI scores ($r = 0.09$, $p = 0.391$) did not correlate with ESCoT total scores at $p < 0.20$. Therefore, these variables did not meet criteria for inclusion in the model.

In the first regression model ($R = 0.42$, $R^2 = 0.18$, $F(1, 88) = 19.28$, $p < 0.001$), age was a significant predictor of ESCoT performance ($p < 0.001$). The inclusion of AQ, EQ and SQ scores produced a significant F-change (F-change = 5.44, $p = 0.022$, $\Delta R^2 = 0.05$). In the final model, only age ($p < 0.001$) and AQ scores ($p = 0.022$) were significant predictors of ESCoT performance, with older age and higher AQ scores predicting poorer performance on the ESCoT. EQ and SQ scores were excluded as predictors from the final regression model.

RME and IQ scores. For the RME scores, VCI scores ($r = 0.28$, $p = 0.009$) met criteria for inclusion in the first stage of the analysis. Age ($r = -0.10$, $p = 0.331$), years of education ($r = -0.07$, $p = 0.531$), gender ($r = -0.06$, $p = 0.554$) and PRI scores ($r = 0.14$, $p = 0.202$) were not included.

In this regression model, ($R = 0.24$, $R^2 = 0.06$, $F(1, 82) = 5.16$, $p = 0.026$), VCI scores ($p = 0.026$) predicted performance on the RME. Higher VCI scores predicted better RME performance. AQ, EQ and SQ scores were not retained in the final model.

RMF and IQ scores. Gender ($r = 0.22$, $p = 0.033$), VCI scores ($r = 0.38$, $p = 0.000363$) and PRI scores ($r = 0.27$, $p = 0.014$) met the criteria for inclusion in the regression models. Age ($r = 0.02$, $p = 0.858$) and years of education ($r = -0.03$, $p = 0.802$) did not correlate with RMF scores at $p < 0.20$.

In this regression model ($R = 0.43$, $R^2 = 0.19$, $F(2, 80) = 9.28$, $p < 0.001$), VCI scores ($p < 0.001$) and gender ($p = 0.041$) were significant predictors of RMF performance. Female participants and those with higher VCI scores performed better on the RMF. No variables were entered into the model in the second stage as they did not meet criteria for inclusion.

In a regression model with PRI scores ($R = 0.35$, $R^2 = 0.12$, $F(2, 80) = 5.60$, $p = 0.005$), both gender ($p = 0.030$) and PRI scores ($p = 0.013$) were predictors of RMF scores. Female participants and participants with higher PRI scores were associated with better performance on the RMF. AQ, EQ and SQ scores were not retained in the final model.

SNQ and IQ scores. Age ($r = 0.14$, $p = 0.18$) and VCI scores ($r = 0.23$, $p = 0.04$) met criteria for inclusion. Gender ($r = 0.07$, $p = 0.523$), years of education ($r = -0.12$, $p = 0.261$) and PRI scores ($r = 0.06$, $p = 0.602$) did not meet criteria for inclusion in the regressions. However, all regression analyses were not significant (all $p > 0.10$).

JoP and IQ scores. Age ($r = 0.05$, $p = 0.638$), years of education ($r = -0.05$, $p = 0.628$) gender ($r = -0.13$, $p = 0.234$), VCI scores ($r = -0.06$, $p = 0.613$) and PRI scores ($r = -0.09$, $p = 0.421$) did not meet criteria for inclusion in the regression models. Moreover, all regression analyses for the JoP were not significant (all $p > 0.10$).

3.3.4. Age adjusted scores

Cognitive ToM. The regression analysis demonstrated a negative association with age; as age increased, performance on cognitive ToM decreased. Rather than producing separate normative data for each age group, we suggest that raw cognitive ToM scores should be adjusted for age accordingly: 18–22 years old= –1 point, 23–77 years old= no change in raw score and 78 years and older= +1 point.

Affective ToM. The regression analysis revealed that age negatively predicted performance on affective ToM. As participants' ages increased, performance on affective ToM decreased. Therefore, raw affective ToM scores should be adjusted for age: 18–26 years old= –1 point, 27–73 years old= no change in raw score and 74 years and older= +1 point.

Gender predicted performance on affective ToM with being female predicting better performance better than being male. However, the difference between the male and female groups was only 0.36 standard deviations (less than 1 point on the ESCoT). Therefore, it is not necessary to adjust the raw affective ToM scores for gender.

Interpersonal Understanding of Social Norms. Since the regression analysis revealed that age predicted performance on interpersonal understanding of social norms, raw scores should be adjusted as follows: 18–19 years old= –2 points, 20–34 years old= –1 point, 35–65 years old=no change, 66–80 years old= +1 point and 81 years and older= +2 points.

3.3.5. Correlations between the ESCoT and established tests

Correlational analyses with the Holm correction for multiple comparisons showed that the ESCoT significantly correlated with the RME ($r = 0.33$, $p = 0.002$) and showed a trend towards significance with the SNQ ($r = 0.19$, $p = 0.074$). The RME correlated with the RMF ($r = 0.38$, $p < 0.001$) and SNQ ($r = 0.34$, $p = 0.002$). The RMF also showed a trend towards significance with the SNQ ($r = 0.19$, $p = 0.077$). None of the tests significantly correlated with the JoP (all $p > 0.10$).

3.3.6. ESCoT inter-rater reliability and internal consistency

To establish the reliability of the scoring, we calculated inter-rater reliability for the ESCoT using intraclass correlation (ICCs). A second independent rater scored a sample of 5 participants from each age group. The consistency (ICCs) for the 15 ratings was 0.90, indicating high inter-rater reliability.

We assessed internal consistency for the ESCoT by calculating Guttman's Lambda 4 reliability coefficient. This method has been shown to be a better measure of internal consistency than Cronbach's alpha (Sijtsma, 2009). Guttman's Lambda 4 reliability coefficient for the ESCoT was 0.70 which is acceptable (Nunnally, 1978).

3.4. Discussion

The current study presented a new within subjects' measure of social cognition that assesses cognitive and affective ToM, as well as intra- and interpersonal social norm understanding, within the same test. We examined the effects of age, measures of intelligence and the BAP on the ESCoT and established tests of social cognition. Additionally, we investigated the relationship between the ESCoT and established measures of social cognition. Total ESCoT scores were predicted by the age of participants and their AQ scores, here increasing age and AQ scores resulted in poorer performance. Investigation of the subcomponents of the ESCoT revealed that performance on cognitive ToM was significantly predicted by age, with increasing age resulting in decreased performance on cognitive ToM. Affective ToM was also predicted by age but also gender; in this instance, better performance was associated with being younger and female. Moreover, performance on interpersonal understanding of social norms was predicted by age and AQ scores – increasing age and AQ scores were predictive of poorer performance. On the subtest of intrapersonal understanding of social norms, higher AQ scores predicted poorer performance.

Notably, the ESCoT total score and sub-test measures were not associated with the two measures of intelligence; verbal comprehension (VCI) and perceptual reasoning (PRI). This contrasts with performance on some of the more standard tests of social cognition. In the present study, we found that participants with higher verbal comprehension scores performed better on the RME, while RMF performance was significantly predicted by measures of verbal comprehension, perceptual reasoning and gender. Here, female participants and those with higher verbal comprehension and perceptual reasoning scores performed better on this measure of affective ToM. The correlation analysis demonstrated that ESCoT total scores significantly correlated with the RME and showed a trend towards significance with the SNQ, indicating convergent validity.

Similar to previous findings in the literature which have demonstrated aged-related difference in cognitive ToM (Bailey & Henry, 2008; Bottiroli et al., 2016; Castelli et al., 2010; Duval et al., 2011; Fischer et al., 2016; German & Hehman, 2006; Moran et al., 2012; Saltzman et al., 2000), age predicted poorer performance in cognitive ToM on the ESCoT. This provides further evidence that, as we get older, we experience difficulties in our ability to infer what another individual is thinking. Moreover, we found that increasing age predicted poorer performance in participants' ability to infer what another is feeling, comparable to some (Bailey et al., 2008; Fischer et al., 2016; Slessor et al., 2007; Sullivan & Ruffman, 2004), but in contrast to other studies (Bottiroli et al., 2016; MacPherson et al., 2002; Wang & Su, 2006). It could be argued that the findings here are more representative of the population, as we included adults aged 18 – 85 years while Bottiroli et al. (2016) only included younger and older adults. Or, as Henry et al.

(2013) have argued, age-related differences can be the consequence of the type of task used. For example, Phillips et al. (2002) examined how well older adults were able to assess the severity of contextual emotions of individuals in short stories. They found younger and older adults did not significantly differ in this ability. However, forced choice tests offer limited insights in understanding the relationship between age and social cognition. Primarily because there are few real-world social interactions where inferring what another person is feeling is forced-choice in nature. Overall, these results suggest that the process of healthy aging is associated with difficulties in both components of ToM.

To our knowledge, this is the first study to assess the ability to understand social rules in the same task as ToM and explicitly examine interpersonal (did X behave as other people should behave?) and intrapersonal (would you have acted the same as X?) understanding of social norms. Age was found to predict poorer performance on interpersonal understanding of social norms. These findings add to the preliminary findings of Halberstadt et al. (2011) who showed poorer performance of older adults compared to younger adults on interpersonal understanding of social norms. We provide a novel finding in regards to intrapersonal understanding of social norms; we showed that the age of participants was not a predictive variable of performance. This suggests that age does not impact our own knowledge of how we should behave in social situations, and not all our social cognitive abilities are negatively affected by age. Both of these findings demonstrate that understanding of social norms warrants further investigation.

Although both cognitive and affective ToM were affected negatively by age, we do provide some evidence for a dissociation between the two processes in that performance is predicted by different demographic variables. This is analogous to the findings that cognitive and affective ToM correlate with different cognitive processes (Bottiroli et al., 2016). Cognitive ToM performance was negatively predicted by age while affective ToM was significantly predicted by age and gender. Like Duval et al. (2011), we found that both cognitive and affective ToM show impairments with advancing age in the same study. The advantage in this study was that we were able to measure cognitive and affective ToM within the same test, unlike Duval et al. (2011) who relied on different tests to measure these abilities and was therefore unable to control for task difficulty. Gender was only found to predict performance on affective ToM; this is similar to research found in the literature which has shown that women are significantly better at inferring what a character is feeling compared to men (Ahmed & Miller, 2011; Baron-Cohen et al., 2015; Baron-Cohen, Wheelwright, Hill, et al., 2001). These results show that, as well as considering the consequences of aging on our social cognitive abilities, we should consider the gender of the sample population. Furthermore, they highlight the importance of adopting social cognitive tests that assess cognitive and affective ToM separately and suggest composite tests are not appropriate to accurately examine ToM in aging populations. Using within subjects tests are essential if we are to better understand whether aging does indeed affect cognitive and affective ToM in the same way.

The only test of social cognition that was associated with the measures of the BAP was the ESCoT, suggesting that perhaps the ESCoT is more sensitive to difficulties in social abilities of individuals on the BAP compared to established tests. Here, lower scores in inter- and intrapersonal understanding of social norms were associated with higher scores on the AQ. Additionally, we found that the presence of more autistic traits predicted poorer overall performance on the ESCoT. These are novel findings but makes sense in the context of the BAP, as impaired social cognition is related to the milder social-behavioural phenotype described as part of the BAP

(Losh & Piven, 2007; Sasson et al., 2013; Wainer et al., 2011). Research on the understanding of social norms in healthy aging is limited but these findings are in line with research that show that adults with ASD perform poorer than controls on tests such as the Faux Pas which implicitly assess social norms understanding (Zalla et al., 2009). However, the relationship between ASD and intrapersonal understanding of social norms is less clear and requires further investigation For example, Baez et al. (2012) found that adults with ASD do not significantly differ on this ability compared to controls. Nonetheless, the observed relationship between the ESCoT and the AQ demonstrates that this new test of social cognition may offer new insights into the relationship between the BAP and social cognition in healthy aging populations and may be valuable in ASD research.

An advantage of the ESCoT over other tests of social cognition, is that overall performance was not related to measures of IQ, namely verbal comprehension and perceptual reasoning performance. However, this is not the typical finding with social cognition measures. Charlton et al. (2009) found that performance on Happé's Strange Stories test (a composite ToM task) was fully mediated by performance IQ, executive function, and information processing speed and was partially mediated by verbal IQ. Moreover, again on Happé's Strange Stories test, Sullivan and Ruffman (2004) both found that ToM abilities were related to perceptual reasoning abilities. In both the current study and previous studies in the literature (Ahmed & Miller, 2011; Golan et al., 2006; Peterson & Miller, 2012), performance on the RME and RMF was found to be predicted by verbal comprehension. In one study, the only significant predictor of performance on the RME test was verbal comprehension which accounted for 11.7% of the variance (Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004). This has implications for studies using the RME and RMF to investigate affective ToM as they appear to be tests of verbal comprehension as well as affective ToM.

A limitation of the present study is that we did not examine the relationship between executive functions and the ESCoT. Given that social cognition has been associated with executive abilities in aging (Ahmed & Miller, 2011; Bottiroli et al., 2016; Duval et al., 2011; Rakoczy et al., 2012), future work might explore potential associations between the ESCoT and processes such as inhibition, set-shifting and updating. Finally, it has been suggested that the clinical assessment of social cognition should emulate the way in which individuals process social situations in everyday life (Henry et al., 2015). As argued by Henry et al. (2013) dynamic-visual information such as images depicting a social interaction that lead to a protagonist in a particular mental state is more ecologically valid and information-rich compared to verbal narratives. Consequently, dynamic cartoons were chosen as the mode of presentation in the ESCoT. This allowed perceivers to use many more cues to make inferences (Moran, 2013), similar to real-life. Videos of real individuals interacting would be the ideal stimuli for assessing social cognitive abilities to maximise ecological validity. However, social interactions are highly complex (Van Overwalle, 2009) and social information can be difficult to control in real interactions. Therefore, it may be difficult to separate the specific social cognitive process that the test is intending to measure. With animated characters, specific social cognitive abilities can be more easily isolated and individual social differences can be controlled; essentially all of the parameters can be regulated. For these reasons, we chose to use animated interactions for the ESCoT.

This study is the first to assess cognitive ToM and affective ToM, as well as interpersonal and intrapersonal understanding of social norms within the same test in younger, middle-aged and older adults. We have provided further evidence for similar but distinct components of ToM and evidence for social norm understanding. These findings are useful in furthering our understanding of the consequences of aging on our social cognitive abilities. They also demonstrate specific advantages of the ESCoT over other tests of social cognition. The ESCoT is able to assess distinct aspects of social cognition within a single task and using a within subjects design, allowing for systematic comparisons of these abilities. In conclusion, these findings show that the ESCoT is a useful measure of social cognition and, unlike established and standard tests of social cognition, performance is not predicted by measures of verbal comprehension and perceptual reasoning. This is particularly valuable in order to get an accurate assessment of the influence of age on our social cognitive abilities.

Chapter 4: Validation of the ESCoT in Autism Spectrum Disorders (ASD)

In Chapter 3 the ESCoT proved to be sensitive to the effects of ageing on social cognitive abilities and showed associations with the BAP. To validate it as a test of social cognition I utilised it in a sample of adults with Autism Spectrum Disorders and again compared it to traditional tests. To further understand the psychometric properties of the ESCoT, the associations with personality traits, intelligence and age were further examined, but in a population of adults with Autism Spectrum Disorders. Moreover, given the associations with age on performance of the ESCoT, this chapter also considered the age-adjustments. To aid in the development of the ESCoT as a clinical test, in this chapter I also created normative data for the ESCoT which could be used to identify abnormal performance.

Data from the ASD adults were collected by myself. Normative data were collected by myself and undergraduate students Maya Bertlich, Rebecca Cameron, Sharon Jany and Terin Dorrian.

[2]This chapter has been submitted in its complete form as a journal paper to Autism Research:

Baksh, R.A., Abrahams, S., Bertlich, M., Cameron, R., Jany, S., Dorrian, T., Baron-Cohen, S., Allison, C., Smith, P., MacPherson S.E., & Auyeung, B. (under review). Social cognition in adults with Autism Spectrum Disorders: Validation of the Edinburgh Social Cognition Test (ESCoT). *Autism Research.*

[2] The section numbering has been changed to fit in with the thesis structure although the format is consistent with the journal

4.1. Introduction

In everyday social interactions, we use abilities such as theory of mind (ToM; i.e., the ability to recognize other people's mental states to understand and predict their behaviour) and the understanding of social norms (Baez et al., 2013; Baez et al., 2012) to interact and respond appropriately to others. These processes are a part of our social cognitive abilities (Adolphs, 2009; Baez et al., 2016; Baez et al., 2012; Henry et al., 2015; Van Overwalle, 2009).

Tests that assess social cognition are important in clinical settings because standard neuropsychological tests do not assess social abilities (Dodich et al., 2015; McDonald, 2012). Social cognition tests are more sensitive than traditional neuropsychological tests of cognition at differentiating neurodegenerative diseases (Bora et al., 2015; Elamin, Pender, Hardiman, & Abrahams, 2012; Gregory et al., 2002). Adenzato and Poletti (2013) and Pardini et al. (2012) highlight the importance of including social cognition tests in clinical assessments since deficits in this domain can occur without other cognitive impairments.

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterized by difficulties in social functioning and communication, alongside repetitive behaviours and/or unusually narrow interests (American Psychiatric Association, 2013). ASD adults experience social isolation (Orsmond et al., 2004; Orsmond et al., 2013), superficial and less supportive friendships (Baron-Cohen & Wheelwright, 2003; Orsmond et al., 2013) and have difficulties maintaining meaningful relationships (Palmen et al., 2012). These social difficulties occur despite ASD adults having a desire for intimacy and social connectedness (Müller et al., 2008). Underlying these difficulties are impairments in social cognition (Baez & Ibanez, 2014; Baez et al., 2012; Dziobek et al., 2006; Murray et al., 2017; Scheeren et al., 2013).

As a defining characteristic of ASD adults is some level of impairment in social interactions (Brewer, Young, & Barnett, 2017), ToM is an important social cognitive ability in explaining some of the social functioning impairments seen in ASD (Baron-Cohen, 1991; Happé, 1994). ToM difficulties cause significant social deficits which can profoundly limit functional capacity to engage in meaningful interpersonal relationships and quality of life (Henry et al., 2015). Researchers have postulated that specific ToM impairments in ASD adults may be the consequence of deficits in the ability to interpret the verbal and non-verbal social communications of other individuals or in communicating with others in accordance with normative expectations (APA 2013). These impairments in ToM can manifest themselves as difficulties in the ability to take the perspective of another individual in ASD adults (Baron-Cohen, Wheelwright, Hill, et al., 2001).

ToM is a multi-dimensional concept, with processes differing based on whether they refer to cognitive or affective judgments (Shamay-Tsoory et al., 2010). Cognitive ToM is defined as the ability to make inferences about the intentions and beliefs of another individual. Affective ToM refers to the ability to make inferences about what another individual is feeling (Kalbe et al., 2010; Sebastian et al., 2011; Shamay-Tsoory et al., 2010). Considerable research has shown that ASD adults experience difficulties in both aspects of ToM (Baron-Cohen, Wheelwright, Hill, et al., 2001; Mathersul et al., 2013; Murray et al., 2017).

Early studies examining social cognition in adults used false-belief tests designed for children and found that ASD adults performed as well as neurotypical controls (NC) (Happé, 1994; Jolliffe & Baron-Cohen, 1999; White et al., 2009) but still showed marked problems in social interactions in everyday life (Dziobek et al., 2006; Palmen et al., 2012). To overcome this limitation in sensitivity, researchers developed more advanced tests and demonstrated difficulties in adults with ASD in

Reading the Mind in the Eyes (RME) (Baron-Cohen, Wheelwright, Hill, et al., 2001), the Awkward Moments Test (Heavey et al., 2000), the Movie for the Assessment of Social Cognition (MASC) (Dziobek et al., 2006), Reading the Mind in Films Test (RMF) (Golan et al., 2006) and The Awareness of Social Inference Test (TASIT) (Mathersul et al., 2013). People with ASD also perform poorly on story-based tests such as the Strange Stories test (Happé, 1994) and the Faux Pas (Spek et al., 2010; Zalla et al., 2009).

When examining social cognition in ASD, some authors suggest utilizing context-sensitive tests involving real-world scenarios (Baez & Ibanez, 2014). This notion is supported by evidence that ASD adults can pass forced-choice social cognition tests (Baez et al., 2012; Izuma et al., 2011; Klin, 2000; Schilbach et al., 2012), but have difficulties on tests which require spontaneous attributions of mental states (Senju et al., 2009).

Traditional ToM tests using written stories do not capture contextually specific ToM abilities used in everyday social interactions (Frith, 2004; Klin, 2000; Lugnegård et al., 2013). ASD individuals can pass the Strange Stories test but still exhibit difficulties in real-world social interactions (Scheeren et al., 2013). The abstract nature of these tests limits their ecological validity because the relationship to real-world functioning is unclear (Mathersul et al., 2013). In an attempt to address this limitation, McDonald et al. (2003) developed the Awareness of Social Inference Test (TASIT), which uses short-clips of social interactions. The TASIT is sensitive to clinical populations such as Traumatic Brain Injury patients and predictive of real-world function (McDonald et al., 2004). However, it is a lengthy test with an administration time of 60-75 minutes (Mathersul et al., 2013; McDonald et al., 2003), which limits the TASIT's application in time-sensitive clinical environments. The MASC (Dziobek et al., 2006) is similar to the TASIT, however it is dubbed in English and there is limited validation of its use in English speaking populations.

Other limitations include a lack of content validity among social cognition tests in ASD (Spek et al., 2010) and mixed results in terms of impaired ASD performance compared to NC (Baron-Cohen, Wheelwright, Hill, et al., 2001; Couture et al., 2010; Roeyers et al., 2001). In addition performance appears to be related to intellectual abilities. Verbal comprehension significantly correlates with or predicts performance on the RME (Baker et al., 2014), Strange Stories test (Kaland et al. (2002), Reading the Mind in the Films (RMF; Golan et al., 2006) and the TASIT (McDonald et al., 2003). Perceptual reasoning also significantly correlates with performance on the RME (Baker et al., 2014). Such findings may limit the interpretation from these tests.

Social cognition consists of several different abilities that are simultaneously required during social interactions, although existing tests typically assess only one or two aspects. Furthermore certain social cognitive abilities have received less attention in the literature. An individual's interpersonal (how another person should behave) and intrapersonal (how they themselves should behave) understanding of the social norms that govern their behaviour are important social cognitive abilities. Violating a social norm can be detrimental to existing relationships or opportunities to form social relationships. These abilities have been examined separately in ASD adults, showing mixed findings (Baez et al., 2012; Gleichgerrcht et al., 2013; Lehnhardt et al., 2011; Thiébaut et al., 2016; Zalla et al., 2009). To our knowledge, there is currently no clinical test of inter-and intrapersonal understanding of social norms within the same test. Similarly, these abilities have never been examined alongside ToM abilities within the same test. Researchers typically investigate social norm understanding and ToM using different tests. For example, Baez et al. (2012) found that ASD adults were not impaired on affective ToM measured by the RME or intrapersonal understanding of social norms; assessed by the Social Norms Questionnaire (Rankin, 2008). This makes direct comparisons problematic, since the tests may vary in difficulty.

4.1.1. Aims of the current study

We recently developed the Edinburgh Test of Social Cognition (ESCoT; Baksh, Abrahams, Auyeung, & MacPherson, under review), which assesses cognitive and affective ToM and inter- and intra-personal understanding of social norms within the same test. We have demonstrated that poorer performance on inter- and intra-personal understanding of social norms and ESCoT total scores were both predicted by the presence of more autism-like traits. Age predicted poorer performance on inter-personal understanding of social norms and ESCoT total scores. Poorer performance on the cognitive and affective ToM ESCoT subtests was predicted by increasing age while female participants were better at inferring what another person was feeling. Finally, performance on the ESCoT was not predicted by verbal comprehension or perceptual reasoning abilities unlike established tests. Here, we sought to validate the ESCoT in a sample of ASD adults. While new tests have been published such as Strange Stories Film Task (Murray et al., 2017) and Story-based Empathy Task (Dodich et al., 2015), these tests only assess ToM. Moreover, none of them assess social cognitive abilities in a contextually-driven and within-subjects' manner.

Our first aim was to examine the convergent validity of the ESCoT against established tests of social cognition. We predicted that better performance on the ESCoT would correlate with better performance on the traditional tests of social cognition. Our second aim was to compare ASD adults and NC adults on the ESCoT and established tests of social cognition. We predicted that ASD adults would be impaired on cognitive ToM (Castelli, Frith, Happé, & Frith, 2002; Klin, 2000; Murray et al., 2017); affective ToM (Baron-Cohen, Wheelwright, Hill, et al., 2001; Dziobek et al., 2006; Golan et al., 2006) and interpersonal understanding of social norms (Thiébaut et al., 2016; Zalla et al., 2009), but not intrapersonal understanding of social norms (Baez et al., 2012; Gleichgerrcht et al., 2013) compared to NC adults. We evaluated the psychometric properties of the ESCoT and compared these to traditional social cognition tests by examining the influence of intelligence, ASD traits, empathy and systemizing traits on performance. This final aim was to derive normative data for the ESCoT from a neurotypical population.

4.2. Method

4.2.1. Edinburgh Social Cognition Test (ESCoT)

The ESCoT consists of eleven dynamic, cartoon-style social interactions (each approximately 30 seconds long): one practice interaction, five interactions involving social norm violations and five interactions without social norm violations. Participants watched the animated interaction on a computer screen and a static storyboard depicting a summarized version of the interaction was presented at the end. The storyboard remained on the screen during the subsequent questions for each interaction.

Participants were asked five questions after viewing each animation relating to: (1) general story comprehension; (2) cognitive ToM; (3) affective ToM; (4) interpersonal understanding of social norms; and (5) intrapersonal understanding of social norms. See Table 5 for details.

To allow participants to give their optimal interpretation of each interaction and capture the quality of their response, they were prompted with the question, “Can you tell me more about what you mean by that?" or "Can you explain that in a little bit more detail?" Participants were prompted if they gave a limited response or their response lacked important information from the interaction. Each participant was prompted only once for each question. The general comprehension question was not scored as omissions and misinterpretations would become evident in the subsequent questions. Participants were still asked the social cognition tests even if they misinterpreted the social interaction. Each question was awarded a maximum of 3 points, resulting in a score of 12 points for each social interaction. The total maximum score for the test was 120 points and the ESCoT took approximately 20 – 25 minutes to complete. We recently reported high inter-rater reliability (0.90) and acceptable levels of Guttman's Lambda 4 reliability (0.70) for the ESCoT in a NC population (Baksh et al., under review).

4.2.1.1. Table 5. Description of the questions from the ESCoT

ESCoT question	Social cognitive ability	Purpose
Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?	–	Examine whether participants understood what occurred in the interaction.
What is X thinking?	Cognitive ToM	Assess participants' ability to make inferences about another person's cognitive state.
How does X feel at the end of the animation?	Affective ToM	Assess the ability to make inferences about the affective states of the character in the interaction.
Did X behave as other people should behave?	Interpersonal understanding of social norms	Assess participants' understanding of the subtle societal rules that govern social behaviour and whether the character in the interaction was adhering to these rules.
Would you have acted the same as X in the animation?	Intrapersonal understanding of social norms	Assess how the participants themselves would have acted in the interaction.

The responses for cognitive ToM, affective ToM and interpersonal understanding of social norms were scored similarly. Scores were based on the quality of the answer with maximum points awarded for successfully extracting and integrating the relevant information and articulating it in a contextually specific manner. Importantly, response length was not related to quality; participants could score maximum points with a minimal response. For the intrapersonal understanding of social norms, responses that considered the social nuances of the interaction were scored more highly than responses that highlighted personal attributes of the participant.

4.2.2. Participants.

4.2.2.1 Experiment 1

We recruited 236 NC between the ages of 18 and 85 years (some were included in this study as controls) to establish normative data and derive ESCoT cut-off scores for the subtests and total scores based on the lowest 5th percentile.

This included 147 younger adults (67 males, *M* age = 23.39, *SD* = 4.11, range = 18-35, *M* education = 16.90, *SD* = 2.20), 30 middle-aged adults (15 males, *M* = 50.60, *SD* = 5.77, range = 45-60, *M* education = 15.53, *SD* = 2.86) and 59 older adults (23 males, *M* = 72.44, *SD* = 6.05, range = 65-85, *M* education = 14.58, *SD* = 2.88).

None of the NC had any self-reported history of neurological or psychiatric disorders based on the Wechsler Adult Intelligence Scale (WAIS-III) exclusion criteria (Wechsler, 1997).

4.2.2.2 Experiment 2

Nineteen adults (12 males) aged 19-66 years (*M* = 38.47, *SD* = 15.63) with a diagnosis of Asperger's Syndrome (AS) or High-Functioning Autism (HFA) according to established DSM-IV criteria (American Psychiatric Association, 2000) were recruited from charities and support groups in Edinburgh, UK and from the Cambridge Autism Research Database, UK. Participants confirmed their clinical diagnosis of ASD via official diagnosis letters. A comparison group of thirty-eight NC adults (23 males) aged 19-67 years (*M* = 37.50, *SD* = 17.75) were recruited using online advertisement and through a research volunteer panel in Edinburgh.

Informed consent was obtained from all individuals and the study was approved by the School of Philosophy, Psychology and Language Sciences (Psychology) Ethics committee at the University of Edinburgh. The participants' demographic information, ASD screening questionnaires and IQ scores are reported in Table 7.

4.2.3. Measures

Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II) (Wechsler, 2011): The WASI-II was administered as a measure of verbal comprehension and perceptual reasoning. Participants completed four subtests: Vocabulary; Similarities; Block Design; and Matrix Reasoning. Scores were converted into age-adjusted standardized scores. The Vocabulary and Similarities subsets provided a Verbal Comprehension Index (VCI) and Block Design and Matrix Reasoning provided a Perceptual Reasoning Index (PRI) (McCrimmon & Smith, 2013; Wechsler, 2011b).

Autism Spectrum Quotient (AQ) (Baron-Cohen, Wheelwright, Skinner, et al., 2001): The AQ is a self-report questionnaire that assesses whether individuals with a normal IQ possess traits related to the autism spectrum (maximum score = 50).

The Empathy Quotient (EQ) (Baron-Cohen & Wheelwright, 2004).the EQ measures the ability to identify and understand the thoughts and feelings of others and to respond to these with appropriate emotions (maximum score = 80).

The Systemizing Quotient (SQ) (Wheelwright et al., 2006): the SQ assesses the drive to analyse or construct systems such as mechanical systems (maximum score = 150). The higher the scores, the more autistic characteristics the individual possesses.

The Reading the Mind in the Eyes (RME) (Baron-Cohen, Wheelwright, Hill, et al., 2001): Participants were presented with photographs of the ocular region of different human faces and were required to make a forced-choice response from four adjectives (one target and three foils) which best described what the individual was thinking or feeling. Prior to performing the test, participants were provided with a glossary to clarify what each adjective meant, if they were unsure or unfamiliar with the word. Participants were given unlimited time to respond, responses were recorded verbally and 1 point was awarded for each correct answer, giving a total score out of 36.

The Reading the Mind in Films (RMF) (Golan et al., 2006): Participants viewed short scenes of varying durations involving social interactions from feature films. They were instructed to make a forced-choice response from four adjectives (one target and three foils) that best described what the protagonist was thinking or feeling at the end of the scene. Again, participants were provided with a glossary of the adjectives for clarification and responded verbally. There was no time limit for responses and a correct response was awarded 1 point, giving a total out of 22.

The Social Norms Questionnaire (SNQ) (Rankin, 2008): The SNQ was developed to screen patients for potential behaviour changes and examines how well participants understand the social standards that govern their behaviour in UK mainstream culture. Participants were given a list of behaviours (e.g., tell a stranger you don't like their hairstyle?) and asked to indicate whether or not the behaviours were socially acceptable to perform in the presence of a stranger or acquaintance, not a close friend or family member. A total score (maximum score = 22) was calculated, with higher scores reflecting better performance. The SNQ also calculates the types of errors made by participants. An over-adherence error occurs when the statement is socially acceptable but the participant disagrees with it and a rule-break error is when responses violate a social norm.

4.2.4. Procedure

Participants completed the WASI-II, ESCoT, RME, RMF and SNQ in a single session, which took approximately two hours to complete. The ASD questionnaires were completed online. The order of the tasks was the same for each participant and regular breaks were provided.

4.2.5. Statistical analysis

Parametric and non-parametric analyses were conducted based on initial exploratory analyses (Shapiro-Wilk test, $p > 0.05$). Correlational analyses were conducted on all participants using Spearman's rho correlational analyses to examine the relationship between the ESCoT and the established social cognition tests. To examine overall differences on the ESCoT subtests (cognitive ToM, affective ToM, inter-and intrapersonal understanding of social norms) and SNQ subtests (over-adherence and rule break), a Friedman Test was used. If this yielded a significant difference, follow-up analyses were conducted using independent samples and paired-samples *t*-tests for cognitive and affective ToM while Mann-Whitney U and Wilcoxon signed-rank tests were performed for inter-and intrapersonal understanding of social norms and the SNQ subtests. An independent sample *t*-test was performed to examine mean group differences on the RME. Mann-Whitney *U* tests were performed on ESCoT total scores, RMF and SNQ total scores. The alpha values were set at $p < 0.05$ and the Holm correction to adjust for multiple comparisons was applied. Effect sizes using both partial eta squared (ηp^2) and Cohen's *d* (Cohen, 1988, 1992) were calculated.

The relationship between performance on all social cognition tests and the ASD screening questionnaires (AQ, EQ and SQ) were examined using an exploratory regression analysis. In the first stage, the background predictors (age, gender, years of education) which significantly correlated with the outcome variables (ESCoT total scores and established social cognition tests) at a pre-specified significance level of $p < 0.20$ were entered into the analysis (Altman, 1991) using the enter method. We chose a significance level of $p < 0.20$ over more traditional levels such as $p < 0.05$ since $p < 0.05$ can fail in identifying variables known to be important to the outcome variable and simulation studies have shown that a cut-off of $p < 0.20$ yields better outcomes (Bursac et al., 2008; Lee, 2014). VCI scores were included in the first stage of the regression analysis if VCI scores correlated with the outcome variables (ESCoT total score, RME, RMF and SNQ total scores) at $p < 0.20$. In the second stage, AQ, EQ and SQ scores were entered using the stepwise method (entry criterion $p < 0.05$, removal criterion $p > 0.10$). Finally, we conducted a Receiver Operator Characteristic (ROC) curve analysis to examine the ability of the established tests and the ESCoT to differentiate ASD and NC participants and accurately assign them to their respective group.

4.3. Results

4.3.1 Experiment 1: Cut-off scores to detect abnormal performance on the ESCoT

Raw score age adjustments were applied (see Baksh et al., under review) (see supplementary information; Appendix 1.6). We derived ESCoT cut-off scores for the subtests and total scores based on the lowest 5th percentile. Using the cut-off scores, we found that 6.77% of our 236 NC were impaired on the cognitive ToM subtest, 4.66% on affective ToM, 6.77% on interpersonal understanding of social norms and 6.77% on intrapersonal understanding of social norms. A total of 5.50% of NC adults were impaired on the ESCoT total score. Table 6 shows the cut-offs for each subtest and ESCoT total scores.

4.3.1.1. Table 6. Cut-off scores for ESCoT subtests and total score based on the 5th percentile

	Mean (*SD*)	25th percentile	10th percentile	5th percentile	Range	Maximum score	Cut-off score
Cognitive ToM	21.98 (3.00)	20	18	17	15 - 29	30	17 or less
Affective ToM	24.56 (3.21)	23	20.70	18.85	12 - 30	30	19 or less
Interpersonal understanding of social norms	24.52 (3.35)	23	19.70	18	15 - 30	30	18 or less
Intrapersonal understanding of social norms	26.68 (2.51)	25	23	22	17 - 30	30	22 or less
ESCoT total score	97.75 (7.97)	92.25	87	83	72 - 116	120	83 or less

4.3.2. Experiment 2: Table 7. Demographics information of participants: Mean (SD)

	Max score	ASD n = 19	NC n = 38	Sig*	ηp² (d)
Age		38.47 (15.63)	37.50 (14.75)	ASD = NC	0.001 (0.09)
Gender (M:F)		12:7	23:15	ASD = NC	-
Years of full-time education		15.21 (2.53)	16.16 (2.54)	ASD = NC	0.03 (0.36)
AQ	50	34.63 (7.43)	16.34 (5.07)	ASD < NC	0.69 (2.95)
EQ	80	14.21 (8.55)	29.92 (7.20)	ASD < NC	0.49 (1.97)
SQ	150	48.11 (19.88)	45.32 (12.71)	ASD = NC	0.01 (0.22)
VCI	160	95.50 (15.62)	105.02 (9.97)[a]	ASD < NC	0.19 (0.96)
PRI	135	99.06 (21.13)	107.94 (13.07)[a]	ASD = NC	0.10 (0.68)

ASD, Autism Spectrum Disorder; AQ, Autism Spectrum Quotient; EQ, Empathy Quotient; SQ, Systemizing Quotient; VCI, Verbal Comprehension Index; PRI, Perceptual Reasoning Index. *Analyses were conducted using parametric and non-parametric tests where appropriate. All $p < .05$. [a]NC n = 37.

4.3.3. ESCoT convergent validity

4.3.3.1. Table 8. Correlations between the tests of social cognition for all participants

	ESCoT total score	Cognitive ToM	Affective ToM	Interpersonal norms	Intrapersonal norms	RME	RMF
Cognitive ToM	0.64***						
Affective ToM	0.58***	0.33*					
Interpersonal norms	0.86***	0.39**	0.28*				
Intrapersonal norms	0.47***	0.002	- 0.08	0.55***			
RME	0.48**	0.36**	0.25	0.38**	0.27*		
RMF	0.42**	0.39**	0.36**	0.30*	0.10	0.62***	
SNQ	0.34*	0.33*	0.24	0.19	0.16	0.33*	0.39**

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. ESCoT; Edinburgh Social Cognition Test, RME, Reading the Mind in the Eyes, RMF, Reading the Mind in Films, SNQ, Social Norms Questionnaire. Analyses were conducted non-parametric tests.

As Table 8 shows the cognitive ToM subtest of the ESCoT significantly correlated with the RME, RMF and SNQ. The affective ToM subtest positively correlated with the RMF. Interpersonal understanding of social norms significantly correlated with the RME and RMF. Intrapersonal understanding of social norms significantly correlated with the RME.

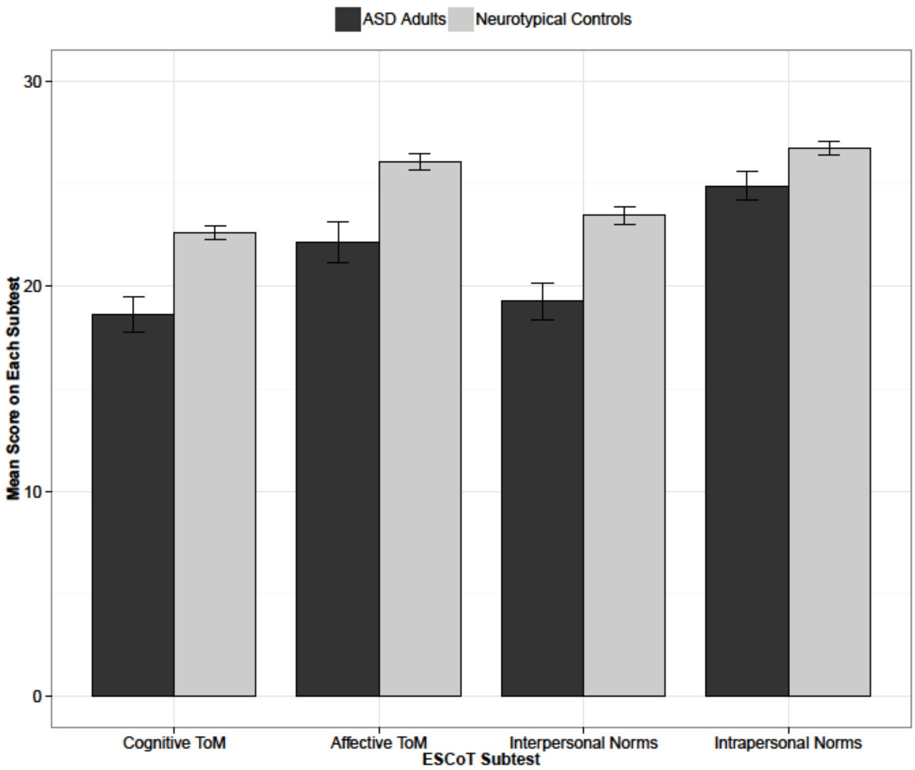
ESCoT total scores significantly positively correlated with the RME, RMF and the SNQ. The RME test significantly correlated with the RMF and SNQ. Performance on the RMF positively correlated with performance on the SNQ.

4.3.4. ESCoT subtest correlations

Cognitive ToM significantly correlated with affective ToM and interpersonal understanding of social norms. While affective ToM positively correlated with interpersonal understanding of social norms. Performance on interpersonal understanding of social norms was only correlated with intrapersonal understanding of social norms.

4.3.5. Group comparisons between ASD adults and NC on ESCoT and established social cognition tests

4.3.5.1. Figure 17. Performance of adults with ASD and NC on the subtests of the ESCoT. Adults with ASD performed poorer than NC on all subtests (all $p < 0.01$)



Error bars = Standard error

A non-parametric Friedman test showed a statistically significant difference between the subtests of the ESCoT ($\chi^2(3) = 74.91$, $p < 0.001$) for NC and ASD. Post-hoc analysis with Holm correction for multiple comparisons demonstrated performance was poorer on the cognitive ToM than affective ToM ($t(56) = -7.17$, $p < 0.001$, $\eta p^2 = 0.20$, $d = 1.04$). As shown in figure 1, ASD adults scored significantly lower than NC adults on cognitive ToM ($t(23.26) = -4.40$, $p < 0.001$, $\eta p^2 = 0.45$, $d = 1.82$) and affective ToM, ($t(23.76) = -3.70$, $p = 0.002$, $\eta p^2 = 0.37$, $d = 1.52$).

All participants performed poorer on inter- compared to intra-personal understanding of social norms, ($Z = -6.31$, $p < 0.001$, $\eta p^2 = 0.70$, $d = 3.05$). Furthermore a significant difference was found between groups, with the ASD group performing poorer than NC, on the inter-personal understanding of social norms ($U = 140.50$, $p < 0.001$, $\eta p^2 = 0.25$, $d = 1.15$) and intra-personal understanding of social norms ($U = 226.50$ $p = 0.021$, $\eta p^2 = 0.09$, $d = 0.64$).

Table 9 shows the group comparisons on the established social cognition tests and ESCoT total scores. Overall performance on the ESCoT was significantly poorer for the ASD group than the NC group. Moreover, scores were significantly lower for the ASD group on the RME and RMF compared to NC.

As Table 9 shows ASD adults performed poorer than NC on the SNQ total scores. However there were no statistically significant differences between ASD adults and NC for the SNQ subtests ($\chi^2(1) = 0.49$, $p = 0.484$).

4.3.5.2. Table 9. Results by Group for the tests of social cognition: Mean (SD)

	Max score	ASD $n = 19$	NC $n = 38$	Statistic (df)	p-value	ηp^2 (d)
ESCoT total score	120	84.95 (10.11)	98.87 (4.92)	$U = 64.50$	$p <$ 0.001	0.44 (1.79)
RME	36	23.26 (3.84)	27.47 (4.03)	$t(55) = -$ 3.77	$p <$ 0.001	0.21 (1.02)
RMF	22	10.26 (2.54)	14.03 (2.17)[a]	$U = 94.00$	$p <$ 0.001	0.36 (1.50)
SNQ total score	22	17.37 (2.22)	18.95 (1.84)	$U =$ 208.50	$p =$ 0.009	0.12 (0.74)

ESCoT; Edinburgh Social Cognition Test, RME, Reading the Mind in the Eyes, RMF, Reading the Mind in Films, SNQ, Social Norms Questionnaire. Analyses were conducted using parametric and non-parametric tests where appropriate. [a]NC n = 37.

4.3.6. Relationship between social cognition tests, ASD screening questionnaires and IQ for all participants

The variables that correlated with ESCoT total scores at $p > 0.20$ were age (r_s (57) = – 0.19, p = 0.155), years of full-time education (r_s (57) = 0.32, p = 0.016) and VCI scores (r_s (55) = 0.39, p = 0.003). These were included in the regression analysis using the enter method in the first stage. None of the predictor variables correlated significantly at $p < 0.01$, therefore the effect of suppressor variables was not examined. In the stepwise regression analysis for ESCoT total score, years of full-time education (β = 0.84, p = 0.022) and AQ scores (β = – 0.62, $p < 0.001$) were retained in the model and accounted for a significant proportion of variance in ESCoT total scores (R = 0.78, R^2 = 0.61, F(4, 50) = 19.86, $p < 0.001$).

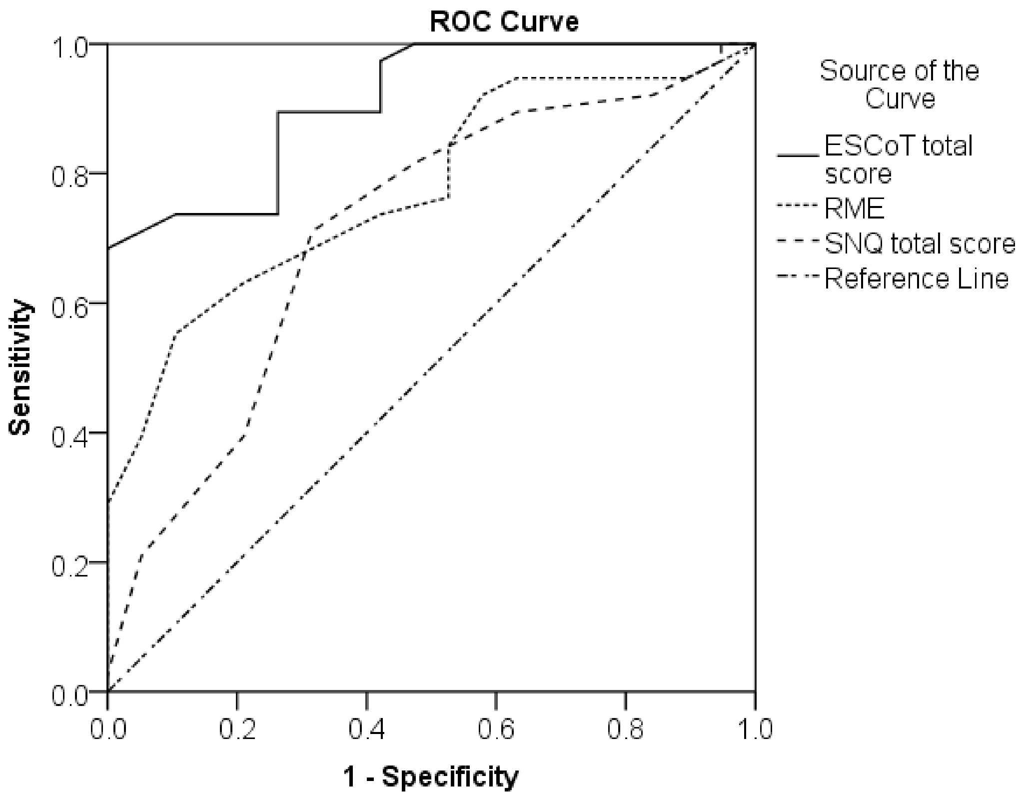
Only VCI significantly correlated with RME scores at $p < 0.20$ (r_s (55) = 0.30, p = 0.025). This was included in the regression analysis using the enter method in the first stage. In the final model, VCI scores (β = 0.09, p = 0.041) and EQ scores (β = 0.14, p = 0.009) accounted for a significant proportion of variance in RME performance (R = 0.44, R^2 = 0.19, F(2, 52) = 6.20, p = 0.004).

For the RMF, participant gender (1 = male, 2 = female, r_s (56) = 0.25, p = 0.059) and VCI scores (r_s (54) = 0.45, p = 0.001) were included in the first stage of the analysis. In the final model, VCI scores (β = 0.10, $p < 0.001$) and AQ scores (β = – 0.11, p = 0.001) were retained and accounted for a significant proportion of variance in RMF scores (R = 0.65, R^2 = 0.42, F(3, 50) = 12.15, $p < 0.001$).

Participants' VCI scores was included in the first stage of the regression analysis for SNQ scores (r_s (55) = 0.34, p = 0.010). In the final model, VCI scores (β = 0.06, p = 0.004), EQ scores (β = 0.06, p = 0.009) and SQ scores (β = 0.03, p = 0.038) accounted for a significant proportion of variance in SNQ scores (R^2 = 0.32, F(2, 52) = 7.87, p < 0.001).

4.3.7. ROC analysis for social cognition tests

4.3.7.1. Figure 18. ROC curves for the ESCoT, RME and SNQ



The closer the curve comes to the reference line, the less accurate the test.

Our ROC curve analysis (see Figure 18) shows the accuracy of the social cognition tests in correctly assigning participants to their group. The Area Under the Curve (AUC) values and 95% confidence intervals for the tests were: 0.91 (0.83 – 0.98) for the ESCoT total score, 0.77 (0.65 – 0.89) for the RME, 0.87 (0.77 – 0.97) for the RMF and 0.71 (0.57 – 0.86) for the SNQ total score. One NC participant was unable to complete the RMF, and the RMF was not included.

3.3.8. Number of ASD adults impaired on the ESCoT

Based on our cut-off scores, 36.84% of ASD adults were impaired on the cognitive ToM subtest compared to 6.77% of NC adults, and 26.31% were impaired on affective ToM compared to 4.66% of NC. On interpersonal understanding of social norms, 36.84% of the ASD group was impaired compared to 6.77% of the NC group. A total of 15.79% of adults with ASD were impaired on intrapersonal understanding of social norms compared to 6.77% of the NC adults. Finally, 42.11% of ASD adults were impaired on overall ESCoT scores compared to 5.50% of the NC adults.

4.4. Discussion

We present a new test of social cognition that assesses cognitive ToM, affective ToM and inter-and intra-personal understanding of social norms within the same clinical test. We investigated the convergent validity of the ESCoT against traditional tests and compared performance of ASD adults to NC adults on these tests. Moreover, we examined the influence of intelligence and ASD diagnosis on the ESCoT and traditional tests of social cognition. The ESCoT showed good convergent validity with more traditional social cognition tests with significant correlations with the RME, RMF and SNQ. Furthermore ASD adults performed poorer on all subtests of the ESCoT and traditional tests compared with NC. The regression results showed that better overall performance on the ESCoT was predicted by more years of education and lower AQ scores. Similar to our previous findings (Baksh et al., under review), ESCoT total score was not predicted by the two measures of intelligence; verbal comprehension (VCI) and perceptual reasoning (PRI). This contrasts with performance on the traditional social cognition tests included in this study. We found that higher VCI scores predicted better performance on the RME, higher VCI and EQ scores predicted better performance on the RMF while higher VCI, EQ and SQ scores predicted better performance on the SNQ. Finally, the ESCoT was superior to the traditional tests in assigning ASD and NC to their respective groups. A total of 42.11% of ASD adults were impaired on the ESCoT compared to 5.50% of NCs.

We have provided evidence of convergent validity for the ESCoT as a test of social cognition by demonstrating significant associations between the ESCoT and traditional social cognition tests. Of note, we found that the cognitive and affective ToM subtests of the ESCoT positively correlated with the RME. There is currently debate relating to what the RME assesses and some authors have argued that the RME is a test of emotional recognition (Oakley, Brewer, Bird, & Catmur, 2016). While it could be argued that the RME is an affective ToM measure (Duval et al., 2011), our findings suggest that it relates to both components of ToM. Indeed, the RME asks participants to infer what the person is thinking or feeling. Intrapersonal understanding of social norms did not correlate with cognitive and affective ToM of the ESCoT, but was positively correlated with the RME. Furthermore the RME also correlated with our measure of empathy. Perhaps the RME may be related to several aspects of social cognition. The positive correlations between the subtests of the ESCoT (particularly cognitive and affective ToM) suggests that performance on one ability is associated with performance on other abilities, but still show differentiation in that they are predicted by different but overlapping variables. Performance on cognitive ToM was predicted by age, but performance on affective ToM was predicted by age and gender (Baksh, Abrahams, Auyeung, & MacPherson, under review). These findings further show that while cognitive and affective ToM are distinct, they do overlap (Kalbe et al., 2010; Sebastian et al., 2011; Shamay-Tsoory et al., 2010) and both should be considered when assessing ToM.

Poorer performance of ASD adults compared to NC on cognitive ToM, affective ToM and interpersonal understanding of social norms supports previous findings (Baron-Cohen, Wheelwright, Hill, et al., 2001; Castelli et al., 2002; Golan et al., 2006; Murray et al., 2017; Thiébaut et al., 2016; Zalla et al., 2009). Although the ESCoT showed good sensitivity on all subtests of the test, the finding that ASD adults showed impaired intrapersonal understanding of social norm is somewhat in contrast to our prediction and previous findings of intact performance (Baez et al., 2012; Gleichgerrcht et al., 2013). Our findings show that ASD adults have difficulties with how they should behave in social interactions. However it is possible that the ASD group had difficulties in processing the wider context of the interaction, due to difficulties in weak central coherence (the inability to understand context) (Frith, 1989, 2003). In this study, individuals with ASD generally knew when a social norm had been violated and responded appropriately to the yes/no aspect of the question. However, in general participants with ASD gave egocentric responses (e.g. I'm a nice person) regarding why they would/would not have behaved as the character in the animation. Instead of referencing the wider context of the interaction (e.g. they needed help, helping others is the right thing to do) to explain why they would have behaved in a particular way.

A major advantage of the ESCoT over existing tests is the magnitude of the reported effects. Our effects sizes for the strength of the group differences on cognitive and affective ToM is greater than those on the RME and RMF. Increased ecological validity may explain the greater effect sizes found for the ESCoT compared to the RME, which lacks important contextual information, and the RMF, which uses preexisting stimuli that are overdramatized (Murray et al., 2017). With the ESCoT, we have shown that contextually-driven tests more clearly demonstrate group differences between ASD and NC. Performance on the ESCoT may be more representative of the everyday difficulties faced by ASD adults compared to NCs. There are several other advantages of the ESCoT over existing tests in the social cognition literature. Firstly, unlike tests like the TASIT, the ESCoT is a short and detailed test of social cognition with self-contained interactions. The ESCoT also provides researchers and clinicians with two subtests of ToM and social norm understanding.

We found that all participants performed better on affective ToM, compared to cognitive ToM, which is similar to previous findings (Bottiroli et al., 2016; Shamay-Tsoory et al., 2007). Moreover, participants were better on intrapersonal understanding of social norms compared to interpersonal understanding. While other studies may find differential performance on social cognitive abilities using different tests, these tests are not matched for difficulty. Matching social cognition components for equivalent difficulty is challenging to achieve. Future studies could examine ways of controlling for level of difficulty between subtests. The ESCoT assesses different aspects of social cognition within the same test. Similar to previous findings (Murray et al., 2017), we found that poorer performance on the ESCoT in the ASD group could not be explained by general cognitive abilities while performance on the traditional tests was predicted by VCI and PRI, similar to previous studies (Baker et al., 2014; Golan et al., 2006; Kaland et al., 2002; McDonald et al., 2003). This is an advantage for the ESCoT as it can be used in clinical populations in which intelligence may be compromised. Moreover, our NC group did not perform at ceiling on the test. The variability of performance in the control group is extremely beneficial for a test in nonclinical populations as it increases the sensitivity of the test. Further usefulness of the ESCoT is its superior ability at differentiating the ASD and NC groups with an AUC value of 0.91.

A limitation of this study is the small sample size for the ASD group. However, the large effects sizes (e.g. Cohens d = 1.79) for the ESCoT indicate that, even with a sample size of ASD adults, we were able to detected meaningful group differences. ASD is a heterogeneous condition (Ghaziuddin and Mountain-Kimchi (2004) and this is reflected in our findings. Overall, ASD performed poorer then NC, but individually, 42.11% were impaired on the ESCoT. This highlights the complexity of ASD and suggests that perhaps individuals with ASD should not be examined in terms of group means. The groups were not matched on verbal comprehension scores, this should be noted when considering the results of the traditional social cognition tests. Finally, while ASD adults provided independent verification of diagnosis, having the participants complete a more in depth interview about their diagnosis would have been beneficial.

4.4.1. Conclusion

We found that adults with ASD perform poorer than NCs on cognitive ToM, affective ToM and inter-and intrapersonal understanding of social norms. These impairments may be responsible for the difficulties frequently observed in social interactions. The convergent validity between the ESCoT and established tests of social cognition show that the ESCoT is a sensitive test of social cognition in ASD adults. We showed that the ESCoT is able to detect large effects with a limited sample and shows better diagnostic accuracy than established tests. Many of the current tests of social cognition have limited use in clinical settings (Dodich et al., 2015) but we have demonstrated that the ESCoT may be a useful test to assess patients and aid in the detection of potential difficulties in ToM and social norm understanding.

Chapter 5: Sex, the Broader Autism Phenotype, Social Anxiety Disorder, Empathy and the ESCoT in younger adults

Chapter 1 introduced the BAP in relation to social cognition, while Chapter 3 investigated its rate of occurrence in the neurotypical population. It also looked at the relationship between sex, BAP and IQ on performance of the ESCoT across age groups. The relationship between sex and the BAP and performance on tests of social cognition will be examined in greater detail in the forthcoming chapter. Here the complex interplay between sex, empathy, and subclinical expressions of Social Anxiety Disorder (SAD) and performance on the ESCoT will also be examined but within a specific cohort. I explored whether performance of younger (18 – 35 year olds) neurotypical adults was influenced by the sex of participants and measures of BAP, empathy and subclinical levels of SAD. The secondary aim of this chapter was to further examine the efficacy of the ESCoT as a research tool to identify the variables which influence performance on tests of social cognition.

Data in this chapter were collected by undergraduate students Sharon Jany and Terin Dorrian.

5.1. Introduction

Research on social cognition is often concerned with group comparisons across populations. For example, comparing performance between age groups (Chapter 3), NC and adults with ASD (Chapter 4) or NC and neurodegenerative diseases (Bora et al., 2015). It is also interesting to examine social cognition within a population, and investigate the influence of personality traits on our social abilities. Research has shown that while men and women are similar in cognitive abilities, there are sex differences in cognition (Hyde, 2016). Mental health conditions such as Social Anxiety Disorder (SAD) and clinical disorders such as ASD manifest in the general population in subclinical forms (Freeth, Bullock & Milne, 2013). The subclinical presentations of these conditions are particularly interesting since they are associated with social cognitive impairments (Losh & Piven, 2007; Samson, Lackner, Weiss, & Papousek, 2012), show sex differences (Baron-Cohen, Wheelwright, Skinner, et al., 2001; Fehm, Pelissolo, Furmark, & Wittchen, 2005; Toussaint & Webb, 2005) and interact with empathy (Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004; Carroll & Chiew, 2006). Consequently this chapter was interested in investigating the effects and interplay of sex, personality traits and empathy in younger (18 – 35 years old) men and women on the ESCoT. This study differed from Chapter 3 in that it examined performance on the ESCoT within a cohort.

5.1.1. Sex differences in Social cognition

Sex-related differences in social cognitive abilities have not been well-established. Sex differences have been found on cognitive ToM tests, with women demonstrating significantly better perspective-taking than men (Davis, 1980; Nettle & Liddle, 2008; Stiller & Dunbar, 2007). Research into potential sex-related differences in affective ToM have reported similar findings to those found in cognitive ToM, again, with women performing better than men (Ahmed & Miller, 2011; Baron-Cohen et al., 2015; Carroll & Chiew, 2006; Kirkland, Peterson, Baker, Miller, & Pulos, 2013; Schiffer, Pawliczek, Müller, Gizewski, & Walter, 2013; Vellante et al., 2013; Voracek & Dressler, 2006). For example, a recent meta-analysis by Kirkland et al. (2013) reported a small (g = 0.18) but significant female advantage on the RME, demonstrating that women are better at inferring what another individual is thinking or feeling compared to men.

While, studies report a female advantage in ToM, Russell, Tchanturia, Rahman, and Schmidt (2007) found that men performed significantly better than women on Happé's Strange Stories test. Other researchers have failed to find a female advantage in affective ToM with men and women performing similarly (Adenzato et al., 2017; Baron-Cohen, Wheelwright, Hill, et al., 2001; Jarrold, Butler, Cottington, & Jimenez, 2000; Mar, Oatley, Hirsh, dela Paz, & Peterson, 2006; Nettle & Liddle, 2008). However, many other studies do not report sex-related results (e.g., Lawrence, Shaw, Baker, Baron-Cohen, and David, 2004). Consequently it is unclear whether sex-related differences were not examined in the first place, or if no sex-related differences were found and therefore not reported (Kirkland et al., 2013).

A recent study by Adenzato et al. (2017) has highlighted the need to consider sex when investigating social cognition. They reported that transcranial direct current stimulation (tDCS) over the medial prefrontal cortex selectively enhanced cognitive ToM performance in women participants but not men. They showed that females that received anodal tDCS over the medial prefrontal cortex performed better on the cognitive ToM task compared with females that received tDCS over the vertex. This effect was observed in female participants but not male. The authors suggest that investigating sex-related differences should be mandatory in studies of social cognition. However, the Adenzato et al. (2017) study only included 16 participants in each group and the study did not report a baseline assessment of cognitive ToM between men and women, but administered tDCS to half of participants. Therefore it is difficult to interpret whether sex differences existed prior to administering tDCS. Overall, the evidence for a female advantage in tests of social cognition remains equivocal.

5.1.2. Sex differences in the BAP

Some authors have found substantial sex discrepancies in the diagnosis of ASD. One study found a sex ratio (M:F) of 9:1 from a community sample in England (Brugha et al., 2011). However the consensus sex ratio is approximately 4:1 (Werling & Geschwind, 2013). Unsurprisingly in neurotypical populations, men typically present with more autistic-like traits than women (Austin, 2005; Baron-Cohen, Wheelwright, Skinner, et al., 2001; Freeth, Bullock, & Milne, 2013; Ruzich et al., 2015). These sex differences are typically found using self-report measures such as the AQ (Carroll & Chiew, 2006; Voracek & Dressler, 2006; Wheelwright et al., 2006). Baron-Cohen, Wheelwright, Skinner, et al. (2001) found that men scored significantly higher on the AQ than women, with 40% of men scoring at intermediate levels (AQ score 20+) compared to 21% of women.

5.1.3. Social Anxiety Disorder (SAD)

Another variable which has shown sex-related differences, and associations with social cognition, is Social Anxiety Disorder (SAD). SAD is the most common anxiety disorder and is characterised by marked or intense fear of social or performance-based situations where scrutiny or evaluation by others may occur. Individuals with SAD fear social or performance-based situations because they are concerned they will say or do something that will result in embarrassment or humiliation. As a result, exposure to feared situations is typically accompanied by anxious anticipation, distress, and avoidance. In some cases, individuals' concerns can be so pronounced that they avoid most social interactions (American Psychiatric Association, 2013; Bögels et al., 2010; Stein & Stein, 2008). SAD is a debilitating disorder which can impede social development and is associated with significant functional impairments (Lipsitz & Schneier, 2000). Moreover, SAD is associated with a number of negative outcomes such as suicidal ideation, financial dependency, and the development of comorbid psychiatric disorders (Schneier, Johnson, Hornig, Liebowitz, & Weissman, 1992).

While SAD is a clinical disorder, there is a need for accurate estimates of social anxiety in the general population for the appropriate development of mental health interventions (Furmark et al., 1999). SAD affects millions of people worldwide with a lifetime prevalence of approximately 12% (Kessler et al., 2005).

5.1.4. Sex differences in SAD

Anxiety disorders are more prevalent among women than among men (Bekker & van Mens-Verhulst, 2007). Prevalence rates for SAD based on sex show rates ranging from 10.3% – 15.5% for women and 8.7% – 11.1% for men (Kessler et al., 1994; McLean, Asnaani, Litz, & Hofmann, 2011). Yet, sex differences in terms of SAD are inconsistent in the literature. Some studies have reported higher rates of SAD in women compared to men (Fehm et al., 2005; Freeth et al., 2013; Furmark et al., 1999; Magee, Eaton, Wittchen, McGonagle, & Kessler, 1996; Offord, Boyle, Campbell, & Goering, 1996; Schneier et al., 1992). Others, however, have found no sex differences in prevalence rates between women and men in populations in the United States. (Bourdon et al., 1988; McLean et al., 2011). Consequently, the influence of sex on SAD is unclear and requires further investigation.

5.1.5. Social cognition and SAD

Similarly to ASD where traits of the disorder are distributed in the general population and influence performance on tests of social cognition, the same is found in SAD (Freeth et al., 2013). However, despite difficulties in social interactions being a primary characteristic of individuals with SAD, only a handful of studies have attempted to objectively measure social cognitive abilities such as ToM in individuals with SAD. Samson et al. (2012) found that higher self-reported levels of social anxiety in neurotypical adults was significantly related to lower enjoyment of cartoons that involved cognitive ToM inferences, but not of semantic cartoons or visual puns. Individuals with a diagnosis of SAD also perform poorer than controls on measures of affective ToM (Hezel & McNally, 2014; Washburn, Wilson, Roes, Rnic, & Harkness, 2016). Furthermore, Hezel and McNally (2014) and Washburn et al. (2016) both found that, in comparison to controls, individuals with SAD are more likely to attribute greater meaning to what others were thinking and feeling in social interactions.

5.1.6. Empathy

Empathy can broadly be defined as our reaction to the observed emotional experiences of another individual (Davis, 1980). Empathy is an interesting phenomena to examine in the general population because it plays an important role in social understanding (Lawrence et al., 2004). A popular tool for assessing empathy in neurotypical populations is the EQ. Using this questionnaire Baron-Cohen and Wheelwright (2004) have found that neurotypical adults exhibit subclinical difficulties in empathising with another individual in the absence of any clinical disorder.

5.1.7. Sex differences in empathy

Sex-related differences are typically found in empathy, with considerable research demonstrating that women are more empathic than men (Davis, 1980; Davis & Franzoi, 1991; Eisenberg & Lennon, 1983; Hall, 1978; Han, Fan, & Mao, 2008; Hoffman, 1977; Rueckert & Naybar, 2008; Toussaint & Webb, 2005). Using the EQ, many studies have shown sex differences favouring women compared to men (Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004; Carroll & Chiew, 2006; Lawrence et al., 2004; Mar et al., 2006; Voracek & Dressler, 2006; Wheelwright et al., 2006). Moreover, Baron-Cohen and Wheelwright (2004) found that 14% of neurotypical men scored in the "ASD range" on the EQ (i.e., equal to or fewer than 30 points) compared to 4% of neurotypical women.

5.1.8. Empathy and social cognition

The RME is a common test that is used when investigating the relationship between social cognition (affective ToM) and empathy. However, using this test, researchers report mixed findings. In neurotypical individuals, higher scores on the RME are associated with higher levels of empathy (Carroll & Chiew, 2006; Cook & Saucier, 2010; Lawrence et al., 2004; Voracek & Dressler, 2006). However, no association between affective ToM and empathy has been found using the RME and EQ (Vellante et al., 2013) or RME and The Interpersonal Reactivity Index (Mar et al., 2006).

On the other hand, neuroimaging data shows that the concepts of empathy and ToM are closely related (Reniers, Völlm, Elliott, & Corcoran, 2014). Neuroimaging studies have found that empathy and ToM activate similar, as well as distinct neural networks. Common regions of activation included the medial PFC, TPJ and temporal poles. Compared to empathy, ToM tests also activate the lateral orbitofrontal cortex, middle frontal gyrus, cuneus and superior temporal gyrus.(Gallagher & Frith, 2003; Reniers et al., 2014; Saxe & Powell, 2006; Shamay-Tsoory, Tomer, Goldsher, Berger, & Aharon-Peretz, 2004; Shamay-Tsoory, Tomer, Berger, & Aharon-Peretz, 2003; Völlm et al., 2006). In an attempt to more directly compare empathy and ToM in a single study, Völlm et al. (2006) found that empathy and ToM rely on the networks associated with making inferences about the states of others, but empathising requires neural networks involved in emotional processing such as the anterior and posterior cingulate and amygdala.

5.1.9. The relationship between the BAP, SAD and empathy

Difficulties in empathic abilities are often cited as a typical characteristic of adults with ASD (Baron-Cohen & Wheelwright, 2004; Blacher, Kraemer, & Schalow, 2003; Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007). Adults with ASD show lower levels of empathy than neurotypical individuals, resulting in difficulties in interpersonal interactions and relationships (Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004; Rogers et al., 2007). Indeed, studies investigating the relationship between the AQ and EQ often show a negative association between autistic-like traits and levels of empathy (Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004; Carroll & Chiew, 2006). Moreover, research suggests a positive relationship between autistic-like traits and subclinical social anxiety, wherein individuals who exhibit higher scores on the AQ demonstrate higher levels of social anxiety (Freeth et al., 2013; Kunihira, Senju, Dairoku, Wakabayashi, & Hasegawa, 2006; Liss, Mailloux, & Erchull, 2008; Rosbrook & Whittingham, 2010; White, Ollendick, & Bray, 2011).

5.1.10. Interim summary

To summarise, the research discussed above suggests that there is a complex interplay between sex, personality and social cognition. Research has found evidence of some sex-related differences in social cognition (Adenzato et al., 2017; Baron-Cohen et al., 2015; Nettle & Liddle, 2008). Men exhibit more autistic-like traits (Austin, 2005; Baron-Cohen, Wheelwright, Skinner, et al., 2001; Freeth et al., 2013) and lower levels of empathy than women (Baron-Cohen & Wheelwright, 2004; Lawrence et al., 2004; Mar et al., 2006). The findings on sex-related differences in subclinical presentations of SAD are mixed, some studies find sex differences, while others have failed to find differences between men and women (Fehm et al., 2005; Freeth et al., 2013; McLean et al., 2011). Moreover, these subclinical presentations of clinical disorders and lower levels of empathy are frequently associated with difficulties in social cognition (Losh & Piven, 2007; Samson et al., 2012; Voracek & Dressler, 2006)

5.1.11. Rationale for the present study

Social cognition impairment is a major problem underlying difficulties in interpersonal relationships in several psychiatric populations (Patin & Hurlemann, 2015). It is important to examine and identify the variables which might influence performance on social cognition tests such as empathy, the BAP and subclinical levels of SAD. While neurotypical individuals can exhibit autistic-like traits and subclinical levels of SAD, the consequence of these personality traits in everyday functioning is unclear (Sasson et al., 2013). Moreover, subclinical expressions of SAD are often not considered on tests of social cognition. However, SAD is important to consider with the other variables mentioned because of the positive associations between autistic-like traits and subclinical levels of SAD (e.g. Freeth et al., 2013) and the negative associations between social cognition and autistic-like traits (e.g. Baron-Cohen et al., 2001). It may be possible that subclinical levels of SAD are a mediating factor between these variables. Moreover, there is little research investigating the relationship between empathy and SAD, but these may be important to consider together in understanding the influence of personality traits on social cognition. Furthermore, the limited studies investigating ToM in SAD highlight the need to further understand the social cognitive difficulties faced by individuals with SAD, since high social anxiety is often associated with difficulties in developing and sustaining interpersonal relationships (Alden & Taylor, 2004). Research suggests that relative to individuals with ASD, individuals with SAD make "excessive" ToM errors compared to non-anxious controls. Specifically, they are more likely to attribute greater meaning to what others are thinking and feeling. In this regard, their ToM impairments are in the opposite direction to individuals with ASD (Hezel & McNally, 2014; Washburn et al., 2016). A limitation of the current literature is that studies which use self-report questionnaires of the BAP, empathy and SAD make assumptions about the consequences of the relationships they find on our social abilities, but do not include tests of social cognition. Therefore, these studies are unable to identify their influence on objective tests of social cognition.

In the current study, younger adults were chosen as the population to examine the relationship between social cognition, the BAP, empathy and SAD for several reasons. Firstly, studying SAD in younger adults is important as this cohort shows the highest prevalence rates compared to older adults (Bourdon et al., 1988; Fehm et al., 2005; Offord et al., 1996) and onset of SAD after the age of 25 years is uncommon (Schneier et al., 1992). Additionally, SAD is associated with educational underachievement (Lipsitz & Schneier, 2000). Therefore, it is important to understand subclinical presentations of the disorder in the neurotypical population, particularly, in student populations where individuals experience significant changes to their daily lives when they undertake higher education.

Research has shown that students exhibiting more autistic-like traits score significantly lower on questionnaires assessing adaptation to university life (Trevisan & Birmingham, 2016). Likewise, the BAP significantly predicts relationship outcomes in newly formed social relationships at university (Faso, Corretti, Ackerman, & Sasson, 2016). Neurotypical students who score above the clinical threshold for symptoms of ASD self-report higher levels of social anxiety than students with fewer autistic traits. Moreover, higher BAP traits are significantly correlated with subclinical expressions of SAD in students (White et al., 2011). Recent results in this population also suggests that social situations in particular induce anxiety in individuals who have more autistic-like traits (Freeth et al., 2013). Furthermore, empathy and SAD are positively correlated in students (Tibi-Elhanany & Shamay-Tsoory, 2011), demonstrating that highly socially anxious individuals show elevated levels of empathic tendencies. While these relationships are interesting, there is limited research examining the relationship between social cognitive abilities, SAD and empathy in this population.

Similar to the ageing literature, research into sex-related differences in social cognition has tended to focus on single measures such as the RME (Voracek & Dressler, 2006) and examine cognitive and affective ToM using separate tests (e.g., Adenzato et al., 2017). Some studies use composite measures that assess both cognitive and affective ToM, but only report a single score (e.g., Hezel & McNally, 2014; Russell et al., 2007) and researchers have yet to examine sex differences in inter-and intrapersonal understanding of social norms. The ESCoT provides a research tool to address these limitations. Moreover, it would be interesting to examine the relationship between EQ and measures of ToM on the ESCoT because research has suggested that many of the items on the EQ tap ToM abilities (Rogers et al., 2007), for example 'it is hard for me to see why some things upset people so much.'

5.1.12. Aim and hypotheses of the present study

The aim of this chapter was to explore potential sex-related differences in personality measures and social cognition. Specifically, it sought to investigate the associations between the BAP, levels of empathy, social anxiety and the ESCoT subtests. The study aims to determine whether autistic-like traits, empathy and subclinical presentations of SAD predict performance on the ESCoT in a neurotypical younger (18 – 35 years old) adult population.

It was predicted that:

1. Women would perform better than men on the subtests of the ESCoT.
2. The sex of participants would affect scores on measures of the BAP, empathy and social anxiety. Women would score lower on the BAP, higher on empathy and higher on social anxiety than men.
3. There would be strong associations between the BAP, levels of empathy, social anxiety and the ESCoT subtests. BAP would negatively correlate with social anxiety, ESCoT subtests and empathy. Autistic-like traits and subclinical social anxiety would positively correlate. Social anxiety would negatively correlate with levels of empathy and the ESCoT subtests.
4. The BAP, levels of empathy and social anxiety would predict performance on the subtests of the ESCoT.

5.2. Method

5.2.1. Participants

Participants were recruited as part of an undergraduate Year 4 Honours dissertation project which Professor Abrahams, Dr Auyeung and I supervised during the 2015/2016 academic year. These data were reanalysed in the current study using altered research questions and different statistical techniques.

A total of sixty participants (35 females) aged between 18 and 25 years took part in the study. They were recruited through online platforms such as Facebook and from the local undergraduate community. Participants were entered into a prize draw to win a £20 voucher for participation. The study was approved by the School of Philosophy, Psychology and Language Sciences (Psychology) Ethics committee.

A summary of the participants' demographic information can be found in Table 10.

5.2.2. Materials

The Edinburgh Social Cognition Test (ESCoT), a full description of the ESCoT can be found in Chapters 3, section 3.2.2.3.

Autism-Spectrum Quotient (AQ) (Baron-Cohen, Wheelwright, Skinner, et al., 2001)

Empathy Quotient (EQ) (Baron-Cohen & Wheelwright, 2004).

Full descriptions of the AQ and EQ can be found in Chapter 3, section 3.2.2.2.

Liebowitz Social Anxiety Scale (LSAS) (Liebowitz, 1987). The LSAS is a commonly used self-report scale for the assessment of SAD (Fresco et al., 2001). It consists of 11 social and 13 performance situations, which are rated on a 4-point (0-3) scale of fear/anxiety and avoidance behaviours. Participants are required to rate how anxious or fearful they feel in a situation and how often they avoid the situation. A total score was generated by summing the fear and avoidance ratings for all items. The maximum score was 144, with higher scores suggesting higher levels of social anxiety.

5.2.3. Procedure

The study was completed in two parts. In part 1, participants completed an online survey which consisted of demographic questions, and the AQ, EQ and LSAS and took approximately 15 minutes to complete. Part 2 consisted of a 30 minute face-to-face assessment in which participants completed the ESCoT. On completion of parts 1 and 2, each participant was debriefed to the purpose of the study.

5.2.4. Data Analysis

ESCoT subtest raw scores were age-adjusted based on the findings from Chapter 3. Parametric and non-parametric analyses were conducted based on initial exploratory analyses (Shapiro-Wilk test, $p > 0.05$).

Group differences between men and women on the ESCoT subtests were performed using a Friedman Test to examine if there was an overall statistically significant difference. Follow-up analyses were conducted Wilcoxon signed-rank test for comparisons between cognitive and affective ToM and inter-and intrapersonal understanding of social norms. An independent t-test was used to compare performance between men and women on cognitive ToM. While Mann-Whitney U tests were used for group comparisons on affective ToM and inter-and intrapersonal understanding of social norms. Correlational analyses were conducted using Spearman's rho correlation coefficient to examine the relationship between the BAP, levels of empathy, social anxiety and the ESCoT subtests. The alpha values were set at $p < 0.05$ and the Holm correction was used to adjust for multiple comparisons.

The relationship between performance on the ESCoT total scores and subtests and the personality questionnaires (AQ, EQ and LSAS) were examined using regression analysis. In the first stage, the background predictors (age, sex, years of education) which showed a correlation with the outcome variables (ESCoT total scores subtests scores) at a pre-specified significance level of $p < 0.20$ was entered into the analysis (Altman, 1991) using the enter method. A significance level of $p < 0.20$ was chosen over more traditional levels such as $p < 0.05$ since $p < 0.05$ can fail in identifying variables known to be important and simulation studies have shown that a cut-off of $p < 0.20$ yields better outcomes than a cut-off of $p < 0.05$ (Bursac et al., 2008; Lee, 2014). In the second stage, AQ, EQ and LSAS scores were entered using the stepwise method (entry criterion $p < 0.05$, removal criterion $p > 0.10$) to examine their effect on performance.

5.3. Results

5.3.1. Differences between male and female participants

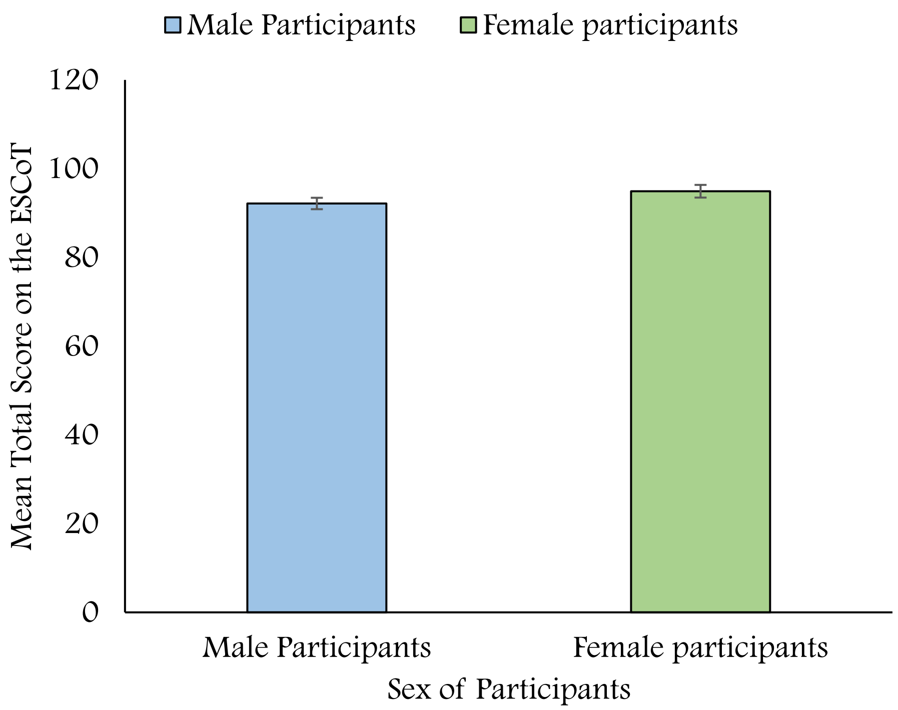
5.3.1.1. Table 10. Demographic information and personality measures of male and female participants

Variable	Overall mean (n = 60)	Male (n = 27)	Female (n = 33)	Range	Statistic (df)	p-value
Age (SD)	22.38 (3.22)	22.37 (1.93)	22.39 (4.01)	18 – 35	U = 387.50	p = 0.381
Years of education	16.37 (1.23)	16.15 (1.13)	16.55 (1.30)	14 – 19	U = 318.00	p = 0.038
AQ (max = 50)	17.25 (7.67)	19.81 (7.32)	15.15 (7.40)	4 – 41	U = 279.50	p = 0.013
EQ (max = 80)	44.73 (11.98)	39.07 (11.05)	49.36 (10.78)	15 – 68	t = -3.63 (55.12)	p = 0.001
LSAS (max = 144)	40.98 (21.17)	40.04 (21.64)	41.76 (21.08)	9 – 95	t = -0.31 (55.07)	p = 0.757

AQ = Autism Spectrum Quotient; EQ = Empathy Quotient; LSAS = Liebowitz Social Anxiety Scale. Analyses were conducted using parametric and non-parametric tests where appropriate. Significant group differences are in bold.

Table 10 shows the results of sex-related differences on measures of the BAP, empathy and levels of social anxiety. In this sample, there was a significant difference in years of education between men and women. Additionally, men exhibited significantly more autistic-like traits than women and self-reported lower levels of empathy compared to women. There was no statistically significant difference in self-reported levels of social anxiety between men and women.

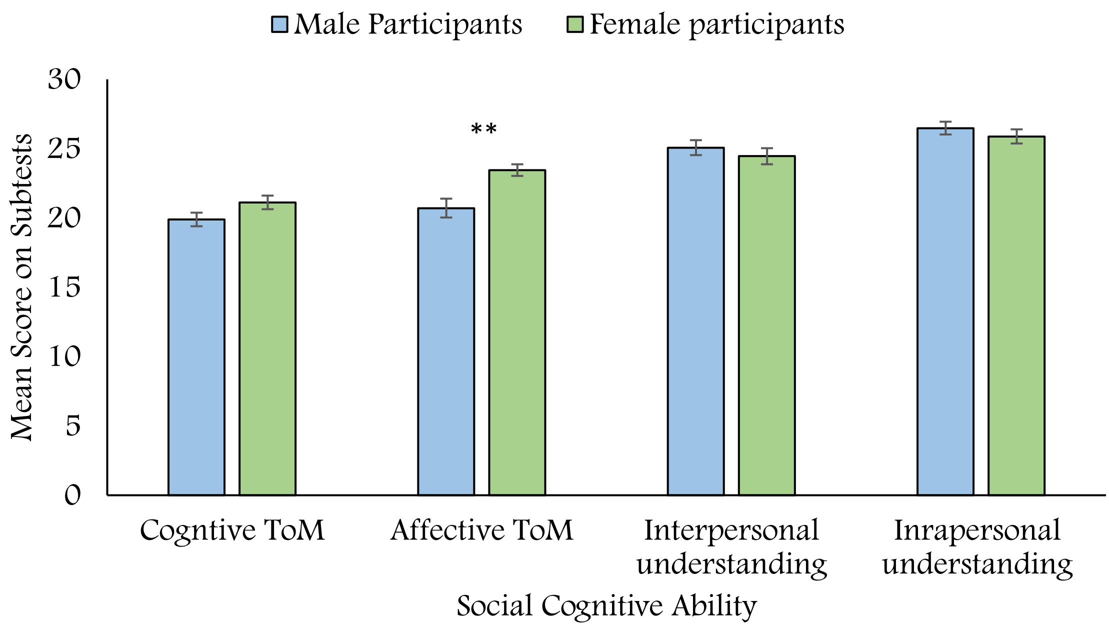
5.3.1.2. Figure 19. Performance of male and female participants on the ESCoT



Error bars = Standard error

There was no statistically significant difference between men and women in overall performance on the ESCoT, $t(58) = -1.41$, $p = 0.165$.

5.3.1.3. Figure 20. Performance of male and female participants on the subtests of the ESCoT



Error bars = Standard error. **$p < 0.01$

A Friedman Test for all participants found that there was a statistically significant difference in performance between the subtests of the ESCoT, $\chi^2(3) = 80.23$, $p < 0.001$.

For the following analyses *p*-values were adjusted using the Holm correction. There was a significant difference in cognitive ToM compared to Affective ToM, $Z = -3.35$, $p = 0.003$, where performance was poorer on cognitive ToM than affective ToM. There was a significant difference in performance between interpersonal and intrapersonal understanding of social norms, $Z = -3.45$, $p = 0.003$. Participants performed better on intrapersonal understanding of social norms compared to interpersonal understanding of social norms.

As Figure 20 shows, there was a statistically significant sex-related difference on affective ToM performance, $U = 235.00$, $p = 0.003$. Women performed better than men on this subtest of the ESCoT.

There was no significant sex-related difference between men and women on cognitive ToM, $t(58) = -1.79$, $p = 0.079$, interpersonal understanding of social norms, $U = 402.00$, $p = 0.515$ and intrapersonal understanding of social norms, $U = 392.00$, $p > 0.422$.

5.3.4. The relationship between autistic traits, empathy, social anxiety and subtests of the ESCoT and ESCoT total score

5.3.4.1. Table 11. Correlations between the BAP, empathy and social anxiety scores

	EQ	AQ	LSAS	Cognitive ToM	Affective ToM	Interpersonal understanding of social norms
AQ	**-0.66***					
LSAS	-0.29	**0.57***				
Cognitive ToM	0.27	-0.007	0.07			
Affective ToM	0.12	-0.18	0.09	0.21		
Interpersonal understanding of social norms	0.10	-0.19	-0.12	0.20	**0.32***	
Intrapersonal understanding of social norms	-0.03	0.10	0.12	0.07	0.04	**0.43***

AQ = Autism Spectrum Quotient; EQ = Empathy Quotient; LSAS = Liebowitz Social Anxiety Scale. *Correlations were conducted using the Holm correction for multiple comparisons, $p < 0.05$. Significant correlations are in bold.

The table above (Table 11) shows that participants who scored higher on the AQ subsequently scored lower on the EQ. Higher scores on the EQ also resulted in lower self-reported levels of SAD. Participants who performed better on interpersonal understanding of social norms also performed significantly better on affective ToM and intrapersonal understanding of social norms. After the Holm correction was applied, the positive correlation between EQ scores and cognitive ToM and the negative correlation between EQ and LSAS scores were not significant (both $p = 0.05$).

ESCoT total score. The predictor variables that correlated with ESCoT total scores at $p < 0.20$ were sex (r = 0.18, $p = 0.165$), years of education (r = 0.38, $p = 0.003$) and age (r = 0.17, $p = 0.104$),

Years of education ($p = 0.012$) was the only significant predictor of performance on ESCoT total scores, R = 0.40, $R^2 = 0.16$ ($F(3, 56) = 3.58$, $p = 0.019$). Higher levels of education predicted better overall performance. AQ, EQ and LSAS scores were not retained in the final model.

Cognitive ToM. The predictor variables that correlated with cognitive ToM scores were years of education (r = 0.32, $p = 0.007$) sex (male = 1, female = 2, r = 0.23, $p = 0.040$) and age (r = 0.44, $p < 0.001$) and were included in the regression analysis using the enter method in the first stage.

In the regression model, age ($p = 0.003$) was a significant predictor of cognitive ToM performance with an R = .51, $R^2 = 0.26$ ($F(3, 56) = 6.43$, $p = 0.001$). Being older predicted better performance on cognitive ToM. The sex of participants showed a trend toward statistical significance ($p = 0.078$). AQ, EQ and LSAS scores were not retained in the final model.

Affective ToM. The predictor variables that correlated with affective ToM scores at the $p < 0.20$ level were age (r = -0.13, $p = 0.168$), sex (r = 0.42, $p < 0.001$) and years of education (r = 0.13, $p = 0.158$). These were included in the first stage using the enter method.

In the regression model, only sex ($p = 0.002$) was a significant predictor of performance on affective ToM, R = 0.46, $R^2 = 0.22$ ($F(3, 56) = 5.11$, $p = 0.003$). Being female predicted better performance on this subtest of the ESCoT. AQ, EQ and LSAS scores were not retained in the final model.

Interpersonal understanding of social norms. Years of education (r = 0.39, $p = 0.001$) and age (r = 0.13, $p = 0.159$) correlated with interpersonal understanding of social norms and meet criteria for inclusion in the first stage of the regression model. Sex (r = -0.10, $p = 0.223$) did not meet criteria for inclusion in the first stage of the regression model.

Years of education ($p = 0.004$) was a significant predictor of performance on interpersonal understanding of social norms, R = 0.39, $R^2 = 0.15$ ($F(2, 57) = 5.20$, $p = 0.008$). Higher levels of education predicted better performance in interpersonal understanding of social norms. AQ, EQ and LSAS scores were not retained in the final model.

Intrapersonal understanding of social norms. The predictor variables that correlated with intrapersonal understanding of social norms scores at the $p < 0.20$ level were sex (r = -0.11, $p = 0.196$) and years of education (r = 0.16, $p = 0.116$) and were included in the regression analysis using the enter method in the first stage. Age (r = 0.02 $p = 0.432$) did not meet criteria for inclusion in the first stage of the regression model.

This regression model was not statistically significant, R = 0.21, R^2 = 0.04 (F (2, 57) = 1.32, p = 0.276.

5.4. Discussion

The purpose of this study was to examine the effects of sex, measures of the BAP, empathy and SAD on performance on the ESCoT. Unlike initial predictions, the only significant sex difference between men and women was found in affective ToM. Here, women performed significantly better than men. As predicted, women exhibited fewer autistic-like traits and higher levels of empathy compared with men. Contrary to the predictions, men and women did not differ in their levels of social anxiety. Performance on the AQ and EQ were negatively correlated, while social anxiety was positively associated with AQ scores. It was predicted that the BAP, levels of empathy and social anxiety would be related to performance on the subtests of the ESCoT. However, regression analyses found that younger individuals who are older (age range 18 – 35 years old) performed better on cognitive ToM, while being female predicted superior performance on affective ToM.

Also noteworthy was a statistically significant difference in subtest performance between cognitive and affective ToM. In this instance, participants performed better in the affective ToM subtest than the cognitive ToM subtest. Participants also performed better on intrapersonal understanding of social norms compared to interpersonal understanding of social norms. Higher years of education resulted in better performance in interpersonal understanding of social norms. Finally, higher years of education also predicted better overall performance on the ESCoT.

A sex-related difference was found in affective ToM, with women performing better than men in this social cognitive ability. This is similar to much of the literature exploring affective ToM in men and women (Ahmed & Miller, 2011;

Baron-Cohen et al., 2015; Carroll & Chiew, 2006; Kirkland et al., 2013; Schiffer et al., 2013; Voracek & Dressler, 2006). However, this is in contrast to Jarrold et al. (2000) who found no sex-related difference in affective ToM in neurotypical students. Jarrold et al. (2000) may not have found a significant difference because they used the RME which some authors have argued is a test of emotional recognition (Oakley et al., 2016). Moreover, it remains unclear whether sex differences exist in emotional processing (Deng, Chang, Yang, Huo, & Zhou, 2016). In the present study, both the group comparisons and the regression analysis found no significant difference or associations between sex and cognitive ToM. This is similar to the findings of Chapter 3 but is in contrast to previous literature, which showed that women are better than men at inferring what another person is thinking (Davis, 1980; Nettle & Liddle, 2008; Stiller & Dunbar, 2007). A potential explanation for the null finding may be task related; previous studies have used tests which may have also assessed affective aspects of ToM by the nature of the questions. This study included explicit questions of cognitive and affective ToM. These findings demonstrate that sex is an important variable to consider when investigating affective ToM, but not cognitive ToM in younger neurotypical populations.

Consistent with the BAP literature examining sex-related differences, women self-reported fewer autistic traits than men (Austin, 2005; Baron-Cohen, Wheelwright, Skinner, et al., 2001; Carroll & Chiew, 2006; Freeth et al., 2013; Ruzich et al., 2015; Voracek & Dressler, 2006; Wheelwright et al., 2006). This would appear to suggest that men are closer to the clinical end of the Autism spectrum than women. A possible mechanism for this finding is that lower severity of autistic traits in women may be the result of increased sensitivity to early environmental influences that operate to promote social competency. Research has found no evidence to suggest sex-specific genetic influences for ASD (Taniai, Nishiyama, Miyachi, Imaeda, & Sumi, 2008). But there is evidence from structure equation modelling that shows that girls are more sensitive, compared to boys, to environmental influences that improve their ability to develop reciprocal social behaviours. Consequently reducing the penetrance of genetic liability for autistic-like traits (Constantino & Todd, 2003). Alternatively, these results might suggest that fewer women identify with the list of traits typically associated with ASD as measured by the AQ. The behaviours that the AQ probes are extremely specific and at times, male orientated, for example 'I usually notice car number plates or similar strings of information'. Indeed, Haney (2016) has recently suggested in a sex-bias criteria used to identify ASD, leaving females with ASD undiagnosed or misdiagnosed. Therefore, this could perhaps decrease the probability of a female participant responding to exhibit that behaviour. Participants are asked if they agree that they exhibit the stated behaviour, for example 'I am fascinated by dates'. A participant may answer 'definitely disagree' because they are not interested in dates. This would suggest that they do not exhibit this narrow interest, however they may be fascinated by colours, which is another specific interest, but was not mentioned in the questionnaire. It is worth noting that there were no significant correlations between cognitive and affective ToM and BAP traits which is similar to Sasson et al. (2013), Kunihira et al. (2006) and the results from Chapter 3. This suggests that while BAP traits may indicate difficulties in social cognition, establishing a link between self-reported BAP traits and objective measures of social abilities such as ToM is more challenging.

Performance on the AQ was similar to previous studies investigating autistic-like traits in neurotypical students (Baron-Cohen, Wheelwright, Skinner, et al., 2001; Freeth et al., 2013). In this sample, the overall mean score on the AQ was 17.25, with men scoring 19.81 and women scoring 15.15. These results are similar to Freeth et al. (2013) and Baron-Cohen, Wheelwright, Skinner, et al. (2001). The highest score on the AQ was 41, which is substantially above the recommended cut-off of 32 in neurotypical populations (Baron-Cohen, Wheelwright, Skinner, et al., 2001). In fact, 3 participants scored above the cut-off, indicating the presence of considerable autistic-like traits. However, removing these participants did not change the results of the present study.

The distribution of AQ scores reported here provides support for the notion that autistic-like traits lie on a continuum in the neurotypical population (Constantino et al., 2006; Constantino & Todd, 2005). Unfortunately, information regarding the incidence of participants with relatives with ASD was not collected in the current sample. Therefore, it is unclear whether the participants who scored higher on the AQ have a family history of ASD. Future studies would benefit from obtaining this information to provide a possible explanation for higher scores of participants in the neurotypical population. Future studies might also explore the broader, medium and narrow autism phenotype suggested by Wheelwright, Auyeung, Allison, and Baron-Cohen (2010). Using the AQ they defined the narrow autism phenotype (NAP) as scores which are ≥ 3 SD above the mean. Individuals on the NAP have a large number of autistic-like traits, and most (but not all) will have a diagnosis of ASD. An individual with the medium autism phenotype (MAP) has a medium number of autistic traits (defined as individuals scoring between 2 to 3 SDs above the mean on the AQ). Separating participants into these groups may allow for better analysis of the relationship between subclinical autistic-like traits and social cognitive abilities, since the social abilities of these different groups along the autism spectrum could then be examined.

Using the EQ, these results reaffirmed previous findings (Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004; Carroll & Chiew, 2006; Lawrence et al., 2004; Mar et al., 2006; Voracek & Dressler, 2006; Wheelwright et al., 2006) that women exhibit higher levels of self-reported empathy than men. Of the 5 participants (8%) who scored in the "ASD range" (i.e., equal to or fewer than 30 points), 4 of them were men. Moreover, the 17 participants who scored lower than 40 points on the EQ, 12 of them (70%) were men. Nevertheless, when interpreting the sex-related differences found in empathy, it is worth considering that sex differences have been found to be a function of the assessment methods used. In a meta-analysis, Eisenberg and Lennon (1983) found the largest effect sizes for sex-related differences favouring women in empathy with self-report scales. Moderate differences were found for self-report measures in laboratory situations. No sex-related differences were found for physiological or unobtrusive observations of nonverbal reactions to another's emotional state. Therefore, it is unclear whether the sex-related difference in EQ scores is due to the sex of participants or the self-report method used to measure empathy.

Unlike the findings of Freeth et al. (2013), who showed that female students scored significantly higher on the LSAS than their male counterparts, the present study did not find this sex-related difference. The present finding shows that neurotypical adults do not differ in self-reported levels of social anxiety, similar to Bourdon et al. (1988) and McLean et al. (2011). A possible reason for the contrary findings to Freeth et al. (2013) is sample size. Potential sex-related differences were investigated in 1325 students in Freeth et al.'s (2013) study; here the sample only consisted of 60 participants. Yet, Bourdon et al.'s (1988) sample consisted of 10,954 women and 7,618 men while McLean et al.'s (2011) consisted of 11,463 women and 8,550 men. Another potential explanation is age of the sample population. SAD has a very early onset (Stein & Stein, 2008) and the prevalence of SAD decreases with age (Grant et al., 2005; Kessler et al., 2005). The samples of Bourdon et al. (1988) and McLean et al. (2011) were much older than the current study, and Freeth et al. (2013). Consequently perhaps sex differences are present in younger adults, as found in Freeth et al.'s (2013) student population, however this study may have been under-powered and not able to detect the presence of sex-related differences in subclinical expressions of SAD. A similar limitation which may have impacted the results of the present study was that few participants reported experiencing high levels of social anxiety, resulting in less variance in the data.

There was a highly significant negative correlation between EQ scores and AQ scores. This is a common association found between empathy and autistic-like traits (Baron-Cohen et al., 2003; Baron-Cohen & Wheelwright, 2004; Carroll & Chiew, 2006). Moreover, autistic-like traits and social anxiety were positively correlated, much like the results reported by Freeth et al. (2013), White et al. (2011) and others. These results show that the presentation of less severe autistic traits is associated with difficulties in understanding the observed emotional experiences of another individual and increased levels of anxiety about social situations. Consequently, in populations like the current sample, there is a need to provide support for individuals who exhibit higher levels of the BAP. Especially in higher education situations, as the transition to university life is significant for students, both academically and socially (Hanley et al., 2015). This is further highlighted by previous research which has shown that the BAP can have adverse outcomes on real-world social functioning (Jobe & White, 2007; Wainer et al., 2011). For example, one study found that the BAP was associated with increase loneliness, fewer friendships and shorter durations of friendships in student populations (Jobe & White, 2007).

It is interesting to note that while previous imaging research has shown that ToM and empathy are related (Reniers et al., 2014), an association between affective ToM and empathy was not observed. However, these findings are similar to previous authors using the RME and self-report measures of empathy in younger neurotypical populations (Mar et al., 2006; Vellante et al., 2013). An important caveat of the imaging data is the researchers concluded that ToM and empathy were related because they activated the same brain regions. However similar activation does not always mean that cognitive processes are related, given the interconnectivity of neural networks. These findings suggest that perhaps empathy and ToM are not as related as previously proposed. Another reason for the lack of a significant correlation may be because these domains were measured using different methods. Empathy was assessed using a self-report questionnaire, while ToM was measured using a more objective measure. Similar to the results between the BAP and ToM, the lack of a significant correlation could potentially reflect the difficulties of pairing self-report and objective tests. To date, no study has compared self-report empathy to self-report ToM or objective measures of empathy to objective tests of ToM. Future studies might use objective and self-report measures of empathy and examine their relationship to ToM to further investigate this notion.

The neurotypical students in this study performed significantly better on affective ToM compared to cognitive ToM. This finding is similar to the findings reported elsewhere in the literature in younger adults (Bottiroli et al., 2016; Shamay-Tsoory et al., 2007). However, the findings in the present study are novel compared to those previously reported as it explicitly assessed cognitive and affective ToM in the same test. Unlike, Bottiroli et al. (2016) who adapted the Faux Pas test to measure cognitive and affective ToM. As I have previously argued, the Faux Pas test is primarily an affective ToM and social norm understanding test. Moreover, Shamay-Tsoory et al. (2007) used a basic cognitive and affective ToM test (JoP) with low ecological validity since participants simply have to point to the picture the face was thinking about/liked in the experimental task.

In this study it was possible to directly measure the disassociation between cognitive and affective ToM in a more ecological test, one that was specifically designed to assess cognitive and affective ToM in a single test. This finding adds further support for related but distinct aspects of ToM reported by several lesion and imaging studies (Sebastian et al., 2011; Shamay-Tsoory & Aharon-Peretz, 2007; Shamay-Tsoory et al., 2006; Shamay-Tsoory et al., 2005). These findings further emphasise the need to assess cognitive and affective ToM separately, rather than using composite tests such as Happé's Strange Stories test. Furthermore, employing tests which only assess single apects of ToM such as the RME may not provide a comprehensive representation of ToM performance.

Results showed that age positively predicted performance on cognitive ToM. However, in Chapter 3, increasing age predicted poorer scores on cognitive ToM. The participants in this study were relatively young (M = 22.38, SD = 3.22). Therefore it is reasonable to suggest that their cognitive ToM abilities may still be developing (De Luca et al., 2003). Moreover, some aspects of social cognition will undoubtedly be experienced based, so the youngest adults in the sample may not have been exposed to enough situations to effectively infer what an individual is thinking, as optimally as the older adults in the sample. The results of this study and those of Chapter 3 might suggest that our cognitive ToM ability may continue to develop to a certain age, reach an optimal level of effectiveness and then decrease as we get older. Further detailed investigation is needed before any conclusions can be drawn.

Finally, the results showed that participants with higher levels of education performed better on interpersonal understanding of social norms and overall on the ESCoT. In this instance, years of education accounted for 15% of the variance in interpersonal understand of social norms and 16% of the variance in overall performance. Higher levels of education were also found to significantly predict overall performance on the ESCoT in Chapter 4 with adults with ASD and neurotypical controls. In Chapter 3, years of education did not significantly predict overall performance on the ESCoT, nor did verbal comprehension and perceptual reasoning. Interestingly, in Chapter 3, there was a greater distribution of years of education (M = 15.70, SD = 3.00) compared to a much smaller distribution here (M = 16.37, SD = 1.23). It is currently unclear what could be behind this finding and future studies could examine the exactly nature for the effect of education, particularly when Chapter 3 and 4 did not find a significant effect of measures of IQ.

The present study showed the importance of considering sex when investigating such constructs as the BAP and empathy. It replicated previous findings examining the relationship between the BAP and empathy and the BAP and SAD in a neurotypical younger population. Moreover, this study was a further utilization of the ESCoT as a research tool. While measures of the BAP, empathy and social anxiety were not found to be associated with performance on the ESCoT, this study showed that the ESCoT is capable of replicating previous findings associated with sex-related differences in affective ToM and suggests a dissociation between cognitive and affective ToM performance. Moreover, it demonstrated some novel findings in terms of the relationship between cognitive ToM and age. Taken together, these results show that using the ESCoT can provide fresh and interesting insights in the study of social cognition.

Chapter 6: The clinical validity of the ESCoT: Relation to behaviour change in dementia

So far I have shown that the ESCoT is an advantageous and valid research tool. However, when the ESCoT was developed, the overall aim was to design a valid tool to aid in identifying social cognitive difficulties in clinical settings. Therefore, the aim of this chapter was to investigate whether the ESCoT would be sensitive to impairments in dementia.

Data in this chapter were collected by myself and Professor Abrahams.

6.1. Introduction

Many clinical disorders such as schizophrenia and bipolar disorder exhibit social cognitive impairments at initial presentation of the disease or as a consequence of disease progression (Green et al., 2015; Henry et al., 2015; Poletti et al., 2012). In addition to clinical disorders, neurodegenerative diseases often exhibit declines in social abilities and behaviour (Elamin et al., 2012; Shany-Ur et al., 2012). Additionally, social cognition may play an important role in the clinical care of neurodegenerative diseases like dementia (Elamin et al., 2012) in identifying patients who may need extra post-diagnostic support. Consequently, there is a critical necessity for tests which assess our social cognitive abilities in clinical settings (Henry et al., 2015). As previously mentioned, there are important limitations that hinder the use of current tests of social cognition in clinical settings. For example, few tests of social cognition examine more than one or two abilities within the same test, limiting their representation of our social abilities.

Alzheimer's disease (AD) is a progressive neurological disease which causes irreversible loss of neurons and eventually leads to a dementia. The main characteristics of AD includes progressive impairment in memory, judgment, decision making, orientation to physical surroundings, and language (Dubois et al., 2007). While they are poorly understood because of confounding variables such as general cognitive functioning, difficulties in social abilities are found in mild AD (Kemp et al., 2012). Frontotemporal dementia (FTD) consists of three subtypes, behavioural variant FTD (bvFTD), semantic dementia and progressive non-fluent aphasia (Rascovsky et al., 2011). Major hallmarks of bvFTD patients are insidious changes in personality and behaviour, but relatively intact performance on traditional frontal executive tasks (Rascovsky et al., 2011).

AD and frontotemporal dementia (FTD) are common types of dementia (Bora et al., 2015). AD is the most common form of dementia among older adults and FTD is the second-most common young-onset dementia (Poletti et al., 2012). Structured social cognition tests may be useful particularly in AD and bvFTD (Henry, Von Hippel, Molenberghs, Lee, & Sachdev, 2016) since traditional neuropsychological tests are limited at assessing social cognition (Bora et al., 2015; Gregory et al., 2002). Moreover, extensive research has shown that social cognitive abilities are impaired in dementias like AD and bvFTD (Bora et al., 2015; Gregory et al., 2002; Poletti et al., 2012).

6.1.1. ToM difficulties in patients with dementia

Brain regions which are important for ToM are specifically affected by neurodegenerative processes in patients with age-related pathologies (Kemp et al., 2012). However the research examining ToM in neurodegenerative patients is mixed. Research has shown that AD patients have intact first-order cognitive ToM abilities. Koff, Brownell, Winner, Albert, and Zaitchik (2004) found that compared to NC adults AD patients showed no deficits in their ability to attribute a false belief to another person or in identifying their own previous false beliefs. Yet, in another study, 65% of AD patients failed a second-order false belief test (Cuerva et al., 2001). Studies utilising both first and second-order false belief tests have shown that AD patients are impaired on second-order tests (Fernandez-Duque, Baird, & Black, 2009; Gregory et al., 2002) but show intact performance on first-order false belief (Gregory et al., 2002) or perform at ceiling (Fernandez-Duque et al., 2009) compared to NC adults. Youmans and Bourgeois (2010) examined first-order and second-order false belief tests with and without memory support in AD patients and NC adults. They found significant cognitive ToM difficulties when a memory support was provided and showed that group differences in ToM impairments were independent of comprehension and memory performance. However, it should be noted that in this study, first and second-order stimuli were combined for analysis, so these results may be difficult to interpret given the research discussed. With the exception of Youmans and Bourgeois (2010), the cognitive ToM impairments found in AD appear to be test specific, first-order false belief abilities are intact, compared to more demanding second-order false belief tests (Kemp et al., 2012). This has led to the suggestion that cognitive ToM impairments relating to false-belief tests in AD are secondary to more global cognitive impairments, rather than a primary cognitive ToM impairment (Kemp et al., 2012; Koff et al., 2004).

Similar inconclusive findings have been found for affective ToM. Laisney et al. (2013) and Castelli et al. (2011) have both reported impairments in the ability to infer what another individual is feeling in AD patients using the RME, but Gregory et al. (2002) found intact affective ToM on the RME. In the same study by Gregory et al., (2002), patients with AD performed as well as NC adults on the Faux Pas, but they failed the control questions. Moreover, a case report of a 75-year-old woman with AD showed no impairments on affective ToM assessed by the RME and Faux Pas (Modinos, Obiols, Pousa, & Vicens, 2009). From these studies, it is evident that research examining cognitive and affective ToM in AD patients is extremely convoluted.

The literature on bvFTD is much clearer, showing that ToM impairment is a robust finding in patients (Bora et al., 2015). Both cognitive and affective ToM are consistently and reliably impaired in these patients using such tests like the RME and false-belief (Eslinger et al., 2007; Fernandez-Duque et al., 2009; Gleichgerrcht, Torralva, Roca, Pose, & Manes, 2011; Gregory et al., 2002; Lough et al., 2006; Snowden et al., 2001; Snowden et al., 2003; Torralva et al., 2007). Gregory et al. (2002) showed that bvFTD patients were significantly impaired on first- and second-order cognitive ToM tests compared to NC, but they showed no difficulties with the control questions (used to examine general comprehension and memory). This has been replicated by Modinos et al. (2009) who reported a 64-year-old man with bvFTD who presented similar impairments in first-order and second-order false beliefs tests of cognitive ToM. However these results have only been partially supported by another study. Fernandez-Duque et al. (2009) showed intact performance for first-order false belief abilities, but impaired second-order false belief. In regards to affective ToM, impairments of this social cognitive ability has been found using the Faux Pas (Gregory et al., 2002; Torralva et al., 2007). Performance by bvFTD patients on the Faux Pas was significantly worse than NC, showing pronounced errors on the test. These included failing to identify when something hurtful or inappropriate had been said by one character and stating something inappropriate had been said intentionally. Moreover, other patients failed to accurately infer the belief states of the story characters. Similar findings has been observed in case reports by Modinos et al. (2009) using the Faux Pas. On the RME, bvFTD patients frequently attribute the wrong emotions to eye expressions compared to NC adults (Gregory et al., 2002; Lough, Gregory, & Hodges, 2001; Lough et al., 2006; Modinos et al., 2009; Torralva et al., 2007). These findings demonstrate that patients with bvFTD have difficulty inferring what another person is thinking and what they are feeling during social interactions.

To clarify the mixed findings from studies of AD patients, Poletti et al. (2012) conducted a meta-analysis in both AD and bvFTD patients. The results suggested that bvFTD and AD patients are impaired on cognitive ToM measured by second-order false-belief tests. Whereas bvFTD patients are markedly impaired on affective ToM assessed by the Faux Pas and RME. Findings on whether affective ToM is impaired in AD are inconclusive. A more recent a meta-analysis of 30 studies found that cognitive and affective ToM is impaired in both bvFTD (Cohen's d = 1.79) and AD (Cohen's d = 1.15) (Bora et al., 2015). BvFTD patients show more severe impairments in advanced social cognition tests such as the Faux Pas compared to AD patients, where their impairments are relatively modest (Bora et al., 2015). However on closer examination of the specific ToM abilities that are found to be impaired, the research is mixed, deficits in social abilities have been found, but inconsistently between studies.

6.1.2. Social norms understanding difficulties in patients with dementia

Inappropriate social behaviour and disregard for social rules are also found in bvFTD patients (Rascovsky et al., 2011). BvFTD patients are impaired in their interpersonal understanding of social norms abilities (Eslinger et al., 2007). Moreover, bvFTD patients struggle to recognise a faux pas in a social interaction (Bora et al., 2015), which could be argued as demonstrating an inability to make interpersonal judgements about social norms. In terms of intrapersonal understanding of social norms (i.e., how you should behave in a social interaction), the results are mixed. Similar to ToM in AD, deficits in social abilities have been found, but inconsistently between studies. BvFTD patients perform poorer than NC, but AD and bvFTD patients perform similarly (Possin et al., 2013). Other studies have failed to find a difference between bvFTD and NC populations (Baez et al., 2014; Lough et al., 2006). One recent study found that compliance to basic social norms can be maintained in bvFTD, however, more complex normative behaviours that require integration of social contextual information are impaired (O'Callaghan et al., 2016).

6.1.3. Interim summary

Neurodegenerative patients often exhibit declines in social abilities and behaviour; this is particularly true in patients with a diagnosis of dementia (Bora et al., 2015; Gregory et al., 2002; Poletti et al., 2012). Patients with bvFTD show reliable difficulties in their social abilities (e.g., Torralva et al., 2007) but this is not the case for patients with AD as some studies find impairment while others do not (Poletti et al., 2012). Overall, these studies suggest that social cognition can be affected in both AD and bvFTD although only some abilities are differentially affected. These observations provide the opportunity to examine the validity of the ESCoT as a clinical test of social cognition.

6.1.4. Rationale for the present study

The previous chapters have shown the ESCoT to be sensitive to social cognitive difficulties in ageing, ASD adults and sex differences in neurotypical younger adults. These studies show that the ESCoT is a valuable research tool to investigate social cognition. Given the advantages of the ESCoT over traditional tests in terms of ecological validity, effect sizes and the number of social cognitive abilities assessed in a single test, it has the potential to be useful in patients who may exhibit difficulties in their social cognitive abilities (e.g., Chapter 4). Therefore, the present study was interested in examining social cognitive impairments in patients using the ESCoT.

6.1.5. Aims of the present study

The aims of this chapter were to investigate whether the ESCoT could detect impairments in patients with dementia as compared with NC.

It was predicted that:

1. Patients would perform poorer than NC on all the subtests of the ESCoT.

6.2. Method

6.2.1 Participants

A total of 50 participants were recruited for this study. They consisted of 25 patients who were attending a young onset dementia service (males = 16) who were diagnosed according to the current consensus criteria for bvFTD (n = 9) (Rascovsky et al., 2011), AD (n = 12) (Dubois et al., 2007) and amnestic Mild Cognitive Impairment (MCI; n = 4) (Albert et al., 2011). These patients were recruited through The Edinburgh Cognitive Diagnosis Audit Research and Treatment Register (ECog-DART), which was approved by the Scotland A Research Ethics Committee (12/SS/0196).

Age, education and IQ matched NC were taken from participants in Chapter 3 (n = 25; males = 12). These participants were recruited using online advertisement and through a research volunteer panel at the University of Edinburgh. None of the NC had any self-reported history of neurological or psychiatric disorders based on the Wechsler Adult Intelligence Scale (WAIS-III) exclusion criteria (Wechsler, 1997). All participants were administered the tests of social cognition (listed below). The standardized neuropsychological tests, described below, were administered to the patient group only.

A summary of the demographic information for the patients and NC are reported in Table 12.

6.2.2. Materials

6.2.2.1. Measures for patients

The neuropsychological tests were completed as part of the patients' clinical care and were administered by Professor Sharon Abrahams. Premorbid IQ was assessed using the Test of Premorbid Functioning (TOPF) (Wechsler, 2011a).

Patients were assessed on five cognitive domains (memory, executive function, fluency, language, and visuospatial function). Memory (recall and recognition) was assessed using the BIRT Memory and Information Processing Battery (BMIPB) (Coughlan, Oddy, & Crawford, 2007). Executive functions were investigated using the Trail Making test (Reitan, 1955; Reitan & Wolfson, 1993), letter fluency (Abrahams et al., 2000) and the Card Sorting test from Delis-Kaplan Executive Function System (Delis, Kaplan, & Kramer, 2001). Language functions were assessed using the Graded Naming test (McKenna & Warrington, 1983), the Warrington spelling test (Baxter & Warrington, 1994) and the Test for the Reception of Grammar (TROG) (Bishop, 2003). Visuospatial skills were examined using a subsection of the Visual Object and Space Perception Battery (Warrington & James, 1991).

Patients completed the Edinburgh Cognitive and Behavioural Amyotrophic Lateral Sclerosis Screen (ECAS) (Niven et al., 2015) which is a brief cognitive and behavioural assessment routinely used in this clinic. While the ECAS was developed for patients with Amyotrophic Lateral Sclerosis, some of these patients suffer from FTD symptoms and it has been shown to be sensitive to FTD clinically. The ECAS assesses memory, executive functions, fluency, language and visuospatial abilities. Patients could score a maximum of 135 on the cognitive assessment, with a cut-off score of 105 or below suggestive of abnormal performance.

6.2.2.2. Assessment of behaviour change in patients

Behaviour change was assessed using the Frontal Behaviour Inventory (FBI) (Kertesz, Davidson, & Fox, 1997).

6.2.2.3. Measures for NC adults

In the NC group, the WASI-II (Wechsler, 2011b) was used to assess IQ. A full description of the WASI-II can be found in Chapter 3, section 3.2.2.1.

6.2.2.4. Measures of social cognition for patients and NC adults

To assess social cognition, all participants completed the ESCoT, the RME (Baron-Cohen, Wheelwright, Hill, et al., 2001) and the SNQ (Rankin, 2008). A full description of these tests of social cognition can be found in Chapter 3, section 3.2.2.3.

6.2.3. Procedure

All participants completed the tests of social cognition in one session which took approximately 1.5 hours to complete. NC completed the WASI in the same session, while the FBI was administered to a caregiver after the patients completed the battery of social cognition tests.

6.2.4. Statistical Analyses

The analysis for this chapter was divided into two sections. Firstly, performance of a total patient group (12 AD, 9 bvFTD and 4 MCI) was compared to performance of NC on the ESCoT, RME and SNQ. These were conducted using parametric and non-parametric analyses based on initial exploratory analyses (Shapiro-Wilk test, $p > 0.05$). The statistical techniques applied in previous Chapters were used here (ANOVAs, Friedman Test and Mann-Whitney *U).* Post hoc comparisons were conducted using Hochberg's GT2 where appropriate and *p*-values were adjusted using Holm corrections. The alpha values were set at $p < 0.05$. ESCoT subtest raw scores were age-adjusted based on the findings from Chapter 3. Correlational analysis was conducted using Spearman's rank correlation to examine any potential relationships between the ESCoT and the ECAS in the patient group in this section as well. Next, a preliminary subgroup analysis was undertaken and the patient group were divided based on diagnosis (AD, bvFTD, MCI) and their performance was compared to NC. Amnestic MCI exhibit relative high rates of conversion rates to AD (Mauri, Sinforiani, Zucchella, Cuzzoni, & Bono, 2012) and show social cognitive impairments (Bora & Yener, 2017). Consequently due to few patients in this group, they were combined into the AD group. This section used the same statistical techniques as the previous section.

6.3. Results

Data were missing from the patient groups for several of the neuropsychological measures and tests of social cognition, these are highlighted beneath each individual table.

6.3.1. Patients and NC

Firstly, data from the patient group and NC adults were compared (see Appendix 1.7 for neuropsychological testing of patients).

6.3.1.1. Table 12. Demographic data for patients and NC adults

	Patients (n = 25)	NC (n = 25)	p-value
Age (SD)	62.28 (6.27)	62.64 (9.12)	$p = 0.872$
Years of education	12.06 (2.25)[a]	13.32 (2.05)	$p = 0.051$
IQ*	102.57 (10.81)[b]	108.68 (14.96)	$p = 0.126$

*IQ was assessed using the TOPF (Test of premorbid functioning) for patients and WASI-II (Wechsler Abbreviated Scale of Intelligence. [a] patients, n = 24, [b] patients, n = 21

6.3.1.2. Table 13. Performance of patients on the ECAS

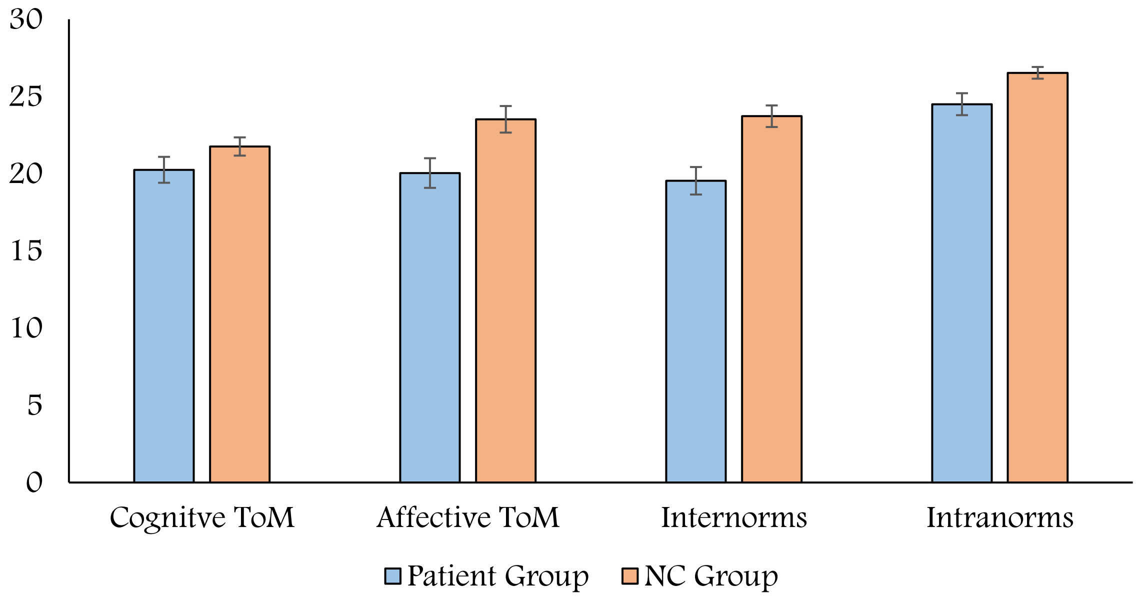
	Maximum score	Patients (n = 25)	Numbers impaired*
Language	28	21.89 (5.13)	17
Fluency	24	7.11 (6.09)	14
Executive functions	48	19.44 (8.63)	19
Memory	24	9.22 (6.22)	19
Visuospatial	12	10.67 (1.66)	8
Total	136	71.33 (19.08)	21

*Cut-offs from Niven et al. (2015).

6.3.1.3. Comparison between patient group and NC on tests of social cognition

Performance on the tests of social cognition were investigated between the patient group and NC adults on the ESCoT, RME and SNQ.

6.3.1.3.1. Figure 21. Performance of patients and NC on the ESCoT



Error bars = Standard error

Comparisons using a Mann-Whiney *U* test between patients (M = 84.33, SD = 13.37) and NC (M = 95.52, SD = 7.80) on ESCoT total scores showed a significant difference (U = 149.50, p = 0.003). On the subtests of the ESCoT (Figure 21) the patient group performed significantly worse than NC on affective ToM ($t(47)$ = -2.71, p = 0.009) interpersonal understanding of social norms ($t(47)$ = -3.72, p = 0.001) and intrapersonal understanding of social norms ($t(35.57)$ = -2.51, p = 0.014). The groups did not significantly differ on cognitive ToM ($t(47)$ = -1.49, p = 0.114).

6.3.1.3.2. Table 14. Means (*SD*) of patients and NC on the RME and SNQ

Test of social cognition	Patients (n = 25)	NC (n = 25)
RME	23.41 (6.22)[a]	26.68 (3.67)
SNQ	17.57 (2.29)[b]	19.20 (1.58)

[a]patients n = 22; [b]patients n = 23.

The groups did not significantly differ on the RME (U = 189.00, p = 0.07) but did significantly differ on the SNQ (U = 161.00, p = 0.008); the NC group performed better than the patients.

6.3.1.4. Examining the number of patients impaired on the ESCoT

Using the cut-off scores calculated in Chapter 4, the number of patients who were impaired on the ESCoT was summated.

6.3.1.4.1. Table 15. Percentage of patients impaired on the ESCoT based on cut-off scores from Chapter 4

	% of patients impaired (n = 24)
Cognitive ToM	20.83%
Affective ToM	37.50%
Interpersonal understanding of social norms	37.50%
Intrapersonal understanding of social norms	29.16%
ESCoT total	37.50%

According to the cut-offs derived in Chapter 4, more patients were impaired on affective ToM and interpersonal understanding of social norms compared to the other two subtests, the least percentage of patients were impaired on cognitive ToM. Total scores showed similar levels of impairments as affective ToM and interpersonal understanding of social norms.

6.3.1.5. Examining the associations between the ECAS and measures of social cognition in patients

Potential relationships between performance on the ECAS domains and tests of social cognition were examined using Spearman's correlations to determine whether these variables were significantly related in the patient group.

6.3.1.5.1. Table 16. Correlations between the ECAS and tests of social cognition

	Cognitive ToM	Affective ToM	Interpersonal understanding of social norms	Intrapersonal understanding of social norms	ESCoT total	RME	SNQ
Language	0.26	0.40	0.40	0.19	0.35	0.49	**0.62***
Fluency	0.17	0.23	0.48	0.03	0.27	0.24	0.52
Executive function	0.27	0.45	**0.59***	0.37	0.47	0.24	0.54
Memory	0.07	0.31	0.05	0.33	0.19	0.11	0.17
Visuospatial	0.24	0.21	0.28	-0.11	0.20	0.07	0.12
ECAS total	0.27	0.38	0.47	0.22	0.39	0.38	0.53

*$p < 0.05$. Significant correlations are in bold. p-values were adjusted using Holm corrections

Table 16 shows that the only significant correlations after Holm corrections were between performance on language of ECAS and the SNQ, and executive functions of the ECAS and interpersonal understanding of social norms. Better performance on language and executive functions correlated with better performance on social norm understanding.

6.3.2. Subtypes of dementia patients and NC adults

To examine the sensitivity of the ESCoT at identifying social cognitive impairments in different subtypes of dementia, preliminary analyses were undertaken between the subgroups where the performance of AD and bvFTD patients were compared to the NC adults. Amnestic MCI exhibit relatively high rates of conversion rates to AD (Mauri et al., 2012) and show social cognitive impairments (Bora & Yener, 2017). Consequently, due to the low numbers in the groups, amnestic MCI and AD patients were combined to an AD/MCI group. These analyses were preliminary due to the relatively small sample of AD/MCI and bvFTD patients.

Demographic information and neuropsychological testing of FTD and AD/MCI patients for this analysis can be found in Tables 17 and 18 below.

6.3.2.1. Table 17. Demographic information of patients by subtypes and NC adults

	FTD (n = 9)	AD/MCI (n = 16)	NC (n = 25)	p-value
Age (SD)	65.33 (6.44)	60.56 (5.66)	62.64 (9.12)	$p = 0.338$
Years of education	11.78 (2.22)	12.23 (2.32)[a]	13.32 (2.05)	$p = 0.087$
IQ*	98.00 (10.02)[b]	104.86 (10.80)[c]	108.68 (14.96)	$p = 0.301$

*IQ was assessed using the TOPF (Test of premorbid functioning) for patients and WASI-II (Wechsler Abbreviated Scale of Intelligence) for NC. [a]AD/MCI, n = 15; [b]FTD, n = 7; [c]AD/MCI, n = 14.

6.3.2.2. Table 18. Neuropsychological testing of FTD and AD/MCI patients

	FTD (n = 9)	AD/MCI (n = 16)	p-value
Memory			
BMIPB – story recall			
Immediate	13.56 (7.97)	10.94 (7.48)	$p = 0.187$
Delay	10.89 (9.05)	7.69 (7.67)	$p = 0.452$
% retained	69.67 (43.41)	60.00 (41.22)	$p = 0.718$
BMIPB – figure recall			
Copy	73.78 (11.73)	72.80 (9.77)[a]	$p = 0.379$
Immediate recall	44.33 (18.14)	32.56 (18.94)	$p = 0.144$
Delayed recall	37.33 (21.57)	29.40 (20.54)[a]	$p = 0.378$
% retained	80.78 (18.32)	76.20 (28.13)[a]	$p = 0.861$
BMIPB – FSCRT			
Free recall	13.63 (7.09)[b]	13.19 (8.16)	$p = 0.899$
Cued	43.25 (3.69)[b]	36.00 (10.26)	**$p = 0.020$**

Sensitivity to cuing (%)	85.75 (10.58)[b]	72.67 (22.04)[a]	$p = 0.068$
Delay	4.88 (1.73)[b]	3.54 (3.80)[c]	$p = 0.132$
Cued	14.63 (1.51)[b]	11.85 (3.98)[c]	$p = 0.093$
Executive functions			
Trail Making Test (seconds)			
Part A	48.25 (21.43)[b]	50.06 (23.46)	$p = 0.928$
Part B	118.86 (35.90)[d]	115.25 (78.00)[e]	$p = 0.432$
Letter fluency			
Total score	17.33 (14.37)	33.31 (15.46)	**$p = 0.014$**
Animal fluency	12.14 (4.81)[d]	14.50 (4.24)	$p = 0.252$
D-KEFS card sorting (scaled score)	8.00 (2.07)	7.88 (3.18)	$p = 0.734$
Language functions			
Graded naming test	13.33 (8.86)	17.69 (7.25)	$p = 0.196$
Warrington spelling test	17.43 (10.23)[d]	22.09 (6.56)[g]	$p = 0.253$
TROG	34.17 (7.78)[f]	37.92 (15.83)[c]	$p = 0.791$
Visuospatial			

Number location	8.20 (1.92)[g]	6.60 (3.63)[h]	*p* = 0.751
Dot counting	9.80 (0.45)[g]	9.90 (0.32)[h]	*p* = 0.604
Behaviour change			
FBI			
Negative behaviours	22.80 (3.56)[g]	8.69 (8.02)[c]	***p* = 0.007**
Disinhibition	16.80 (5.67)[g]	5.62 (5.99)[c]	***p* = 0.012**
Total	39.60 (7.30)[g]	14.31 (13.44)[c]	***p* = 0.007**

BMIPB, BIRT Memory and Information Processing Battery; FSCRT, Free and selective cued reminding test; D-KEFS, Delis-Kaplan Executive Function System; TROG, Test for Reception of Grammar; FBI, Frontal behaviour inventory. Significant group differences are in bold. [a]AD/MCI n = 15; [b]bvFTD n = 8; [c]AD/MCI n = 13; [d]bvFTD *n* = 7; [e]AD/MCI n = 12; [f]bvFTD n = 6; [g]AD/MCI n = 11; [g]bvFTD n = 5; [h]AD/MCI n = 10; Number of patients in each group.

As Table 18 shows, the bvFTD group and AD/MCI group did not differ on many of the neuropsychological tests. The two groups showed significant differences on the cued recall of the FSCRT. On this measure of memory, the MCI/AD group performed poorer than the bvFTD group. The groups significantly differed on letter fluency, with bvFTD patients showing poorer performance. The bvFTD also exhibited significantly more behaviour changes than the AD/MCI group as reported by a caregiver.

6.3.2.3. Table 19. Performance of FTD and AD/MCI patients on the ECAS

	Maximum score	FTD (n = 9)	AD/MCI (n = 16)	p-value	Numbers impaired*
Language	28	21.89 (5.13)	24.38 (5.19)	$p = 0.127$	17 (7 bvFTD, 10 AD/MCI)
Fluency	24	7.11 (6.09)	14.81 (6.92)	**$p = 0.011$**	14 (8 bvFTD, 6 AD/MCI)
Executive functions	48	19.44 (8.63)	30.31 (9.82)	**$p = 0.011$**	19 (9 bvFTD, 10 AD/MCI)
Memory	24	9.22 (6.22)	7.06 (6.18)	$p = 0.411$	19 (6 bvFTD, 13 AD/MCI)
Visuospatial	12	10.67 (1.66)	11.00 (2.00)	$p = 0.409$	8 (4 bvFTD, 4 AD/MCI)
Total	136	71.33 (19.08)	87.31 (24.15)	$p = 0.102$	21 (9 bvFTD, 12 AD/MCI)

Significant group differences are in bold. *Cut-offs from Niven et al. (2015).

As Table 19 shows, the bvFTD group significantly differed from the AD/MCI groups on measures of fluency and executive functions on the ECAS. In both cases, they performed poorer than the AD/MCI group. It is evident that both groups were cognitively impaired, as all FTD patients and 12/16 AD/MCI patients scored below the clinical cut-off (105) for the ECAS.

6.3.2.4. Table 20. Mean (*SD*) performance of bvFTD, AD/MCI patients and NC on the tests of social cognition

Social cognition tests	bvFTD (n = 8)	AD/MCI (n =16)	Controls (n = 25)	p-value	Post hoc
ESCoT total	78.50 (15.28)	87.25 (11.75)	95.52 (7.10)	**p = 0.005**	NC > bvFTD & AD/MCI
Cognitive ToM	19.25 (4.53)	20.75 (3.92)	21.76 (2.95)	p = 0.284	–
Affective ToM	18.63 (6.59)	20.75 (3.49)	23.52 (4.28)	**p = 0.020**	NC > bvFTD
Interpersonal understanding of social norms	17.25 (3.58)	20.69 (4.33)	23.72 (3.48)	**p < 0.001**	NC > bvFTD & AD/MCI
Intrapersonal understanding of social norms	23.38 (3.54)	25.06 (3.39)	26.52 (1.92)	**p = 0.020**	NC > bvFTD
RME	22.38 (8.03)	24.00 (5.16)[a]	26.68 (3.67)	p = 0.077	–
SNQ	17.00 (2.20)	17.87 (2.36)[b]	19.20 (1.58)	**p = 0.017**	NC > bvFTD

[a]AD/MCI = 14; [b]AD/MCI n = 15; Number of patients in each group. Post hoc comparisons were conducted using Hochberg's GT2. p-values were adjusted using Holm corrections. Significant group differences are in bold.

6.3.2.5. Examining the number of patients impaired on the ESCoT

Using the cut-off scores calculated in Chapter 4, the number of dementia patients who were impaired on the ESCoT was investigated.

6.3.2.5.1. Table 21. Percentage of patients impaired on the ESCoT based on cut-off scores from Chapter 4

	bvFTD (n = 8)	AD/MCI (n = 16)
Cognitive ToM	12.5%	25.0%
Affective ToM	62.5%	25.0%
Interpersonal understanding of social norms	62.5%	25.0%
Intrapersonal understanding of social norms	37.5%	25.0%
ESCoT total	50.0%	31.3%

More patients with a diagnosis of AD/MCI were impaired on cognitive ToM than bvFTD patients while this was the reverse for affective ToM and inter-and intrapersonal understanding of social norms. Here, more bvFTD than AD/MCI patients were impaired. Finally, half of the bvFTD patients were impaired on ESCoT total scores compared to 31.5% of AD/MCI patients.

6.4. Discussion

The aim of the present study was to investigate the sensitivity of the ESCoT in patients with dementia. Even with a small sample of patients (n = 24), the ESCoT was sensitive to social cognitive impairments in patients compared to NC. As predicted, patients were impaired compared to NC on ESCoT total scores, affective ToM and inter-and intrapersonal understanding of social norms. However, the groups did not differ on cognitive ToM. Correlational analyses showed a significant relationship between social norms understanding and fluency and executive functions measured by the ECAS. Moreover, preliminary results showed that ESCoT total scores and interpersonal understanding of social norms were sensitive to impairments in bvFTD and AD/MCI patients. Affective ToM and intrapersonal understanding of social norms were impaired in bvFTD patients compared to NC.

Poorer performance of the patients compared to NC is consistent with previous research on tests of social cognition (Bora et al., 2015; Gregory et al., 2002; Poletti et al., 2012); suggesting that the ESCoT is sensitive to the social cognitive impairments found in patients with dementia. Consequently, the ESCoT may be a helpful clinical test for clinicians to use with patients who they suspect may have difficulties in social cognition. This study adds to the literature showing that patients experience difficulties in affective ToM (Poletti et al., 2012) and could potentially explain the difficulties patients face in their interpersonal relationships when engaging in social situations with others since they appear to show impairments in inferring what another person is feeling. Unlike previous literature (Bora et al., 2015; Poletti et al., 2012) the present study did not find a difference on cognitive ToM between NC and patients. This is an unexpected finding since the patients showed impairment in affective ToM and may suggest dissociation in performance on the two aspects of ToM in patients. Perhaps in patients, compared to cognitive ToM, their affective ToM abilities are more sensitive to neural changes as a consequence of neurodegeneration. These findings also contrast to Chapter 3 in which age-related differences were found for both cognitive and affective ToM. Altogether these two findings suggest a different pattern of impairments for healthy and pathological ageing. Future studies could examine this finding more closely by investigating healthy and pathological ageing within the same study.

The patients in this study showed impairments on both inter-and intrapersonal understanding of social norms compared to NC adults. This is consistent to the literature on these social cognitive abilities (Bora et al., 2015; Eslinger et al., 2007; Possin et al., 2013). Compared to NC adults, but similar to the ASD adults in Chapter 4, patients show marked impairments in understanding how someone else should behave in a social interaction and how they should behave themselves. The observation that ASD adults and patients experience difficulties in these two abilities is concurrent with the difficulties both groups face in social interactions (Baez et al., 2012; Eslinger et al., 2007). The present study added a novel finding to research on inter-and intrapersonal understanding of social norms since it examined these two abilities within the same test. Here, it was also shown that performance on interpersonal understanding of social norms was associated with better performance on executive functions. Perhaps to understand how someone else should behave in a social interaction, an individual needs to recall a list of social norms, inhibit their own opinions of how to behave, and apply this information to another person. This is another novel finding using the ESCoT since research only typically examines the relationship between ToM and executive functions (Gregory et al., 2002; Lough & Hodges, 2002; Lough et al., 2006). According to the results of the correlational analysis, the influence of executive functions on a patient's interpersonal understanding of social norms warrants future investigations. The only caveat for this finding is that it is unclear which executive function was significantly associated with interpersonal understanding of social norms. Therefore future studies could examine this relationship by investigating individual executive functions.

While the numbers of the groups were small, splitting the patient group by diagnosis did show some intriguing preliminary results. Firstly, it highlighted the mixed findings of cognitive ToM in dementia research. As no statistically significant difference was found between the groups, this is similar to previous researchers for AD patients (Koff et al., 2004) and bvFTD (Fernandez-Duque et al., 2009) but inconsistent to results typically found for bvFTD patients on cognitive ToM (Bora et al., 2015). It is worth noting that the cognitive ToM question in this study was a first-order cognitive ToM question which may explain the null findings, as second-order cognitive ToM questions typically find significant group differences (Kemp et al., 2012). The impaired affective ToM abilities found in the bvFTD group adds to the usual findings for this social cognitive ability when compared to performance of NC adults (Gregory et al., 2002; Lough et al., 2001; Lough et al., 2006; Modinos et al., 2009; Torralva et al., 2007). It was also shown that compared to AD patients, bvFTD patients are impaired on affective ToM while AD and NC adults do not significantly differ, which has been previously found (Funkiewiez, Bertoux, de Souza, Lévy, & Dubois, 2012). Affective ToM appears to be more significantly impaired in bvFTD than AD which may explain why this group reports more difficulties in social interactions (Bora et al., 2015).

Like Possin et al. (2013) but not others (Baez et al., 2014; Lough et al., 2006), it was found that bvFTD patients performed poorer than NC on intrapersonal understanding of social norms, but bvFTD and AD patients did not differ. This may have been due to the small sample size of the groups. Alternatively, it could have been because the intrapersonal understanding of social norms subtest of the ESCoT requires integration of social contextual information, which has been shown to be impaired in bvFTD patients (O'Callaghan et al., 2016). The ESCoT is the first test to objectively measure inter-and intrapersonal understanding of social norms abilities in the same test in a dementia population. Poorer performance in the bvFTD group on inter-and intrapersonal understanding of social norms compared to NC may explain the socially inappropriate behaviours frequently seen in these patients (Rascovsky et al., 2011). The results suggest that they are unable to explain why another individual behaved appropriately or inappropriately in a social interaction or how themselves would have behaved in the interaction.

Based on the cut-off scores, it would seem that, in bvFTD patients, affective ToM and interpersonal understanding of social norms are the most impaired social abilities on the ESCoT compared to AD/MCI patients. The cut-off scores also show that bvFTD patients are more impaired on the ESCoT than AD/MCI patients, similar to previous findings by Bora et al. (2015), this is particularly evident for ESCoT total score where 50% of patients were impaired compared to 31.5% of AD/MCI patients. Since similar to previous suggestions (Bora et al., 2015), the traditional neuropsychological tests were limited in their ability to differentiate bvFTD and AD/MCI. While the study sample size is limited, these results provide preliminary evidence that the ESCoT could be used to differentiate these two types of dementia.

In this study, it was found that, unlike the RME, the ESCoT was sensitive to impairments in the patients with dementia, showing a clear advantage over this established test. The SNQ demonstrated a significant difference between bvFTD and NC. However, it only measures a single social cognitive ability. On the other hand, the ESCoT assesses four abilities in the same test, giving clinicians a more representative view of the abilities that are used in social interactions. However, there are limitations that should be addressed. Firstly, the sample of dementia patients, especially in the FTD group, was limited, which may explain the null finding in cognitive ToM. This was a particularly unexpected finding since previous studies have shown that both bvFTD and AD are impaired on this social ability (Poletti et al., 2012). Another limitation relating to sample size was combining the AD and MCI patients. While MCI patients exhibit relative high rates of conversion rates to AD (Mauri et al., 2012) and show social cognitive impairments (Bora & Yener, 2017) combining patients in the prodromal stages of neurodegeneration, who are more functionally independent, with those with a diagnosis of AD may have inflated the performance of the AD patients, skewing the performance of this group. Consequently, future studies should use larger sample sizes to examine cognitive and affective ToM in dementia patients separately. Furthermore, both of the dementia groups were impaired, with 84% (21/25) of patients scoring below cut-off on the ECAS. Therefore, it is difficult to conclude whether the social cognitive impairments observed were independent of general cognitive functioning.

In the present study, it was demonstrated that patients experience difficulties in the abilities that are required for successful social interactions. Moreover, the results of this study provide validation of the ESCoT as a test of social cognition in patients with dementia and patients with bvFTD. Consequently, there is evidence to suggest that the ESCoT may be a useful clinical test of social cognition.

Chapter 7: The positivity bias, age and stimuli type

The previous chapters have investigated social processes in healthy ageing, ASD adults, younger adults and patients with dementia. In Chapter 3, I found that affective ToM performance was negatively predicted by increasing age, suggesting an age-related difference in the ability to infer what another individual is feeling. However, this is only one aspect of processing emotional information, other abilities may remain intact, and may be less susceptible to age-related changes. The following chapter returns to examining the consequences of healthy ageing on social processes. Here I looked at the relationship between the positivity bias found in older adults and its relationship to different types of stimuli in older, middle-aged and younger neurotypical adults.

Data in this chapter were collected by myself.

7.1. Introduction

The ability to process emotive content is an important skill for individuals because it is required for social functioning (Keltner & Gross, 1999; Keltner & Haidt, 1999). As Chapter 3 demonstrated, healthy ageing is associated with a change in affective ToM. This finding suggest that this social cognitive ability is negatively predicted by age and as individuals get older, they demonstrate measurable differences in affective ToM compared to their younger counterparts.

While affective ToM inferences are important, it is not the only emotive content we process in our environment (Adolphs, 2009). Age-related changes in affective ToM abilities leads to the question of what is the consequence of healthy ageing on our ability to process other emotional content. Indeed, there is research to suggest that the processing of emotional information changes with age. For instance, with declines in physical health and cognitive abilities, there is reason to believe well-being would decrease with age (Mather & Carstensen, 2005). Yet with advancing age, older adults experience improvements in emotional well-being (Scheibe & Carstensen, 2010). Researchers have argued that this is partly due to age-related changes in the processing of emotional information (Carstensen & Mikels, 2005). With an ever-increasing ageing population, the relationship between ageing and the changes to specific processes is one of the important issues to be solved (Meguro et al., 2001). Consequently, it would be interesting to examine this age-related change in greater detail.

7.1.1. The Socioemotional Selectivity Theory

The Socioemotional Selectivity Theory proposes that the perception of time plays a fundamental role in the selection and pursuit of social goals, specifically informational-focused goals (collecting new information) or emotion-related goals.

It suggests that when time is perceived as expansive, individuals concentrate on gathering information and experiencing novel situations. When constraints on time are perceived, an individual will prioritise regulating emotional states to optimise well-being and maximise the limited time. According to the Socioemotional Selectivity Theory, as individuals get older, the assessment of time left to live causes a shift in importance from information forced goals to emotion-related goals (Carstensen, 1993; Carstensen, Isaacowitz, & Charles, 1999; English & Carstensen, 2015; Mather & Carstensen, 2005).

There is empirical evidence to support the Socioemotional Selectivity Theory in both younger and older adults. Previous authors have shown that when individuals are asked whom they would choose to spend time with, younger adults indeed show a preference for novel situations and gathering social information. This is in contrast to older adults who prefer spending time with friends and family members (Fredrickson & Carstensen, 1990; Fung, Carstensen, & Lutz, 1999). Additionally, Carstensen and Fredrickson (1998) found that younger adults with terminal illnesses tend to show the same preference for emotion-related goals as older adults. When older adults are asked to imagine medical advances which would offer them longer life, they show a preference for information-focused goals commonly found in younger adults (Fung et al., 1999). Recently Barber, Opitz, Martins, Sakaki, and Mather (2016) asked younger and older participants to think of time as limited or expansive while completing a recall task of emotional stimuli. They found that regardless of age, when participants were asked to imagine time as limited, this improved their ability to recall positive stimuli.

7.1.2. The positivity bias

A consequence of the time constraints faced by older adults to prioritise emotional gratification could result in changes in the way emotional information is processed, potentially favouring positive information when attending to or recalling information (Barber et al., 2016). Indeed, one prediction of the Socioemotional Selectivity Theory is that since older adults are particularly focused on emotion-related goals associated with emotional satisfaction, their processing of information should shift towards positive information (Reed, Chan, & Mikels, 2014).

Based on this notion of age-related differences in processing information suggested by the Socioemotional Selectivity Theory, Mather and Carstensen (2003) tested whether emotionally gratifying biases influence initial attention. Their assumption was that, when viewing faces, older adults would orientate towards positive and away from negative stimuli. They investigated the influence of sad, angry and happy faces on the attentional resources of younger and older adults using a dot-probe task. One emotional and one neutral face appeared side by side on a computer screen for one second. Once these faces disappeared, a dot appeared behind one of the faces and participants were instructed to respond to the dot. When older adults were shown pairings of neutral and negative faces, they were faster to respond to the target stimulus if a neutral face preceded it. Moreover, older adults were faster when the dot appeared behind positive faces than neutral faces; younger adults did not show this preference. Overall, it was demonstrated that older adults appeared to significantly attend to positive faces over negative faces. Based on these findings, the authors suggested that an age-related positivity bias exists for older adults (Reed et al., 2014).

7.1.3. Support for a positivity bias in older adults

Since the publication of the original study by Mather and Carstensen (2003), the positivity bias has been studied extensively in healthy ageing (Reed et al., 2014). Researchers have found supporting evidence for the positivity bias in an array of domains such as eye tracking (Isaacowitz, Wadlinger, Goren, & Wilson, 2006a, 2006b) where older adults exhibited a significant preference away from negative faces and toward positive ones. Older adults attended more to happy than to sad faces but younger adults did not show such a preference. Researchers have also found the positivity bias in decision-making between older and younger adults. For example, when asked to review choice criteria that contained positive, negative, and neutral information, older adults reviewed and recalled a greater proportion of positive than of negative information compared with young adults (Löckenhoff & Carstensen, 2007). Similar results have been found between older and younger adults when remembering choices about decisions they made, like choosing the best university to attend from a list of advantages and disadvantages (Mather, Knight, & McCaffrey, 2005), word lists (Piguet, Connally, Krendl, Huot, & Corkin, 2008) and health messages (Shamaskin, Mikels, & Reed, 2010).

The positivity bias has been extensively studied in memory. In one autobiographical memory study (Kennedy, Mather & Carstensen 2004), older participants showed a tendency to remember their past more positively compared to younger adults. Charles, Mather, and Carstensen (2003) found better long-term memory for positive information over negative information in older adults compared to younger adults. While working memory abilities for verbal and visual information are found to be lower in older compared to younger adults (Park et al., 2002), working memory involving emotional stimuli are unimpaired in older adults (Mikels, Larkin, Reuter-Lorenz, & Carstensen, 2005). Mikels et al. (2005) also showed that, while older adults performed better on positive relative to negative emotion trials, this pattern of performance was reversed for younger adults. Other studies have found that older adults tend to remember their decisions as being associated with more positive outcomes compared to younger adults (Mather & Johnson, 2000). Moreover, as individuals age, they can recall and recognize more positive and fewer negative stimuli compared to younger adults

(Charles et al., 2003; Mather & Knight, 2005). Other studies have shown that emotional memory for words and faces also shows a small positivity bias as both older and younger adults recall proportionately more positive than neutral and negative words and faces. However, this effect is slightly more evident in older adults (Leigland, Schulz, & Janowsky, 2004). Rapid visual attention related to the recognition of emotional stimuli also demonstrates a positivity bias in older adults (Steinmetz, Addis, & Kensinger, 2010). Finally, a recent meta-analysis of 100 empirical studies showed the age-related positivity bias is reliable, and increases in magnitude as the age disparity between younger and older adults increases (Reed et al., 2014).

7.1.4. Evidence for no positivity bias in older adults

The results discussed above suggest that the positivity bias is an observable effect in healthy ageing that is generalizable in terms of stimuli. Nonetheless, there are studies which have contested the existence of the positivity bias. These studies have found minimal or no age-related differences in preference for positive over negative information due to differing paradigm of measuring the effect (Gallo, Foster, & Johnson, 2009; Grühn, Smith, & Baltes, 2005; Majerus & D'Argembeau, 2011; Williams & Drolet, 2005).

Some research suggests that the positivity bias is not a general theory of older adults preferring positive information over negative (Murphy & Isaacowitz, 2008). When attention to emotional stimuli in older adults has been assessed in voices, matching faces to voices and in bodies/contexts, mixed findings have been found with some studies finding an age-related preference for positive stimuli over negative but others failing to find this effect (Murphy & Isaacowitz, 2008; Reed & Carstensen, 2012). While Isaacowitz et al. (2006b) found partial support for a positivity bias, older adults showed an attentional preference toward happy faces and away from angry ones; the only preference shown by young adults was toward afraid faces. Another study failed to show a significant difference between younger and older adults for negative–neutral pairings with the dot-probe task (Isaacowitz et al., 2006a). Grühn and colleagues (2005) have explicitly noted the lack of consistency regarding the positivity bias, as they failed to find an age-related memory advantage for positive material using emotionally toned words.

Studies which examine the positivity bias with an attention paradigm often report null findings between older and younger adults (Murphy & Isaacowitz, 2008). For example, Isaacowitz, Allard, Murphy, and Schlangel (2009) used a eye-tracking paradigm to measure the precise timeline of attentional shifts and Williams et al. (2006) used an event-related potential (ERP) design to track the temporal pattern of neural responses while older and younger adults viewed emotional faces. In both cases, the authors failed to find the presence of the positivity bias in the rapid processing of emotional stimuli as performance was similar across age groups. Moreover, a meta-analysis by Murphy and Isaacowitz (2008) found that both younger and older adults show small to medium preferences for emotionally valence stimuli over neutral stimuli. Both age groups show a positivity and negativity preference compared to neutral stimuli, importantly few age-related differences were found overall. Age-related positivity bias has only been found for specific measures and the type of measurement and stimuli influences the magnitude of the effect (Murphy & Isaacowitz, 2008).

While memory studies typically find a positivity bias, this result is also not consistent. No positivity bias has been found in the automatic processing in memory for arousing versus non-arousing words. In this study, the author presented participants with list of words varying in both valence and arousal and subsequently tested incidental memory (Kensinger, 2004). They found no age-related difference in remembering high-arousal words. Similarly, Majerus and D'Argembeau (2011) reported no positivity bias for recalling emotional lists of words between older and younger adults. Recognition of emotional word lists (Budson et al., 2006) and emotional pictures (Gallo et al., 2009) have both failed to report a positivity bias advantage in older adults. Budson et al. (2006) showed no difference in the number of emotional versus non-emotional items recognized by younger and other adults. Gallo et al. (2009) found no memory benefit for positive information for older adults compared to younger adults.

Other variables appear to also be important when investigating the positivity bias. It would seem that sample population plays a significant role in observing the positivity bias. Using an eye-tracking paradigm in older adults from Hong Kong, Fung et al. (2008) found that older adults looked away from happy facial expressions compared to younger adults. This result suggests that older adults from Eastern cultures do not show the same attentional preference for positive stimuli as found in Western cultures. However, when Kwon, Scheibe, Samanez-Larkin, Tsai, and Carstensen (2009) used a recall and recognition task of the emotional images in older Korean adults, they found that the relative preference for positive over negative stimuli in memory observed previously in older Americans adults.

7.1.5. Interim summary

To review, research suggests that the processing of emotional information differs between age groups, and the Socioemotional Selectivity Theory posits that this is due to a shift in social goals, as individuals come to the realisation that time is not expansive. Consequently, as individuals get older, perceived time constraints cause a shift to emotion-related goals to maximise well-being (Carstensen, 1993; Carstensen et al., 1999; English & Carstensen, 2015; Mather & Carstensen, 2005).

The Socioemotional Selectivity Theory suggests that older adults should show a preference for positive information over negative (Reed et al., 2014), a term authors have coined the positivity bias (Mather & Carstensen, 2003). While a number of studies have found the presence of the positivity bias in older adults, many have failed to observe this phenomenon (Murphy & Isaacowitz, 2008; Reed & Carstensen, 2012). Evidently, the existence of a positivity bias in older adults is contested in the literature.

7.1.6. Rationale for the present study

The presence of a positivity bias in older adults is debated in the literature, with evidence in favour and against the notion of older adults preferring positive over negative information. It would appear that differences in paradigms and type of measurement (attention or memory) influence the presence of the effect.

With such findings, it is challenging to understand the consequences of healthy ageing on an individual's ability to process emotional information. While the positivity bias has been extensively studied, there are still areas of research to be examined for new insights. For instance, although social interactions have previously been used to examine the positivity bias showing a positivity bias in older adults (Charles et al., 2003), the authors used recall and recognition memory tasks and this effect has not been examined in a attentional task. To date, there appears to be no attempt to examine the positivity bias with stimuli involving social interactions or examined it across types of stimuli (faces and social interactions) within the same attentional task. However, given research showing that stimuli type influences the presence of the positivity bias (Murphy & Isaacowitz, 2008), examining this across types of stimuli might be insightful. To fully understand the age-related differences in preference for positive and negative stimuli, it is essential that we identify whether any observed age-related differences are due to differences in processes specific to emotional processing. Moreover, studies have tended to only compare performance of older and younger adults when investigating the positivity bias. However, middle-aged adults are important to consider in relation to life-span perspective theories such as the SST. Studying the group in the middle of the typical age-related change in the processing of emotional stimuli might provide new insights into the effect. Moreover while it has been investigated in autobiographical memory and eye tracking, there has been no research on whether the positivity bias is specific to humanistic features such as facial expression or a social interaction phenomenon associated with social emotional interactions and abstract but emotionally valence stimuli such as scenes. It would be interesting to examine whether emotional scenes replicated the positivity bias because to date no study has attempted to use this type of stimuli to investigate the positivity bias.

7.1.7. Aims and hypotheses of the present study

The aim of the current study was to examine the age-related positivity bias and investigate whether it is a function of the type of stimuli used within the same task in younger, middle-aged and older adults.

It was predicted that:

1. Older adults would show a preference for positive over negative stimuli in accordance with the positivity bias, while middle-aged and younger adults would not show this preference.

7.2. Method

7.2.1. Participants

A total of 83 participants were recruited for this study: 30 younger adults (19 females), 28 middle-aged adults (15 females) and 25 older adults (15 females). A proportion of the participants in this study were included in Chapter 3. None of the participants had any self-reported history of neurological or psychiatric disorders based on the Wechsler Adult Intelligence Scale (WAIS-III) exclusion criteria (Wechsler, 1997). Participants were recruited from the University of Edinburgh volunteer panel and online advertisements and were reimbursed for their time. The study was approved by the School of Philosophy, Psychology and Language Sciences (Psychology) Ethics committee.

A summary of the participants' demographic information can be found in Table 23.

7.2.2. Materials

7.2.2.1. Background measure of intelligence

Block Design and Matrix Reasoning from the WASI-II (McCrimmon & Smith, 2013; Wechsler, 2011b) were used to measure performance IQ (FSIQ-2). Full descriptions of block design and matrix reasoning can be found in Chapter 3, section 3.2.2.3.

Reaction time task (D'Hondt et al., 2013). The paradigm used to measure the positivity bias was adapted from an attentional task designed by D'Hondt et al. (2013). For each trial, pairings of pictures were presented on a laptop screen on either side of a fixation cross for 500 milliseconds (msec). Participants were instructed to respond to the direction of a detection target which was either a left arrow (<) or right arrow (>). This arrow appeared congruent or incongruent to the picture of the specific condition. A congruent presentation was defined as where the detection target appeared looking to the left picture (see Figure 22). In the same trial, an incongruent trial occurred when the detection target pointed to the right picture (see Figure 23). This was the distinction between congruent and incongruent trials and was used for later analysis of each participants' response to indicate the correct response for that trial.

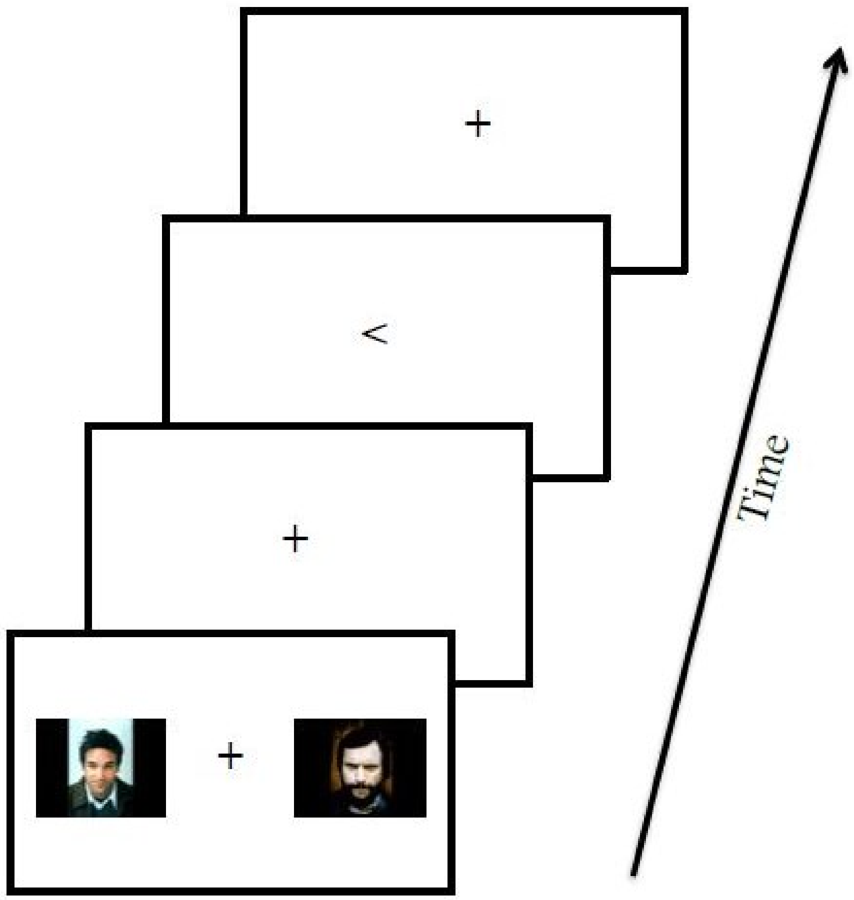
The fixation cross reappeared for an inter-stimulus interval of between 1000 and 2000 msec in duration. Each block consisted of counterbalanced presentation of each pairing of pictures. The stimulus onset asynchrony varied randomly between 200, 250, 300, 350 and 400 msec following the presentation of the pictures. The detection target that the participant was instructed to respond to then appeared for 150 msec. Participants were instructed to keep their gaze on the fixation cross in the centre of the screen throughout the course of the experiment without moving the eyes at any time and to indicate the direction of the arrow as quickly as possible by pressing either the A or L keys on the keyboard. Participants were instructed to press the A key or the left arrow ("<") and the L key for the right arrow (">").

There was one 10-trial practice block followed by 26 experimental blocks, comprised of 10 trials (5 congruent and 5 incongruent) to each, for a total of 260 trials. The stimuli on the left of the screen indicated the current condition. For example, if a positive and negative face appeared on screen and the positive face appeared on the left, this was a positive condition. The reaction time (RT) of participants' responses on each trial and their accuracy were recorded. Only the RT of a correct response was recorded for each trial.

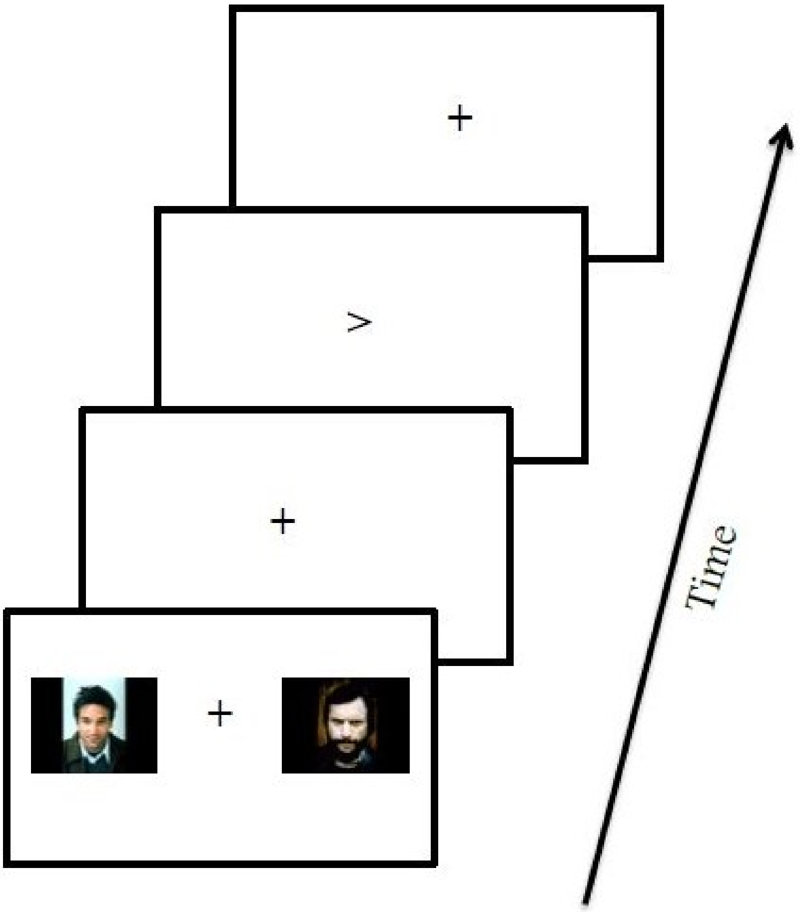
7.2.3. Procedure

7.2.3.1. Protocol for experimental task

7.2.3.1.1. Figure 22. Examples of the positive conditions for a congruent trial



7.2.3.1.2. Figure 23. Examples of the positive conditions for an incongruent trial



Stimuli were taken from the International Affective Picture System (IAPS) (Lang, 2005). There were three types of stimuli: faces, scenes and social interactions. Faces and scenes consisted of positive, negative and neutral faces and scenes. While social interactions stimuli consisted of positive and negative stimuli. There were no neutral social interaction stimuli because it proved difficult find these in the IAPS database. The stimuli were selected based on ratings of valence. Positive stimuli were high on ratings of valance while negative stimuli were low on ratings of valance, neutral stimuli were in the middle of positive and negative stimuli in terms of valance. As sex differences have been found in processing emotional stimuli (Collignon et al., 2010) there were different sets of stimuli for male and female participants.

7.2.3.2. Combination of stimuli

Below is a list of the different combinations of stimuli presented to participants, with congruent and incongruent conditions for each pairing of stimuli.

7.2.3.2.1. Table 22. Combination of stimuli

Positive & negative faces	Positive faces & social interaction positive
Positive & neutral faces	Positive faces & social interaction negative
Negative & neutral faces	Negative faces & social interaction positive
Positive & negative scenes	Negative faces & social interaction negative
Positive & neutral scenes	Neutral faces & social interaction positive
Negative & neutral scenes	Neutral faces & social interaction negative
Social interaction positive & social interaction negative	

7.2.4. Data analysis

Analyses were conducted using parametric and non-parametric analyses based on initial exploratory analyses (Shapiro-Wilk test, $p > 0.05$). Demographic data was analysed using parametric analyses. Data from the reaction time task were analysed using non-parametric methods. Overall significant differences were examined using the Friedman test. If a significant difference was found, follow-up analyses were conducted using the Kruskal-Wallis test, Wilcoxon signed-ranks tests and Mann-Whitney *U* tests to investigate significant differences between the groups. RT and accuracy data were analysed using the same statistically techniques (Friedman test, Kruskal-Wallis test etc.). The alpha values were set at $p < .05$ and the Holm correction was used to adjust for multiple comparisons.

7.3. Results

Data for the experimental task were missing for five participants (4 younger adults and 2 middle-aged adults) as two participants did not complete the task and the correct response rate was 50% or below for four participants. Three middle-aged participants did not complete the WASI-II due to time constraints.

7.3.1. Outliers

Trials were removed if each participants' reaction times (RT) were 2 SD above the mean or less than 150 msec in each condition. A total of 3.28% (*M* number of trials = 8.54) of trials were removed.

7.3.2. Demographic information for the younger, middle-aged and older participants

7.3.2.1. Table 23. Comparisons of demographics information between the age groups

	Older adults (n = 25)	Middle-aged adults (n = 28)	Younger adults (n = 30)	Statistic (*df*)	*p*-value	Post-hoc
Male:Female	10:15	13:15	11:19	–	–	–
Age, years (*SD*)	71.80 (5.79)	51.14 (5.52)	25.03 (4.84)	–	–	–
Education, years	14.68 (2.78)	15.61 (2.87)	17.63 (2.85)	$F(2, 80) = 7.94$	0.001	YA > MA & OA
Performance IQ	115.16 (10.41)	104.16 (14.90)	107.17 (8.10)	$F(2, 77) = 6.81$	0.003	OA > MA & YA

OA = older adults; MA = middle-aged adults; YA = younger adults.

As Table 23 shows, younger adults had significant more years of education, while older adults had higher performance IQ compared to both younger and middle-aged adults.

7.3.3. Examining RT of all congruent versus incongruent trials

Firstly, whether the RT task worked as a measure of attention was considered. When considering participants as one group, the difference in RT between congruent (M = 459.15, SD = 77.13) and incongruent trials approached significance (M = 461.44, SD = 78.15), Z = - 1.94, p = 0.052.

Next the effect that types of faces, scenes and social interactions had on attention in congruent and incongruent trials for older, younger and middle-aged adults was investigated.

7.3.4. Examining the difference in RT for positive, negative and neutral faces in older, middle-aged and younger adults

7.3.4.1. Table 24. Mean (SD) RT in msec for positive, negative and neutral faces in older, middle-aged and younger adults

Pairing of faces*	Older adults (n = 25)		Middle-aged adults (n = 26)		Younger adults (n = 26)	
	Congruent	Incongruent	Congruent	Incongruent	Congruent	Incongruent
Positive and Negative faces	473.97	486.77	464.19	469.57	476.98	485.13
	(82.44)	(84.39)	(101.99)	(131.49)	(122.57)	(136.13)
Positive and Neutral faces	472.56	484.57	468.64	494.79	443.38	436.44
	(62.05)	(72.86)	(104.22)	(102.72)	(98.41)	(94.86)
Negative and Neutral faces	471.32	476.77	467.17	466.63	441.65	442.43
	(69.46)	(70.99)	(100.41)	(105.63)	(113.31)	(106.73)

*Type of stimuli on the left indicates the condition

Table 24 shows that older adults were faster in congruent trials compared to incongruent trials regardless of face type. Younger adults and middle-aged adults also showed this pattern in RT. All participants were faster to respond to congruent compared to incongruent trials for positive and negative faces. Older and middle-aged adults were faster to respond in congruent trials compared to incongruent trials for the positive and neutral faces condition. The opposite pattern was found for younger adults. In all three age groups there was little difference in RT between congruent compared to incongruent trials for negative and neutral faces.

To examine the effect of age on RT of faces, firstly a Friedman test was conducted. This test examined overall differences in RT of all participants and found a statistically significant difference, $\chi^2(5) = 14.83$, $p = 0.011$. Follow-up Kruskal-Wallis tests found no significant differences between the groups in terms of RT for congruent trials in the positive and negative faces condition, $\chi^2(2) = 0.57$, $p = 0.752$, congruent trials in the positive and neutral faces condition, $\chi^2(2) = 3.34$, $p = 0.188$ or congruent trials in the negative and neutral faces condition, $\chi^2(2) = 3.61$, $p = 0.164$. There were also no significant differences in RT for incongruent trials in the positive and negative faces condition, $\chi^2(2) = 1.82$, $p = 0.403$, incongruent trials in the positive and neutral faces condition, $\chi^2(2) = 5.88$, $p = 0.053$ and incongruent trials in the negative and neutral faces condition, $\chi^2(2) = 3.00$, $p = 0.192$.

In the older adult group, Wilcoxon signed ranks tests found no significant differences in RT between congruent and incongruent positive and negative faces, $Z = -1.12$, $p = 0.264$, congruent and incongruent positive and neutral faces, $Z = -1.17$, $p = 0.242$ or congruent and incongruent negative and neutral faces, $Z = -0.58$, $p = 0.563$.

In the middle-aged group, there was a significant difference in RT between congruent and incongruent trials for the positive and neutral faces condition, $Z = -2.73$, $p = 0.006$. On congruent trials, middle-aged participants were faster to respond to the direction of the target arrow if a positive face was on the left of the screen. This was found in the positive and neutral faces condition. There was no significant difference in RT between congruent and incongruent in the positive and negative faces condition, $Z = -0.57$, $p = 0.568$ and congruent and incongruent negative and neutral faces condition, $Z = -0.32$, $p = 0.751$.

Younger adults did not statistically differ in their RTs for congruent and incongruent trials in the positive and negative faces condition, $Z = -0.78$, $p = 0.439$, congruent and incongruent trials in the positive and neutral faces condition, $Z = -0.70$, $p = 0.485$ or congruent and incongruent trials in the negative and neutral faces condition, $Z = -0.83$, $p = 0.409$.

7.3.5. Examining the difference in RT for positive, negative and neutral scenes in older, middle-aged and younger adults

7.3.5.1. Table 25. Mean (SD) RT in msec for positive, negative and neutral scenes

Pairing of scenes*	Older adults (n = 25)		Middle-aged adults (n = 26)		Younger-adults (n = 26)	
	Congruent	Incongruent	Congruent	Incongruent	Congruent	Incongruent
Positive and negative scenes	490.38	481.92	476.64	479.00	422.17	423.05
	(71.99)	(63.46)	(86.23)	(92.81)	(86.07)	(87.66)
Positive and Neutral scenes	489.87	512.78	468.62	473.79	420.34	422.27
	(59.63)	(88.11)	(96.49)	(93.20)	(87.66)	(88.23)
Negative and Neutral scenes	488.52	488.81	457.02	463.15	418.06	415.94
	(67.82)	(61.42)	(87.51)	(91.61)	(88.92)	(85.31)

*Type of stimuli on the left indicates the condition.

The table (Table 25) above shows that older adults were faster to respond to congruent trials compared to incongruent trials for positive and negative scenes and positive and neutral scenes. In these same conditions, there was little difference in RT for middle-aged and younger adults. The RT for negative and neutral scenes was similar across the groups.

The Friedman test was not statistically significant, $\chi^2(5) = 5.07$, $p = 0.408$, consequently post-hoc tests were not performed.

7.3.6. Examining the difference in RT for positive and negative social interactions in older, middle-aged and younger adults

7.3.6.1. Table 26. Mean (SD) RT in msec for social interaction stimuli and social interaction compared to faces

Pairing of scenes*	Older adults (n = 25)		Middle-aged adults (n = 26)		Younger adults (n = 26)	
	Congruent	Incongruent	Congruent	Incongruent	Congruent	Incongruent
Positive and negative social interaction	508.84 (64.40)	504.65 (74.24)	465.19 (89.09)	477.50 (100.14)	405.46 (74.61)	409.38 (82.32)

*Type of stimuli on the left indicates the condition.

In Table 26, it is evident that middle-aged adults were faster to respond in the congruent than incongruent trials for positive and negative social interactions, however older adults were faster in incongruent trials. For positive and negative social interaction stimuli, the Friedman test found no statistically significant difference, $\chi^2(1) = 0.33$, $p = 0.569$, consequently follow-up tests could not be performed.

Next the potential differences in RT between the pairing of faces and social interactions was investigated in older, middle-aged and younger adults.

7.3.7. Examining the difference in RT for social interactions compared to faces in older, middle-aged and younger adults

7.3.7.1. Table 27. Mean (SD) RT in msec for social interaction compared to faces

Pairing of scenes*	Older adults (n = 25)		Middle-aged adults (n = 26)		Younger adults (n = 26)	
	Congruent	Incongruent	Congruent	Incongruent	Congruent	Incongruent
Negative faces and positive social interaction	501.78 (67.41)	509.93 (89.77)	469.45 (85.28)	462.66 (84.91)	426.79 (105.36)	420.85 (87.34)
Negative faces and negative social interaction	515.00 (94.92)	515..56 (74.87)	464.29 (77.57)	459.82 (62.47)	405.97 (77.04)	411.40 (97.80)
Positive faces and positive social interaction	513.73 (80.61)	506.08 (96.74)	457.26 (84.93)	465.62 (82.41)	409.15 (73.58)	411.88 (77.56)
Positive faces and negative social interaction	514.11 (82.89)	507.09 (89.68)	457.77 (69.22)	445.95 (45.53)	399.58 (83.72)	403.90 (77.03)
Neutral faces and positive social interaction	513.69 (90.11)	512.41 (71.48)	450.57 (68.95)	452.58 (85.66)	411.04 (86.05)	402.34 (75.88)
Neutral faces and negative social interaction	506.01 (74.77)	502.62 (73.11)	443.22 (70.08)	447.97 (67.29)	395.13 (61.00)	403.27 (68.99)

*Type of stimuli on the left indicates the condition

The RT in Table 27 shows that for pairings of negative faces and social interaction stimuli, both older and middle-aged adults were faster in congruent than incongruent trials, however younger adults were faster for incongruent trials. RT for negative faces and negative social interactions parings for congruent and incongruent were similar across the three age groups. Middle-aged and younger adults were faster in congruent than incongruent trials for positive faces and positive social interaction stimuli and positive faces and negative social interaction. Older adults were faster in incongruent trials for these two conditions. In both neutral faces and positive social interaction and neutral faces and negative social interaction conditions, all three groups were faster in congruent than incongruent trials.

Friedman test found no statistically significant difference, $\chi^2(3) = 0.46$, $p = 0.928$, when pairing negative faces to positive and negative social interaction conditions for congruent and incongruent trials. When positive faces were paired with positive and negative social interaction, the Friedman test was not significant, χ^2 (3) = 0.38, $p = 0.944$. For neutral faces and positive and negative social interaction, the Friedman test was not significant, χ^2 (3) = 2.47, $p = 0.481$.

7.3.7. Congruent versus incongruent trials across stimuli type (faces, scenes and social interaction)

To examine whether stimuli type influenced responses, congruent and incongruent trials were compared separately across the stimuli type (faces and scenes, faces and social integration and social interactions scenes). This could only be carried out for the positive and negative stimuli since there were no neutral social interaction stimuli.

The RTs for positive and negative stimuli types were compared for the congruent trials using a Friedman test. This analysis was not significant $\chi^2(2) = 0.10$, $p = 0.949$. The Friedman test for incongruent trials was also not significant, $\chi^2(2) = 1.35$, $p = 0.509$.

Following analysis of RT data, accuracy of responses was examined. This was done to investigate whether this variable differed between groups.

7.3.8. Examining the difference in accuracy (%) for positive, negative and neutral faces in older, middle-aged and younger adults

7.3.8.1. Table 28. Mean (SD) accuracy (%) for positive, negative and neutral faces in older, middle-aged and younger adults

Pairing of faces*	Older adults (n = 25)		Middle-aged adults (n = 26)		Younger adults (n = 26)	
	Congruent	Incongruent	Congruent	Incongruent	Congruent	Incongruent
Positive and negative faces	91.20 (8.45)	93.07 (8.70)	94.57 (7.64)	94.32 (8.16)	96.46 (4.64)	95.13 (8.04)
Positive and Neutral faces	97.51 (5.37)	95.51 (7.20)	97.27 (8.32)	99.62 (1.96)	98.03 (4.11)	98.41 (4.73)
Negative and Neutral faces	97.16 (6.19)	95.51 (8.76)	97.27 (6.72)	96.28 (6.72)	96.11 (7.56)	98.33 (5.08)

*Type of stimuli on the left indicates the condition.

In regards to accuracy, older adults were the least accurate for positive and negative faces in both congruent and incongruent trials compared to the other age groups. Accuracy did not differ greatly across the age groups for positive and neutral faces or negative and neutral faces.

The Friedman Test examining overall differences for all participants found a statistically significant different, $\chi^2(5) = 25.18$, $p < 0.001$.

Post-hoc Wilcoxon signed ranks tests for older adults' accuracy scores for the congruent and incongruent trials were not significant between the positive and negative faces condition, Z = -1.16, $p = 0.246$, positive and neutral faces condition, Z = - 1.14, $p = 0.254$ or the negative and neutral faces condition, Z = - 0.72, $p = 0.472$. This was also the case for middle-aged adults in the positive and negative faces condition, Z = -0.61, $p = 0.545$, positive and neutral faces condition, Z = -1.51, $p = 0.131$ and the negative and neutral faces condition, Z = -1.07, $p = 0.285$. In younger adults, Wilcoxon signed ranks tests did not find a significant difference in accuracy between congruent and incongruent trials in the positive and negative faces condition, Z = -2.00, $p = 0.050$, positive and neutral faces condition, Z = -0.43, $p = 0.667$ and the negative and neutral faces condition, Z = -1.33, $p = 0.184$.

Post-hoc Kruskal-Wallis tests revealed a significant difference in accuracy between the three age groups in the positive and negative faces condition for congruent trials, $\chi^2(2) = 13.35$, $p = 0.001$. Mann-Whitney *U* tests found a significant difference in accuracy between older and younger adults, $U = 161.50$, $p < 0.001$. Younger adults were more accurate at responding to the correct direction of the detection target than older adults for positive and negative faces in congruent trials. There was no significant difference in accuracy between older and middle-aged adults, $U = 244.50$, $p = 0.101$ and younger and middle-aged adults, $U = 245.00$, $p = 0.050$.

There was a significant difference in accuracy between the groups in the positive and neutral condition for incongruent trials, $\chi^2(2) = 8.30$, $p = 0.016$. Mann-Whitney *U* tests found a significant difference in accuracy between older and middle-aged adults, U = 231.00, $p = 0.008$. Middle-aged adults were more accurate than older adults at responding to the correct direction of the detection target for positive and neutral faces in incongruent trials. There was no significant difference in accuracy between older and younger adults, $U = 258.50$, $p = 0.081$ and younger and middle-aged adults, $U = 311.00$, $p = 0.285$.

For the reminding conditions, Kruskal-Wallis tests found no significant differences in accuracy between the groups for congruent positive and neutral faces, $\chi^2(2) = 0.20$, $p = 0.906$, congruent $\chi^2(2) = 0.50$, $p = 0.778$ and incongruent $\chi^2(2) = 2.48$, $p = 0.289$ negative and neutral faces and incongruent trials for positive and negative faces, $\chi 2(2) = 0.82$, $p = 0.664$.

7.3.9. Examining the difference in accuracy (%) for positive, negative and neutral scenes in older, middle-aged and younger adults

7.3.9.1. Table 29. Mean (SD) accuracy (%) for positive, negative and neutral scenes

Pairing of scenes*	Older adults (n = 25)		Middle-aged adults (n = 26)		Younger adults (n = 26)	
	Congruent	Incongruent	Congruent	Incongruent	Congruent	Incongruent
Positive and negative scenes	95.51 (6.74)	97.60 (5.97)	98.76 (4.71)	99.23 (2.72)	98.72 (4.79)	97.99 (5.07)
Positive and Neutral scenes	98.80 (3.32)	96.00 (7.64)	98.46 (4.64)	98.03 (4.11)	99.61 (1.96)	97.65 (5.21)
Negative and Neutral scenes	96.34 (6.59)	96.00 (6.44)	98.28 (4.13)	98.08 (4.91)	96.84 (5.61)	96.88 (6.84)

*Type of stimuli on the left indicates the condition.

As Table 29 shows, accuracy for positive, negative and neutral scenes did not differ greatly across the three age groups for congruent and incongruent conditions. The Friedman test was not statistically significant, $\chi^2(5) = 9.81$, $p = 0.081$, consequently post-hoc analyses were be performed.

7.3.10. Examining the difference in accuracy (%) for positive and negative interaction stimuli in older, middle-aged and younger adults

7.3.10.1. Table 30. Mean (SD) accuracy (%) for positive and negative social interaction stimuli

Pairing of scenes*	Older adults (n = 25)		Middle-aged adults (n = 26)		Younger-adults (n = 26)	
	Congruent	Incongruent	Congruent	Incongruent	Congruent	Incongruent
Positive and negative social interaction	97.11 (5.55)	97.60 (4.36)	97.69 (5.14)	98.46 (3.68)	97.65 (5.21)	97.31 (5.33)

Accuracy for congruent and incongruent trials in the positive and negative social interaction condition was very similar for all age groups.

Comparing accuracy for positive and negative social interaction conditions for congruent and incongruent trials, the Friedman test found no statistically significant difference, $\chi^2(1) = 0.04$, $p = 0.835$.

7.3.11. Examining the difference in accuracy for social interactions compared to faces in older, middle-aged and younger adults

7.3.11.1. Table 31. Mean (SD) accuracy (%) for social interaction compared to faces

Pairing of scenes*	Older adults (*n* = 25)		Middle-aged adults (*n* = 26)		Younger-adults (*n* = 26)	
	Congruent	Incongruent	Congruent	Incongruent	Congruent	Incongruent
Negative faces and positive social interaction	96.36 (7.61)	97.11 (5.72)	97.52 (4.62)	98.42 (3.79)	99.19 (2.87)	98.03 (4.99)
Negative faces and negative social interaction	98.40 (3.74)	97.07 (5.78)	97.22 (5.46)	98.80 (3.38)	97.61 (5.28)	96.49 (6.34)
Positive faces and positive social interaction	95.16 (8.75)	97.51 (4.53)	99.23 (2.72)	98.85 (3.26)	97.22 (5.46)	98.42 (3.79)
Positive faces and negative social interaction	95.91 (6.55)	95.47 (7.91)	99.57 (2.18)	96.15 (2.18)	96.33 (8.02)	97.27 (4.60)
Neutral faces and positive social interaction	97.11 (5.55)	94.71 (11.27)	98.03 (4.99)	99.19 (2.87)	98.85 (3.26)	97.22 (6.15)
Neutral faces and negative social interaction	94.58 (7.86)	97.56 (4.44)	96.88 (5.55)	96.84 (7.02)	96.80 (5.67)	97.18 (5.69)

As Table 31 shows, the accuracy for responses when faces were paired with social interactions were similar for all three age groups for congruent and incongruent trials. This was confirmed by statistically testing. The Friedman test found no statistically significant difference, $\chi^2(3) = 0.09$, $p = 0.993$, when pairing negative faces to positive and negative social interaction conditions for congruent and incongruent trials. When positive faces were paired with positive and negative social interaction, the Friedman test was not significant, $\chi^2(3) = 3.89$, $p = 0.274$. For neutral faces and positive and negative social interaction, the Friedman test was not significant, $\chi^2(3) = 3.88$, $p = 0.275$.

7.3.12. Comparing accuracy (%) across stimuli type (faces, scenes and social interaction) for congruent trials

Similar to RT, whether stimuli type affected accuracy of response for congruent and incongruent trials was examined. For congruent trials, the Friedman test found a significant difference, $\chi^2(2) = 10.21$, $p = 0.006$.

For older adults, follow-up Wilcoxon signed rank tests showed a significant difference between faces and scenes for positive and negative stimuli, Z = -2.60, p = 0.009 and positive and negative faces and social interaction stimuli, Z = -2.43, p = 0.015. Older adults were less accurate at responding to the correct direction of the detection target for faces compared to social interaction and faces compared to scenes in congruent trials. There was no significant difference in accuracy for scenes and social stimuli, Z = -0.79, $p = 0.433$.

Middle-aged adults showed a near significant difference in accuracy on faces compared to scenes, Z = -1.81, $p = 0.071$ and faces compared to social interaction, Z = - 1.85, $p = 0.064$. There was no significant difference between scenes compared to social interaction, Z = 0.70, $p = 0.483$.

Younger adults did not differ in accuracy for faces compared to scenes, Z = 0.00, $p = 1.00$, faces compared to social interaction, Z = -0.64, $p = 0.524$ and scenes compared to social interaction, Z = -0.42, $p = 0.673$.

7.3.13. Comparing accuracy (%) across stimuli type (faces, scenes and social interaction) for incongruent trials

For incongruent trials the Friedman test found a significant difference, $\chi^2(2) = 20.44$, $p < 0.001$.

For older adults, there was a significant difference in accuracy for faces and scenes, Z = -2.12, $p = 0.034$ and faces and social interaction, Z = -2.36, $p = 0.018$ for incongruent trials. Older adults were less accurate at responding to the correct direction of the detection target on faces compare to social interaction and faces compared to scenes. There was no significant difference in accuracy for scenes and social interaction, Z = 0.00 $p = 1.00$.

Middle-aged adults significantly differed in accuracy for faces and scenes, Z = -2.86, $p = 0.004$ and faces and social interaction, Z = -2.41, $p = 0.010$. Middle-aged adults were less accuracy for faces compared to social scenes and faces compared to social interaction. There was no significant difference in accuracy for scenes and social interaction, Z = -1.00 $p = 0.317$.

Younger adults did not differ in accuracy on faces compared to scenes, Z = -1.48, $p = 0.139$, faces compared to social interaction, Z = -1.39, $p = 0.165$ and scenes compared to social interaction, Z = -0.09, $p = 0.931$.

7.4. Discussion

The aim of the present study was to examine the positivity bias using the paradigm designed by D'Hondt et al. (2013) to investigate whether the positivity bias is a function of the type of stimuli used. Firstly, no evidence of a positivity bias in older adults was found for faces, scenes or social interaction stimuli. Overall, there was little evidenced for the positivity bias previously reported (e.g. Mather and Carstensen, 2003).

The only statistically significant results were between congruent and incongruent trials for middle-aged adults where these participants were faster to respond to the direction of the target arrow if a positive face preceded it but only in the positive and neutral faces condition. Younger adults were more accurate at responding to the correct direction of the detection target than older adults for positive and negative faces in congruent trials. Middle-aged adults were more accurate than older adults at responding to the correct direction of the detection target for positive and neutral faces in incongruent trials.

In terms of stimulus type, older adults were more accurate at responding to the correct direction of the detection target when social stimuli were presented compared to faces, and scenes compared to faces in congruent trials. This same pattern of results was near significant for middle-aged adults (faces and scenes, $p = 0.071$, faces and social interaction, $p = 0.064$). These stimuli type comparisons were not significant for younger adults. For incongruent trials, older adults were again more accurate at responding to the correct direction of the detection target in social interaction compared to faces, and scenes compared to faces, this was also the case for middle-aged adults. Younger adults did not differ in accuracy across stimuli type.

The results did not show that older adults exhibit a preference for positive information over negative information in terms of their attention, which is in contrast to the original findings by Mather and Carstensen (2003). However, there are other studies that have also failed to demonstrate a positivity bias (Isaacowitz et al., 2006b; Murphy & Isaacowitz, 2008). These findings add to the literature of no difference in the processing of emotional stimuli between younger and older adults (Gallo et al., 2009; Grühn et al., 2005; Majerus & D'Argembeau, 2011; Williams & Drolet, 2005). The paradigms used in these studies differed; some were memory recognition and recall tasks. However it would appear that when an attentional paradigm is used, older adults do not show a preference for positive information over negative. These results are similar to the results of the meta-analysis by Murphy and Isaacowitz (2008) who examined the positivity bias in attentional tasks.

It was found that middle-aged adults showed a preference for positive information. However, this was only observed for positive and neutral faces, not positive and negative faces. Yet, the positivity bias is typically found when presented with positive and negative information (Reed et al., 2014). Similarly, while younger adults were more accurate than older adults for positive and negative faces in congruent trials, the middle-aged adults were better at detecting the target for positive and neutral faces in incongruent trials. Ideally, an interaction between age and congruent for this condition would have more clearly explained this finding. However, due to the non-normal distribution of the data, interactions could not be examined. Based on these findings and the limitations of the statistical techniques employed, this study does not provide evidence for the positivity bias. Future studies could use statistically techniques that do not require normal distribution, for example regression analysis that only requires that the residuals be normally disturbed.

Researchers have not typically examined the potential effect of stimuli type on the positivity bias. However, in the older and middle-aged adult groups, stimuli type did indeed influence the accuracy of responses for these two age groups, but not younger adults. Older and middle-aged adults were less accurate at responding to the direction of the target in the faces conditions than social stimuli or scenes. A possible reason for this finding is that faces are particularly capable at capturing our attention (Langton, Law, Burton, & Schweinberger, 2008). This effect also appears to be a function of age, since it was observed in older and middle-aged adults, but not younger adults.

The difference in findings relating to accuracy and RT across stimuli type could be explained by the type of measurements used. Reaction time responses are reflexive orienting responses while accuracy is more of a voluntary and deliberate choice. Moreover, voluntary attention affects performance in experiments designed around both accuracy and RT (Prinzmetal, McCool, & Park, 2005) and attentional cueing affect accuracy and RT with different time courses (van Ede, de Lange, & Maris, 2012). This is a novel finding in relation to ageing research, thus future studies should expand on this finding further.

One limitation of studies reporting the positivity bias in the literature is that many who report the presence of the positivity bias tend to be from the same research group. For example, Laura Carstensen or her affiliated authors are featured on a large proportion of the studies that have found an age-related positivity bias (e.g. Carstensen & Mikels, 2005; Mather & Carstensen, 2003, 2005; Mather & Knight, 2005; Mather et al., 2005). In contrast, the studies that tend not to find the positivity bias come from other laboratories (for example Gallo et al., 2009; Grühn et al., 2005; Majerus & D'Argembeau, 2011; Williams & Drolet, 2005). This observation makes it difficult to interpret the reliability and generalizability of the positivity bias.

Healthy adult ageing is associated with general atrophy in the brain but the frontal and temporal regions are particularly susceptible to age-related changes (Bartzokis et al., 2001; Raz et al., 2005). These areas are activated during the processing of emotional stimuli (Kumfor, Irish, Hodges, & Piguet, 2014), suggesting that changes to these regions may account for the age-related difference in attention to positive and negative stimuli. Related to this alternative theory, our sample consisted of very high-functioning older adults (IQ = 115.16) compared to middle-aged (IQ = 104.16) and younger adults (IQ = 107.17). If changes in brain regions are responsible for the positivity bias, but our older adult group consisted of high-functioning adults, it is plausible that the null findings related to the positivity bias may have been because of their brain reserve. Brain reserve explains why individuals with higher IQ experience less severe cognitive changes in the presence of age-related pathology (Foubert-Samier et al., 2012; Valenzuela & Sachdev, 2006). Perhaps because they have experienced less atrophy in their frontal and temporal regions as a consequence of their brain reserve (Solé-Padullés et al., 2009). A combination of these ideas may explain the null findings in this sample.

Certain limitations related to the methodology may have influenced the current results. Some authors have argued that the instructions that researchers provide participants in terms of how to process information in the experimental task (e.g., asking participants to accurately remember all information) is likely to interfere with the positivity bias because they could be primed to know what to expect (Reed & Carstensen, 2012). However, this was not the case in this study, as I did not impose any such demands on participants, consequently this does not seem likely.

Another explanation for the null findings could be related to the slow stimulus onset. The current paradigm was adapted from the original paradigm by D'Hondt et al. (2013), but I slowed down the stimuli onset to accommodate slower processing speed typically found in older adults (Salthouse, 1996). However, the stimulus onset may not have been slowed down enough to detect the positivity bias (Reed & Carstensen, 2012). Researchers have found that the preference for positive stimuli in older adults emerges at 500 msec and later after stimulus onset (Isaacowitz et al., 2009). In this same study, attention to negative faces was even slower than for positive faces, leading the authors to suggest that an older adult's early attention (within 500 msec) is skewed away from positive faces. Their bias toward positive and away from negative faces actually increases linearly over time (Isaacowitz et al., 2009). Further evidence for this notion comes from research using ERPs (Williams et al., 2006) and assessing memory for arousing versus non-arousing words (Kensinger, 2004). Another explanation for the absence of the positivity bias in the current sample could be related to the IAPS database and the stimuli used. While sex differences were controlled for in processing emotional stimuli, recent research has shown that the IAPS images vary on more than ratings of valence and arousal, they also vary on such ratings as dominance (Constantinescu, Wolters, Moore, & MacPherson, 2017). In the current study, I did not consider the PAD (Pleasure, Arousal and Dominance) model, which is a dimensional framework for measuring emotions and includes pleasure/valence arousal, and dominance (Mehrabian, 1996). Specifically, the role of dominance in selecting the stimuli was not considered and this may have affected the attention of participants (Maner, DeWall, & Gailliot, 2008). Therefore these limitations need to be considered when interpreting the results of the present study.

Overall, this study found that accuracy for stimuli type is a function of age, with positive and negative faces resulting in older and middle-aged adults making more errors when they are attending to scenes or social interactions, as faces are particularly effective at capturing our attention (Langton et al., 2008). When an attentional task is used, older adults do not show a preference for positive over negative information. However, the experimental paradigm suffered from limitations, such as being too quick to detect the positivity bias, this might have resulted in the null findings. Consequently, more research is needed on the positivity bias using attentional tasks.

Chapter 8: General discussion

This final chapter provides a summary of the empirical findings and a general discussion of the results. Limitations and future directions related to this work are also discussed.

8.1. Aims of this thesis

The main aim of this thesis was to investigate the validity of a new test called the ESCoT, as a research tool and clinical test of social cognition. The ESCoT was utilised in neurotypical participants and individuals with clinical disorders, namely ASD and dementia. In Chapter 3, the ESCoT was administered to a sample of younger adults, middle-aged adults and older adults. In Chapter 4, the ESCoT was validated in a sample of ASD adults, and Chapter 5 involved neurotypical younger adults. These chapters examined the psychometrics of the ESCoT. In Chapter 6, the clinical validity of the ESCoT was examined in patients with dementia. To further examine the age-related changes of affective ToM found in Chapter 3, in Chapter 7, whether the processing of emotional information changes with age, specifically relating to the positivity bias was investigated. The individual findings of these studies have been discussed previously, however this chapter will discuss the results using an all-inclusive approach.

8.2. Summary of Results

Table 32 below provides a summary of the aims of each experimental chapter along with the main findings.

8.2.1. Table 32. The main findings of each experimental study

Chapter	Aim of the study	Main findings
Chapter 3	Examine the relationship between the ESCoT and: a) age; b) measures of intelligence; and c) the Broader Autism Phenotype in comparison to established tests in healthy adults.	• Cognitive ToM was predicted by age and affective ToM was predicted by age and gender. • Age and AQ scores predicted interpersonal understanding of social norms and AQ scores predicted intrapersonal understanding of social norms performance. • ESCoT total score was predicted by age and AQ scores. • Unlike established social cognition tests, ESCoT was not related to measures of intelligence. Performance on the RME correlated with performance on the ESCoT.
Chapter 4	Validate the ESCoT in a sample of ASD adults and neurotypicals, and compare performance to established tests of social cognition.	• ASD adults performed poorer on all subtests of the ESCoT compared to neurotypicals. • ESCoT subtests and total scores correlated with performance on established tests. • Unlike the ESCoT, performance on the established tests was predicted by verbal comprehension. • The ESCoT was more effective than existing tests at differentiating ASD adults from neurotypicals. 42.11% of ASD adults were impaired on the ESCoT compared to 5.50% of neurotypicals.

		• Performance on established tests correlated with performance on the ESCoT and subtests.
Chapter 5	Examine the relationships between sex, Broader Autism Phenotype, social anxiety disorder and empathy on performance of the ESCoT in younger adults.	• Women performed better than men on affective ToM. • Cognitive ToM was predicted by older age and affective ToM was predicted by gender. • Interpersonal understanding of social norms and ESCoT total scores were predicted by more education.
Chapter 6	Explore the clinical validity of the ESCoT in patients with dementia.	• Patients with dementia performed poorer than healthy controls on ESCoT total scores, affective ToM, interpersonal understanding of social norms and intrapersonal understanding of social norms.
Chapter 7	Investigate positivity bias found in older adults and its relationship to the type of stimuli (faces, scenes and social interactions).	• There was no evidence of the positivity bias in older, middle-aged and younger adults in regards to reaction time or accuracy. • Older and middle-aged adults differed in accuracy across stimuli type compared to younger adults; they were less accuracy for faces than social stimuli.

As Table 32 shows, the ESCoT was relatively successful as a test of social cognition. The ESCoT was able to detect age-related differences in healthy ageing, concurrent with some of the literature (Henry et al., 2013). Chapter 3 showed that as individuals get older, their social cognitive abilities are negatively affected. The interplay between personality traits, sex and performance on the ESCoT was investigated in Chapter 5. Limited associations were found between these variables and the ESCoT. The ESCoT found sex differences in performance on affective ToM, similar to the results of Chapter 3. In Chapter 3, being female predicted better performance on affective ToM and in Chapter 5, female participants were shown to have better affective ToM abilities than males. This is similar with the findings of many studies (Ahmed & Miller, 2011; Baron-Cohen et al., 2015; Carroll & Chiew, 2006; Kirkland et al., 2013; Schiffer et al., 2013; Voracek & Dressler, 2006). The results from these two studies suggest that participants' sex should also be considered when evaluating performance on tests of social cognition. Returning to healthy ageing, Chapter 7 found that, while increasing age negatively predicts performance on affective ToM, older, middle-aged and younger adults do not significantly differ in processing positive and negative emotional stimuli, but do differ on their accuracy when processing positive and negative stimuli across stimuli type.

ASD adults were impaired on all subtests of the ESCoT, demonstrating that it is sensitive to the typical impairments found by other tests of social cognition (Baron-Cohen, Wheelwright, Hill, et al., 2001; Mathersul et al., 2013; Murray et al., 2017). Preliminary evidence of the clinical validity of the ESCoT was found in Chapter 6; this chapter showed that a small group of patients with dementia experienced difficulties in performance on the ESCoT. These results confirm the social cognitive impairments found in dementia (Bora et al., 2015; Gregory et al., 2002; Poletti et al., 2012).

In regards to psychometrics, the ESCoT correlated with established measures of social cognition in Chapter 3 and 4 showing convergent validity. Better performance on the ESCoT was significantly related to better performance on traditional tests of social cognition. Other psychometric investigations found acceptable internal consistency (measured by Guttman's Lambda 4 reliability coefficient) and high inter-rater reliability. These results show that the ESCoT has good psychometric properties as a test of social cognition.

8.3. Advantages of the ESCoT as a test of social cognition

There are many tests of social cognition in the literature, however, as Table 1 in Chapter 1 illustrated, many of these tests have important limitations. The ESCoT was developed to address some of these limitations. Based on the results of this thesis, there are several noteworthy advantages of the ESCoT compared to traditional social cognition tests. The chapters (Chapter 4 and 6) which examined the validity of the ESCoT found that compared to established tests of social cognition, the ESCoT is a superior test of social abilities in terms of diagnostic accuracy (see Chapter 4 and 6). A ROC curve analysis in ASD adults and NC found that the ESCoT was better at correctly assigning participants to their respective group. Additionally, in this chapter, the ESCoT showed the highest AUC values compared to the established tests. Higher accuracy rates compared to traditional tests suggest that the ESCoT has potential to be used as a clinical test over more established measures.

Even with a limited sample size in a dementia population (n = 25), the ESCoT was able to detect significant differences in performance between dementia patients and NC. This is in contrast to the RME, which did not find a significant difference. Moreover, the effect sizes for the ESCoT were large in Chapter 4, even with a limited sample of ASD adults, and larger than those for the traditional tests of social cognition. The ESCoT represents a concise (20 – 25 minutes), informative, and now validated test of social cognition to be used in clinical settings. This is in contrast to current clinical tests like the TASIT which takes 60-75 minutes to administer and the GeSoCS which can take up to 60 minutes to complete. Such a short and insightful test like the ESCoT will benefit clinicians and researchers interested in measuring social cognitive abilities in time sensitive environments. Together with the finding of large effects in small samples, the ESCoT signifies a worthy choice for use as a test of social cognition, particularly in clinical populations that can be difficult to recruit large numbers of participants proficiently.

Many tests only assess a single social cognitive ability (e.g., RME, RMF and SNQ), or measure cognitive and affective ToM using different tests and different stimuli. The advantage of the ESCoT is that it assesses four social cognitive abilities, cognitive ToM, affective ToM and inter-and intrapersonal understanding of social norms in a single test using the same stimuli. In everyday social interactions, we often employ several social cognitive abilities simultaneously. Therefore, the ESCoT has an important benefit over existing social cognition tests because it gives researchers and clinicians a measure of several social abilities, and perhaps better insights into how social cognitive abilities are used in the real world.

Similarly, many tests of social cognition are not significantly independent of IQ. Measures of IQ typically significantly predict performance or correlate with tests of social cognition (Baker et al., 2014; Maylor et al., 2002; McDonald et al., 2003). However, in Chapters 3 and 4, results showed that this is not a limitation of the ESCoT.

In Chapter 3, Verbal Comprehension Index (VCI) predicted the performance on the RME (one of the most common tests of social cognition). On the RMF, performance was predicted by VCI and Perceptual Reasoning Index (PRI) scores. In Chapter 4, 19% of variance in performance on the RME was predicted by VCI. While 42% of variance in performance was explained by VCI scores and AQ scores on the RMF. Finally, VCI scores, EQ and SQ scores predicted 19% of performance on the SNQ. It is evident from these findings that while VCI is significantly associated with performance on social cognition tests in the literature, it is not statistically influential to performance on the ESCoT. This gives the ESCoT a great advantage over tests in the literature because it may be more accurately assessing social abilities independently from IQ compared to other tests. Additionally, tests of social cognition like false-belief and the JoP are often too easy for adult participants. On the other hand, the ESCoT does not seem to suffer from this limitation; overall the healthy participants did not perform at ceiling on this measure. At the same time, the sample populations of ASD adults and dementia patients did not exhibit floor effects. Taken together, these findings show that the ESCoT can be used in healthy and clinical populations without concerns of test difficulty.

A criticism of many existing tests of social cognition is that the stimuli they use were not created to be stimuli for a test of social abilities. For example, stimuli for the RME and Awkward Moments Test were created for advertisements, and then repurposed for a test of social cognition. This means that the answers are an interpretation of the authors, and not intentionally designed to represent a specific inference about how a character is feeling or thinking. However, with the ESCoT, each animation was created for the specific purpose of measuring cognitive ToM, affective ToM and inter-and intrapersonal understanding of social norms. Moreover, tests that use verbal texts or static stimuli show low ecological validity (Dziobek et al., 2006). Consequently, this questions their relationship to real-world functioning (Mathersul et al., 2013). Again, the ESCoT utilises dynamic interactions to increase ecological validity, giving it another advantage over tests like the RME. The ESCoT also addressed the issues of context, which has limited many tests of social cognition like the TASIT, RME and RMF. This is because context is needed to process social information (Chung et al., 2010; Love et al., 2015; Vermeulen, 2015) but many tests lack context. However, the interactions and stories, which make up the ESCoT, all contain their own context and can be used independently of each other without loss of context or important social information.

Finally, in regards to the scoring systems used by many existing tests, the ESCoT was designed to account for variability in participant's answers by providing structured guidelines for responses. For instance, on the affective ToM questions, participants could give different affective states instead of trying to give a specific answer. This is in contrast to the RME which uses force-choice answers and there is only one correct answer. However, in the real world, we do not encounter many social interactions that require forced-choice answers, or where there is only one interpretation of how someone is thinking or feeling. Perhaps this modification of assessing an individual's social cognitive abilities may explain the large effect sizes compared to other tests in Chapter 4. As discussed above, the ESCoT provides many advantages over existing tests of social cognition.

8.4. The ESCoT as a clinical test of social cognition

The normative data in Chapter 4 provide cut-off scores to detect abnormal performance based on 236 healthy individuals. From these data, it was found that 42.11% of ASD adults were impaired on the ESCoT, with the highest rates of impairment on cognitive ToM and interpersonal understanding of social norms (36.84% for both cases). Furthermore, 50% of bvFTD patients were impaired on

ESCoT total scores compared to 31.5% of AD/MCI patients; this is in contrast to 5.50% of NC adults.

The results above show that compared to neurotypical controls, more ASD adults and dementia patients were impaired on the ESCoT. This is useful because in clinical settings, which do not pool participants and use means to assess performance, clinical tests need to be sensitive and able to identity poor performance. While the samples of ASD adults (n = 19) and dementia patients (n = 24) were relatively small, the ESCoT was still able to identify individuals who exhibited social cognitive deficits. Examining the findings separately, the discrepancy in impairments of cognitive and affective ToM in the bvFTD and AD/MCI suggests that cognitive and affective ToM are differentially affected in these subtypes of dementia. Furthermore, the impairments of the bvFTD patients on the ESCoT are consistent with clinical presentations of bvFTD patients who experience difficulties interacting with family members and exhibit inappropriate social behaviours as a core feature of their dementia (Rascovsky et al., 2011). As previously mentioned in Chapter 4, the fact that only 42.11% of ASD adults were impaired does raise questions about the usefulness of averaging performance of clinical groups. However, to understand social abilities in clinical populations, and to also be able to generalise the findings, individual case studies cannot be used because they only represent the symptoms of one patient.

Examining the two clinical groups together, there are noteworthy observations. In the ASD group, more individuals were impaired on cognitive ToM compared to affective ToM, while in bvFTD patients, the opposite was found. Furthermore, fewer ASD adults were impaired on the ESCoT compared to both dementia groups. These results suggest that neurodegenerative diseases may have greater impact on social cognitive abilities than neurodevelopmental disorders. Moreover, these results suggest a different clinical profile for the type of impairments found in these two groups, even though both groups exhibit social cognitive impairments. Overall, these findings show that the ESCoT has clinical value as a test of social cognition. It would be interesting to confirm these findings in a larger sample to compare the profiles and confirm if they are indeed different.

8.5. Influence of age on ToM and processing emotional stimuli

In Chapter 3, the regression analysis showed that poorer performance on cognitive ToM was significantly predicted by increasing age. This is in contrast to the results of Chapter 5. In the younger population of Chapter 5 (age range 18 – 35), increasing age predicted better performance on cognitive ToM. These findings highlight questions of the nature of social cognitive tests and what they assess. To discuss this notion in greater detail, we first need to understand the neurodevelopment of the neural regions associated with cognitive processes such as executive functions and tests of social cognition. The functional development of the abilities associated with the frontal regions may be considered a multistage process (Romine & Reynolds, 2005). The most significant developments occur between 6 and 8 years of age. There are then moderate increases between 9 and 12 years old while performance approximates adult levels between adolescence and the early 20s, depending on task demands (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001; Klenberg, Korkman, & Lahti-Nuuttila, 2001; Korkman, Kemp, & Kirk, 2001; Welsh, Pennington, & Groisser, 1991).

Specifically relating to ToM abilities, basic perspective taking emerges in the first 18 months (Sodian, Thoermer, & Metz, 2007), while an understanding of first order false-belief emerges at around 4 years of age (Wellman, Cross, & Watson, 2001) and second order false-belief can be passed by age 6 or 7 (Perner & Wimmer, 1985). Continued development of the regions involved in ToM have been observed between the ages of 20 and 29 (De Luca et al., 2003), in terms of structural and functional developments of the prefrontal cortex and temporo-parietal regions (Blakemore, 2008; Blakemore, den Ouden, Choudhury, & Frith, 2007; Shaw et al., 2008). The extended development into adulthood of the brain regions involved in ToM might be expected to influence performance on tests of social cognition (Dumontheil, Apperly, & Blakemore, 2010). Indeed, Dumontheil et al. (2010) showed age-related improvements with ToM abilities from adolescence to later adulthood.

Consequently, it would stand to reason that if the brain regions involved in social cognition continue to develop into adulthood, this might result in measurable differences in performance, like age positively predicting cognitive ToM performance in younger adults as observed in Chapter 5.

Similarly, it is well established that cognitive processes decline with increasing age (Hedden & Gabrieli, 2004), with the frontal regions and tasks tapping those regions, being particularly susceptible to age-related changes (Bartzokis et al., 2001). This may partially explain the results of Chapter 3, with increasing age and age-related atrophy in the frontal regions reflecting poorer performance on specific social abilities. The results in Chapter 3 suggest that older adults have poorer social abilities than younger adults.

However, given the evidence discussed, perhaps what the ESCoT and tests of social cognition are measuring is the structural differences in the ageing brain through behavioural tests, rather than any meaningful or real-world age-related difference in an individual's social abilities. Anecdotally speaking, in everyday social interactions, it would be difficult to argue that older adults have poorer social skills than younger adults. Some would even argue that the opposite is true (Happé et al., 1998), but experimental tests in laboratory settings would suggest otherwise.

Overall there is evidence to argue that tests of social cognition are simply proxy assessments for structural differences in the brain and not functional age-related changes in our social abilities. Furthermore, they may not be as representative of real-world social abilities as researchers hope. This notion has important implications to interpreting the results of tests of social cognition like the ESCoT when used in healthy ageing research. The experimental results show a specific effect, but real-world interactions with older adults depict a different picture.

To further investigate social cognitive processes in healthy populations, the positivity bias was examined in a sample of older, middle-aged and younger adults. Across three types of stimuli (faces, scenes and social interaction), there was no evidence of an age-related preference for positive stimuli over negative stimuli. This is in contrast to the results of Chapter 3, where increasing age was predictive of poorer performance on affective ToM. Taken together, these two results suggest that while an individual's ability to infer what another person is feeling may be impacted by their age, their attention to positive and negative information is not affected in relation to response times. The variable that suggested an age-related change, similar to affective ToM, was accuracy in responding to positive and negative social stimuli when compared to faces and scenes. This age-related change was not observed in the younger adult group. Older adults may be less accurate with stimuli of faces because of age-related changes in their ability to infer emotive states from faces in social interactions. It appears that there may be some association between these two emotional processes but the exact nature of this this potential relationship is unclear, as they were not examined in the same study. Future research could examine accuracy to faces in a positivity bias paradigm alongside judgements of affective ToM using the same stimuli to further understand this association. In such an experiment, particular precautions would need to be taken due to the linear relationship between positivity bias and stimulus onset, since the positivity bias has been shown to only occur after 500 milliseconds (Reed & Carstensen, 2012).

8.6. Social norm understanding measured by the ESCoT

The ESCoT has added several novel findings to the literature in regards to social norm understanding. Firstly, Chapter 3 showed that, while an individual's cognitive ToM, affective ToM and interpersonal understanding of social norms might be negatively affected by age; their intrapersonal understanding of social abilities remains intact. To date, no study has shown this, nor been able to observe this finding within the same test. This contrasts with the intrapersonal abilities of ASD adults and bvFTD patients, who were found to be impaired on intrapersonal understanding of social norms. Perhaps this introspective skill serves as a compensatory ability, which negates the effects of other age-related deficits on cognitive ToM, affective ToM and interpersonal understanding of social norms. This may explain why even though age-related differences in social cognition abilities are similar to those found in ASD adults and dementia patients, the real-world observations are not as pronounced as in clinical populations.

Inappropriate social behaviour is a hallmark characteristic of bvFTD (Rascovsky et al., 2011), however abilities which may be responsible for this are not routinely measured. Chapter 6 showed that patients with bvFTD do in fact perform poorer than controls on objective measures of interpersonal understanding of social norms. This chapter was also the first study to show a significant correlation between cognitive processes and social norm understanding. In dementia patients, better language skills on the ECAS were correlated with performance on the SNQ, while interpersonal understanding of social norms and executive functions measured by the ECAS also showed a positive correlation. These findings suggest that some aspects of social norms understanding are related to general cognitive abilities. However, these were only preliminary results in a small sample (n = 24). Consequently, future studies could examine this in a larger sample and examine the associations between AD and bvFTD patients separately. This type of analysis may be useful to understand why bvFTD patients exhibit inappropriate social behaviours such as breaking social rules (Carr et al., 2015). The advantage of the ESCoT is that executive functions can be examined alongside objective measures of inter-and intrapersonal understand of social norms within the same test to examine potential dissociations. Moreover, ASD adults also appear to experience difficulties in this ability and this may explain why they struggle with social interactions, because they are unable to understand how another individual should behave in a social interaction.

Another novel finding observed with the ESCoT was that poorer performance on interpersonal understanding of social norms was predicted by more autistic traits in an ageing population. Firstly, this confirms that there is a distribution of autistic-like traits in the neurotypical population (Constantino et al., 2006; Constantino & Todd, 2005) and that these traits have a measurable influence on an individual's ability to understand social norms in the context of how they believe someone else should behave in an interaction. Moreover, for the first time, inter-and intrapersonal understanding of social norms have been assessed, firstly within the same test and secondly within the same test as ToM abilities. This is a great contribution to our understanding of social cognition in healthy ageing research, investigation into the interplay of social abilities with personality traits, and clinical research. The ESCoT also provides a clinical measure of these two abilities that currently does not exist. Until now, there have been limited measures of an individual's understanding of the rules that govern their behaviour in social interactions. With inter-and intrapersonal understanding of social norms being objectively assessed in a test, this has great potential to add new insights into how different sample populations process social information about social norms.

8.7. Limitations and future directions

There are important limitations of this thesis that should be considered. A limitation of the present series of studies is that they did not include an investigation into the effects of executive functions on performance of ToM and social norm understanding in ASD or healthy ageing. However, examining the relationship been executive functions and ToM using the ESCoT would have been insightful, given the debate regarding the relationship between ToM and executive functions (Bottiroli et al., 2016). There is contradictory evidence from correlational studies regarding the relationships between these two constructs. In dementia research, case studies of bvFTD patients have found relatively intact executive function but extremely impaired ToM abilities, suggesting a dissociation between ToM and executive functions, at least in bvFTD patients (Bertoux et al., 2012). This finding has been replicated by other studies (Gregory et al., 2002; Lough & Hodges, 2002; Lough et al., 2006). But some researchers have failed to find this dissociation, showing correlations between social cognition and executive abilities, and suggesting they might rely (at least in part) on similar processes (Eslinger et al., 2007; Snowden et al., 2003; Torralva et al., 2007). A similar pattern of findings is also true in the ageing research, some researchers find a relationship between the two (Bottiroli et al., 2016; Charlton et al., 2009; McKinnon & Moscovitch, 2007; Phillips et al., 2011; Rakoczy et al., 2012), while others have not (Cavallini, Lecce, Bottiroli, Palladino, & Pagnin, 2013; Maylor et al., 2002; Wang & Su, 2013). Consequently, future studies should examine the relationship between ToM and specific executive functions to understand the relationships between these variables.

Measures of IQ did not significantly predict performance on the ESCoT, however full-time education predicted better performance on ESCoT total scores in both Chapters 4 and 5. This is an unexpected finding because IQ performance and education are typically correlated (Deary, Strand, Smith, & Fernandes, 2007), which would suggest that if one predicts performance, so should the other. However, this was not observed, and it is currently uncertain why these results were found. The education levels of participants in both groups were relatively high, resulting in limited variance, but it is unclear how this would affect performance. It may have been a cohort effect in the younger adults because education was treated as a continuous variable in the regression analysis but due to a limited range, it was not continuous but a near zero predictor in terms of variance. As all participants in Chapter 5 had roughly the same years of education, the regression model may have had limited reference points to examine the predictor variable against the outcome variable. Consequently, the results of this chapter may not be able to offer insights into the effects of education on performance on the ESCoT. However, future studies could more specifically examine this unexpected finding by having more varied levels of education. The results may have implications for the scoring of the ESCoT, which may require education adjustments, similar to tests like the Mini-Mental State Examination (Crum, Anthony, Bassett, & Folstein, 1993).

Convergent validity, internal consistency and inter-rater reliability for the ESCoT were all examined in this thesis, with all showing favourable results for the ESCoT. Yet, it would be beneficial to examine further psychometric properties of the ESCoT such as test-retest reliability. This is particularly important if the ESCoT is to be used as a clinical test of social cognition. If the ESCoT is to be used in clinical settings, how participants perform on it after multiple testing should be investigated, as practice effects may be a concern. However, it should be noted that unlike social cognition tests like the RME or RMF, participants are not shown the potential answers, and due to the vague nature of the questions (e.g., what is X thinking?), they may not give the same answer every time. Nonetheless, future research would greatly benefit from examining the test-retest reliability of the ESCoT. Further convergent validity with newer tests which more closely measure the same abilities like the ESCoT such as the Strange Stories Film (Murray et al., 2017) would be valuable. Comparing the ESCoT to newer tests would also be beneficial to investigate which of these tests are best suited to assessing social cognition.

While this thesis demonstrated that social cognitive abilities measured by the ESCoT are negatively impacted by age, future studies might assess the real-world consequences of poorer performance on tests of social cognition in older adults. This might be achieved by examining social functioning (e.g., engagement in social activities, activities of daily living) and social networks (e.g., peer support and friendship groups) and how these relate to performance on the ESCoT. It would be insightful to examine whether individuals who engage in more social activities, and have more friendship groups objectively differ in performance on the ESCoT compared to individuals who engage in fewer social activities or have limited interpersonal relationships in older age. There is research to suggest that adults who exhibit better social cognitive abilities are more competent at social interactions (Bora, Eryavuz, Kayahan, Sungu, & Veznedaroglu, 2006). Although ToM and social functioning are often measured in the same study, level of social functioning is not typically used as the independent variable. Furthermore, social norm understanding could also be examined in relation to social function and social networks.

While it would require refining presentation timings, the easy administration (simply watching an animation and answering questions) of the ESCoT might mean it could be utilised in neuroimaging studies to observe the neural networks that the ESCoT activate. Firstly, to further confirm Shamay-Tsoory and colleagues theory of distinct but overlapping types of ToM (Shamay-Tsoory & Aharon-Peretz, 2007; Shamay-Tsoory et al., 2010; Shamay-Tsoory et al., 2007; Shamay-Tsoory et al., 2006; Shamay-Tsoory et al., 2005) since few studies examine ToM abilities in the same test with imaging techniques. Secondly, this type of investigation would be especially insightful for inter-intra personal understanding of social norms, as there is little neuroimaging data on these social cognitive abilities. Moreover, to date, neuroimaging techniques have not been used on a measure that assess both ToM and social norms understanding within the same test.

8.8. Conclusion

There are many tests of social cognition in the literature, and while these have their advantages, they also have their limitations. The ESCoT was designed to address some of these limitations and has done so relatively successfully, improving on previous tests. The ESCoT represents a sensitive, concise and informative neuropsychological tool to offer new and useful insights in the abilities that individuals use to interact with others. It is hoped that the results from this series of studies have shown that the ESCoT is a valuable research and clinical tool to assess social cognition in healthy and clinical populations and will enable further understanding of social cognitive abilities.

References

Abrahams, S., Leigh, P., Harvey, A., Vythelingum, G., Grise, D., & Goldstein, L. (2000). Verbal fluency and executive dysfunction in amyotrophic lateral sclerosis (ALS). *Neuropsychologia, 38*(6), 734-747.

Adenzato, M., Brambilla, M., Manenti, R., De Lucia, L., Trojano, L., Garofalo, S., . . . Cotelli, M. (2017). Gender differences in cognitive Theory of Mind revealed

by transcranial direct current stimulation on medial prefrontal cortex. *Scientific Reports, 7.*
Adenzato, M., & Poletti, M. (2013). Theory of Mind abilities in neurodegenerative diseases: An update and a call to introduce mentalizing tasks in standard neuropsychological assessments. *Clinical Neuropsychiatry, 10*(5), 223-234.
Adolphs, R. (2009). The social brain: Neural basis of social knowledge. *Annual review of psychology, 60*, 693-716.
Ahmed, F. S., & Miller, L. S. (2011). Executive function mechanisms of theory of mind. *Journal of autism and developmental disorders, 41*(5), 667-678.
Albert, M. S., DeKosky, S. T., Dickson, D., Dubois, B., Feldman, H. H., Fox, N. C., . . . Petersen, R. C. (2011). The diagnosis of mild cognitive impairment due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. *Alzheimer's & dementia, 7*(3), 270-279.
Alden, L. E., & Taylor, C. T. (2004). Interpersonal processes in social phobia. *Clinical psychology review, 24*(7), 857-882.
Altman, D. G. (1991). *Practical statistics for medical research.* London: Chapman and Hall.
American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4 ed.). Washington, DC: Author.
American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: APA.
Amodio, D. M., & Frith, C. D. (2006). Meeting of minds: the medial frontal cortex and social cognition. *Nature reviews neuroscience, 7*(4), 268-277.
Anderson, V. A., Anderson, P., Northam, E., Jacobs, R., & Catroppa, C. (2001). Development of executive functions through late childhood and adolescence in an Australian sample. *Developmental Neuropsychology, 20*(1), 385-406.
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. doi:10.1016/j.paid.2004.04.022
Baez, S., García, A. M., & Ibanez, A. (2016). The social context network model in psychiatric and neurological diseases. *Current Topics in Behavioral Neurosciences*, 1-18.
Baez, S., Herrera, E., Villarin, L., Theil, D., Gonzalez-Gadea, M. L., Gomez, P., . . . Vigliecca, N. S. (2013). Contextual social cognition impairments in Schizophrenia and Bipolar Disorder. *PLoS One, 8*(3), e57664.
Baez, S., & Ibanez, A. (2014). The effects of context processing on social cognition impairments in adults with Asperger's syndrome. *Frontiers in neuroscience, 8*, 270.
Baez, S., Manes, F., Huepe, D., Torralva, T., Fiorentino, N., Richter, F., . . . Ibanez, A. (2014). Primary empathy deficits in frontotemporal dementia. *Frontiers in Aging Neuroscience, 6.* doi:ARTN 262

10.3389/fnagi.2014.00262
Baez, S., Rattazzi, A., Gonzalez-Gadea, M. L., Torralva, T., Vigliecca, N., Decety, J., . . . Ibanez, A. (2012). Integrating intention and context: Assessing social cognition in adults with Asperger Syndrome. *Frontiers in Human Neuroscience, 6*, 1-21.
Bailey, P. E., & Henry, J. D. (2008). Growing less empathic with age: Disinhibition of the self-perspective. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 63*(4), P219-P226.
Bailey, P. E., Henry, J. D., & Von Hippel, W. (2008). Empathy and social functioning in late adulthood. *Aging and Mental Health, 12*(4), 499-503.

Baker, C. A., Peterson, E., Pulos, S., & Kirkland, R. A. (2014). Eyes and IQ: A meta-analysis of the relationship between intelligence and "Reading the Mind in the Eyes". *Intelligence, 44*, 78-92.

Baksh, R. A. (2013). *The Social Scenarios Test - A new test of social cognition for dementia*. Unpublished master's thesis. School of Philosophy, Psychology & Language Sciences. University of Edinburgh. Edinburgh, UK.

Baksh, R. A., Abrahams, S., Auyeung, B., & MacPherson, S. E. (under review). The Edinburgh Social Cognition Test (ESCoT): Examining the effects of age on a new measure of theory of mind and social norm understanding. *PLoS One*.

Bar, M. (2004). Visual objects in context. *Nature Reviews. Neuroscience, 5*(8), 617.

Barber, S. J., Opitz, P. C., Martins, B., Sakaki, M., & Mather, M. (2016). Thinking about a limited future enhances the positivity of younger and older adults' recall: Support for socioemotional selectivity theory. *Memory & cognition, 44*(6), 869-882.

Bargh, J. A., Chen, M., & Burrows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype activation on action. *Journal of personality and social psychology, 71*(2), 230.

Bargh, J. A., & Ferguson, M. J. (2000). Beyond behaviorism: on the automaticity of higher mental processes. *Psychological bulletin, 126*(6), 925.

Baron-Cohen, S. (1991). The theory of mind deficit in autism: How specific is it? *British Journal of Developmental Psychology, 9*(2), 301-314.

Baron-Cohen, S., Bowen, D. C., Holt, R. J., Allison, C., Auyeung, B., Lombardo, M. V., . . . Lai, M. C. (2015). The "Reading the Mind in the Eyes" Test: Complete Absence of Typical Sex Difference in similar to 400 Men and Women with Autism. *PLoS One, 10*(8).

Baron-Cohen, S., & Hammer, J. (1997). Parents of children with Asperger syndrome: what is the cognitive phenotype? *Journal of cognitive neuroscience, 9*(4), 548-554.

Baron-Cohen, S., Jolliffe, T., Mortimore, C., & Robertson, M. (1997). Another advanced test of theory of mind: Evidence from very High Functioning adults with Autism or Asperger Syndrome. *Journal of child psychology and psychiatry, 38*(7), 813-822.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*(1), 37-46.

Baron-Cohen, S., Richler, J., Bisarya, D., Gurunathan, N., & Wheelwright, S. (2003). The systemizing quotient: An investigation of adults with Asperger Syndrome or High–Functioning Autism, and normal sex differences. *Philosophical Transactions of the Royal Society of London B: Biological Sciences, 358*(1430), 361-374.

Baron-Cohen, S., & Wheelwright, S. (2003). The Friendship Questionnaire: An investigation of adults with Asperger syndrome or high-functioning autism, and normal sex differences. *Journal of autism and developmental disorders, 33*(5), 509-517.

Baron-Cohen, S., & Wheelwright, S. (2004). The empathy quotient: An investigation of adults with Asperger Syndrome or High Functioning Autism and normal sex differences. *Journal of autism and developmental disorders, 34*(2), 163-175.

Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "Reading the Mind in the Eyes" test revised version: A study with normal adults, and adults with Asperger Syndrome or High-Functioning Autism. *Journal of child psychology and psychiatry, 42*(2), 241-251.

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.
Bartzokis, G., Beckson, M., Lu, P. H., Nuechterlein, K. H., Edwards, N., & Mintz, J. (2001). Age-related changes in frontal and temporal lobe volumes in men: a magnetic resonance imaging study. *Archives of General Psychiatry, 58*(5), 461-465.
Baxter, D., & Warrington, E. (1994). Measuring dysgraphia: a graded-difficulty spelling test. *Behavioural Neurology, 7*(3-4), 107-116.
Bekker, M. H., & van Mens-Verhulst, J. (2007). Anxiety disorders: sex differences in prevalence, degree, and background, but gender-neutral treatment. *Gender medicine, 4*, S178-S193.
Berthoz, S., Armony, J., Blair, R., & Dolan, R. (2002). An fMRI study of intentional and unintentional (embarrassing) violations of social norms. *Brain, 125*(8), 1696-1708.
Bertoux, M., Delavest, M., de Souza, L. C., Funkiewiez, A., Lépine, J.-P., Fossati, P., . . . Sarazin, M. (2012). Social cognition and emotional assessment differentiates frontotemporal dementia from depression. *J Neurol Neurosurg Psychiatry*, jnnp-2011-301849.
Bishop, D. (2003). *Test for the reception of grammar (TROG-2)*. London: Harcourt Assessment.
Blacher, J., Kraemer, B., & Schalow, M. (2003). Asperger syndrome and high functioning autism: research concerns and emerging foci. *Current opinion in psychiatry, 16*(5), 535-542.
Blair, R. (2004). The roles of orbital frontal cortex in the modulation of antisocial behavior. *Brain and cognition, 55*(1), 198-208.
Blakemore, S.-J. (2008). The social brain in adolescence. *Nature Reviews. Neuroscience, 9*(4), 267.
Blakemore, S.-J., den Ouden, H., Choudhury, S., & Frith, C. (2007). Adolescent development of the neural circuitry for thinking about intentions.
Blanchard-Fields, F. (2007). Everyday problem solving and emotion an adult developmental perspective. *Current Directions in Psychological Science, 16*(1), 26-31.
Bögels, S. M., Alden, L., Beidel, D. C., Clark, L. A., Pine, D. S., Stein, M. B., & Voncken, M. (2010). Social anxiety disorder: questions and answers for the DSM-V. *Depression and anxiety, 27*(2), 168-189. doi:10.1002/da.20670
Bolton, P., Macdonald, H., Pickles, A., Rios, P. a., Goode, S., Crowson, M., . . . Rutter, M. (1994). A case-control family history study of autism. *Journal of child psychology and psychiatry, 35*(5), 877-900.
Bora, E., Eryavuz, A., Kayahan, B., Sungu, G., & Veznedaroglu, B. (2006). Social functioning, theory of mind and neurocognition in outpatients with schizophrenia; mental state decoding may be a better predictor of social functioning than mental state reasoning. *Psychiatry research, 145*(2), 95-103.
Bora, E., Walterfang, M., & Velakoulis, D. (2015). Theory of mind in behavioural-variant frontotemporal dementia and Alzheimer's disease: a meta-analysis. *Journal of Neurology, Neurosurgery & Psychiatry, 86*(7), 714-719.
Bora, E., & Yener, G. G. (2017). Meta-Analysis of Social Cognition in Mild Cognitive Impairment. *Journal of Geriatric Psychiatry and Neurology, 30*(4), 206-213.
Bottiroli, S., Cavallini, E., Ceccato, I., Vecchi, T., & Lecce, S. (2016). Theory of mind in aging: Comparing cognitive and affective components in the faux pas test. *Archives of gerontology and geriatrics, 62*, 152-162.

Bourdon, K. H., Boyd, J. H., Rae, D. S., Burns, B. J., Thompson, J. W., & Locke, B. Z. (1988). Gender differences in phobias: results of the ECA community survey. *Journal of Anxiety Disorders, 2*(3), 227-241.
Brewer, N., Young, R. L., & Barnett, E. (2017). Measuring theory of mind in adults with autism spectrum disorder. *Journal of autism and developmental disorders, 47*(7), 1927-1941.
Brothers, L. (1990). The social brain: a project for integrating primate behavior and neurophysiology in a new domain. *Concepts Neurosci., 1*, 27-51.
Brugha, T. S., McManus, S., Bankart, J., Scott, F., Purdon, S., Smith, J., . . . Meltzer, H. (2011). Epidemiology of autism spectrum disorders in adults in the community in England. *Archives of General Psychiatry, 68*(5), 459-465. doi:10.1001/archgenpsychiatry.2011.38
Budson, A. E., Todman, R. W., Chong, H., Adams, E. H., Kensinger, E. A., Krangel, T. S., & Wright, C. I. (2006). False recognition of emotional word lists in aging and Alzheimer disease. *Cognitive and Behavioral Neurology, 19*(2), 71-78.
Bursac, Z., Gauss, C. H., Williams, D. K., & Hosmer, D. W. (2008). Purposeful selection of variables in logistic regression. *Source code for biology and medicine, 3*(1), 17.
Carr, A. R., Paholpak, P., Daianu, M., Fong, S. S., Mather, M., Jimenez, E. E., . . . Mendez, M. F. (2015). An investigation of care-based vs. rule-based morality in Frontotemporal Dementia, Alzheimer's Disease, and healthy controls. *Neuropsychologia, 78*, 73-79.
Carroll, J. M., & Chiew, K. Y. (2006). Sex and discipline differences in empathising, systemising and autistic symptomatology: Evidence from a student population. *Journal of autism and developmental disorders, 36*(7), 949-957.
Carstensen, L. L. (1993). *Motivation for social contact across the life span: A theory of socioemotional selectivity.* Paper presented at the Nebraska symposium on motivation.
Carstensen, L. L., & Fredrickson, B. L. (1998). Influence of HIV status and age on cognitive representations of others. *Health Psychology, 17*(6), 494.
Carstensen, L. L., Isaacowitz, D. M., & Charles, S. T. (1999). Taking time seriously: A theory of socioemotional selectivity. *American psychologist, 54*(3), 165.
Carstensen, L. L., & Mikels, J. A. (2005). At the intersection of emotion and cognition: Aging and the positivity effect. *Current Directions in Psychological Science, 14*(3), 117-121.
Castelli, F., Frith, C., Happé, F., & Frith, U. (2002). Autism, Asperger syndrome and brain mechanisms for the attribution of mental states to animated shapes. *Brain, 125*(8), 1839-1849.
Castelli, I., Baglio, F., Blasi, V., Alberoni, M., Falini, A., Liverta-Sempio, O., . . . Marchetti, A. (2010). Effects of aging on mindreading ability through the eyes: An fMRI study. *Neuropsychologia, 48*(9), 2586-2594.
Castelli, I., Pini, A., Alberoni, M., Liverta-Sempio, O., Baglio, F., Massaro, D., . . . Nemni, R. (2011). Mapping levels of theory of mind in Alzheimer's disease: a preliminary study. *Aging & Mental Health, 15*(2), 157-168.
Cavallini, E., Lecce, S., Bottiroli, S., Palladino, P., & Pagnin, A. (2013). Beyond false belief: Theory of mind in young, young-old, and old-old adults. *The International Journal of Aging and Human Development, 76*(3), 181-198.
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.
Charlton, R. A., Barrick, T. R., Markus, H. S., & Morris, R. G. (2009). Theory of mind associations with other cognitive functions and brain imaging in normal aging. *Psychology and Aging, 24*(2), 338-348.

Chung, Y. S., Mathews, J. R., & Barch, D. M. (2010). The effect of context processing on different aspects of social cognition in schizophrenia. *Schizophrenia bulletin, 37*(5), 1048-1056.
Cohen, J. (1988). Statistical power analysis for the behavioral sciences Lawrence Earlbaum Associates. *Hillsdale, NJ*, 20-26.
Cohen, J. (1992). A power primer. *Psychological bulletin, 112*(1), 155.
Cohen, S. (2004). Social relationships and health. *American psychologist, 59*(8), 676.
Collignon, O., Girard, S., Gosselin, F., Saint-Amour, D., Lepore, F., & Lassonde, M. (2010). Women process multisensory emotion expressions more efficiently than men. *Neuropsychologia, 48*(1), 220-225.
Colvert, E., Tick, B., McEwen, F., Stewart, C., Curran, S. R., Woodhouse, E., . . . Garnett, T. (2015). Heritability of autism spectrum disorder in a UK population-based twin sample. *JAMA psychiatry, 72*(5), 415-423. doi:10.1001/jamapsychiatry.2014.3028
Constantinescu, A. C., Wolters, M., Moore, A., & MacPherson, S. E. (2017). A cluster-based approach to selecting representative stimuli from the International Affective Picture System (IAPS) database. *Behavior research methods, 49*(3), 896-912.
Constantino, J. N., Lajonchere, C., Lutz, M., Gray, T., Abbacchi, A., McKenna, K., . . . Todd, R. D. (2006). Autistic social impairment in the siblings of children with pervasive developmental disorders. *American Journal of Psychiatry, 163*(2), 294-296. doi:10.1176/appi.ajp.163.2.294
Constantino, J. N., & Todd, R. D. (2003). Autistic traits in the general population: a twin study. *Archives of General Psychiatry, 60*(5), 524-530. doi:10.1001/archpsyc.60.5.524
Constantino, J. N., & Todd, R. D. (2005). Intergenerational transmission of subthreshold autistic traits in the general population. *Biological psychiatry, 57*(6), 655-660. doi:10.1016/j.biopsych.2004.12.014
Cook, C. M., & Saucier, D. M. (2010). Mental rotation, targeting ability and Baron-Cohen's Empathizing–Systemizing theory of sex differences. *Personality and Individual Differences, 49*(7), 712-716.
Coughlan, A. K., Oddy, M., & Crawford, J. R. (2007). *BIRT Memory and Information Processing Battery (BMIPB)*. London: Brain Injury Rehabilitation Trust.
Couture, S., Penn, D., 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*(04), 569-579.
Cramer, D., & Howitt, D. L. (2004). *The Sage dictionary of statistics: a practical resource for students in the social sciences*: Sage.
Crum, R. M., Anthony, J. C., Bassett, S. S., & Folstein, M. F. (1993). Population-based norms for the Mini-Mental State Examination by age and educational level. *Jama, 269*(18), 2386-2391.
Cuerva, A. G., Sabe, L., Kuzis, G., Tiberti, C., Dorrego, F., & Starkstein, S. E. (2001). Theory of mind and pragmatic abilities in dementia. *Cognitive and Behavioral Neurology, 14*(3), 153-158.
D'Argembeau, A., Ruby, P., Collette, F., Degueldre, C., Balteau, E., Luxen, A., . . . Salmon, E. (2007). Distinct regions of the medial prefrontal cortex are associated with self-referential processing and perspective taking. *Journal of cognitive neuroscience, 19*(6), 935-944.
D'Hondt, F., Lassonde, M., Collignon, O., Lepore, F., Honore, J., & Sequeira, H. (2013). "Emotions Guide Us": Behavioral and MEG correlates. *Cortex, 49*(9), 2473-2483.

Davis, M. H. (1980). A multidimensional approach to individual differences in empathy.
Davis, M. H., & Franzoi, S. L. (1991). Stability and change in adolescent self-consciousness and empathy. *Journal of Research in Personality, 25*(1), 70-87. doi:Doi 10.1016/0092-6566(91)90006-C
De Luca, C. R., Wood, S. J., Anderson, V., Buchanan, J.-A., Proffitt, T. M., Mahony, K., & Pantelis, C. (2003). Normative data from the CANTAB. I: development of executive function over the lifespan. *Journal of clinical and experimental neuropsychology, 25*(2), 242-254.
Deary, I. J., Strand, S., Smith, P., & Fernandes, C. (2007). Intelligence and educational achievement. *Intelligence, 35*(1), 13-21.
Delis, D. C., Kaplan, E., & Kramer, J. H. (2001). *Delis-Kaplan executive function system (D-KEFS)*. San Antonio: Psychological Corporation.
Deng, Y., Chang, L., Yang, M., Huo, M., & Zhou, R. (2016). Gender Differences in Emotional Response: Inconsistency between Experience and Expressivity. *PLoS One, 11*(6), e0158666.
Devine, R. T., & Hughes, C. (2013). Silent films and strange stories: theory of mind, gender, and social experiences in middle childhood. *Child Development, 84*(3), 989-1003.
Dodich, A., Cerami, C., Canessa, N., Crespi, C., Iannaccone, S., Marcone, A., . . . Cappa, S. F. (2015). A novel task assessing intention and emotion attribution: Italian standardization and normative data of the Story-based Empathy Task. *Neurological Sciences, 36*(10), 1907-1912.
Dubois, B., Feldman, H. H., Jacova, C., DeKosky, S. T., Barberger-Gateau, P., Cummings, J., . . . Jicha, G. (2007). Research criteria for the diagnosis of Alzheimer's disease: revising the NINCDS–ADRDA criteria. *The Lancet Neurology, 6*(8), 734-746.
Dumontheil, I., Apperly, I. A., & Blakemore, S. J. (2010). Online usage of theory of mind continues to develop in late adolescence. *Developmental science, 13*(2), 331-338.
Duval, C., Piolino, P., Bejanin, A., Eustache, F., & Desgranges, B. (2011). Age effects on different components of theory of mind. *Consciousness and cognition, 20*(3), 627-642.
Dziobek, I., Fleck, S., Kalbe, E., Rogers, K., Hassenstab, J., Brand, M., . . . Convit, A. (2006). Introducing MASC: a movie for the assessment of social cognition. *Journal of autism and developmental disorders, 36*(5), 623-636.
Eddy, C. M., Beck, S. R., Mitchell, I. J., Praamstra, P., & Pall, H. S. (2013). Theory of mind deficits in Parkinson's disease: a product of executive dysfunction? *Neuropsychology, 27*(1), 37.
Eisenberg, N., & Lennon, R. (1983). Sex differences in empathy and related capacities. *Psychological bulletin, 94*(1), 100.
Ekman, P. (1973). Cross-cultural studies of facial expression. *Darwin and facial expression: A century of research in review*, 169-222.
Ekman, P., Sorenson, E. R., & Friesen, W. V. (1969). Pan-cultural elements in facial displays of emotion. *Science, 164*(3875), 86-88.
Elamin, M., Pender, N., Hardiman, O., & Abrahams, S. (2012). Social cognition in neurodegenerative disorders: a systematic review. *J Neurol Neurosurg Psychiatry, 83*(11), 1071-1079.
English, T., & Carstensen, L. L. (2014). Selective narrowing of social networks across adulthood is associated with improved emotional experience in daily life. *International Journal of Behavioral Development, 38*(2), 195-202.
English, T., & Carstensen, L. L. (2015). Socioemotional Selectivity Theory. *Encyclopedia of Geropsychology*, 1-6.

Eslinger, P. J., Moore, P., Troiani, V., Antani, S., Cross, K., Kwok, S., & Grossman, M. (2007). Oops! Resolving social dilemmas in frontotemporal dementia. *Journal of Neurology, Neurosurgery & Psychiatry, 78*(5), 457-460.

Faso, D. J., Corretti, C. A., Ackerman, R. A., & Sasson, N. J. (2016). The broad autism phenotype predicts relationship outcomes in newly formed college roommates. *Autism, 20*(4), 412-424.

Fehm, L., Pelissolo, A., Furmark, T., & Wittchen, H.-U. (2005). Size and burden of social phobia in Europe. *European Neuropsychopharmacology, 15*(4), 453-462. doi:10.1016/j.euroneuro.2005.04.002

Fernandez-Duque, D., Baird, J. A., & Black, S. E. (2009). False-belief understanding in frontotemporal dementia and Alzheimer's disease. *Journal of clinical and experimental neuropsychology, 31*(4), 489-497.

Fischer, A. L., O'Rourke, N., & Thornton, W. L. (2016). Age differences in cognitive and affective theory of mind: Concurrent contributions of neurocognitive performance, sex, and pulse pressure. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, gbw088.

Fiske, S. T., & Taylor, S. E. (2013). *Social cognition: From brains to culture*: Sage.

Foubert-Samier, A., Catheline, G., Amieva, H., Dilharreguy, B., Helmer, C., Allard, M., & Dartigues, J.-F. (2012). Education, occupation, leisure activities, and brain reserve: a population-based study. *Neurobiology of aging, 33*(2), 423. e415-423. e425.

Fredrickson, B. L., & Carstensen, L. L. (1990). Choosing social partners: how old age and anticipated endings make people more selective. *Psychology and Aging, 5*(3), 335.

Freeth, M., Bullock, T., & Milne, E. (2013). The distribution of and relationship between autistic traits and social anxiety in a UK student population. *Autism, 17*(5), 571-581. doi:10.1177/1362361312445511

Fresco, D., Coles, M., Heimberg, R. G., Liebowitz, M., Hami, S., Stein, M., & Goetz, D. (2001). The Liebowitz Social Anxiety Scale: a comparison of the psychometric properties of self-report and clinician-administered formats. *Psychological medicine, 31*(06), 1025-1035.

Frith, C. D. (2008). Social cognition. *Philosophical Transactions of the Royal Society B: Biological Sciences, 363*(1499), 2033-2039.

Frith, U. (1989). *Autism: Explaining the Enigma*. Oxford: Blackwell.

Frith, U. (2003). Autism: Explaining the Enigma (2nd ed.). Oxford: Wiley.

Frith, U. (2004). Emanuel Miller lecture: Confusions and controversies about Asperger syndrome. *Journal of child psychology and psychiatry, 45*(4), 672-686.

Fung, H. H., Carstensen, L. L., & Lutz, A. M. (1999). Influence of time on social preferences: implications for life-span development. *Psychology and Aging, 14*(4), 595.

Fung, H. H., Isaacowitz, D. M., Lu, A. Y., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2008). Age-related positivity enhancement is not universal: older Chinese look away from positive stimuli. *Psychology and Aging, 23*(2), 440.

Funkiewiez, A., Bertoux, M., de Souza, L. C., Lévy, R., & Dubois, B. (2012). The SEA (Social Cognition and Emotional Assessment): A clinical neuropsychological tool for early diagnosis of frontal variant of frontotemporal lobar degeneration. *Neuropsychology, 26*(1), 81.

Furmark, T., Tillfors, M., Everz, P.-O., Marteinsdottir, I., Gefvert, O., & Fredrikson, M. (1999). Social phobia in the general population: prevalence and sociodemographic profile. *Social psychiatry and psychiatric epidemiology, 34*(8), 416-424.

Gallagher, H. L., & Frith, C. D. (2003). Functional imaging of 'theory of mind'. *Trends in cognitive sciences, 7*(2), 77-83.

Gallese, V., Keysers, C., & Rizzolatti, G. (2004). A unifying view of the basis of social cognition. *Trends in cognitive sciences, 8*(9), 396-403.
Gallo, D. A., Foster, K. T., & Johnson, E. L. (2009). Elevated false recollection of emotional pictures in younger and older adults. *Psychology and Aging, 24*(4), 981.
German, T. P., & Hehman, J. A. (2006). Representational and executive selection resources in 'theory of mind': Evidence from compromised belief-desire reasoning in old age. *Cognition, 101*(1), 129-152.
Ghaziuddin, M., & Mountain-Kimchi, K. (2004). Defining the intellectual profile of Asperger syndrome: Comparison with high-functioning autism. *Journal of autism and developmental disorders, 34*(3), 279-284.
Girardi, A., MacPherson, S. E., & Abrahams, S. (2011). Deficits in emotional and social cognition in amyotrophic lateral sclerosis. *Neuropsychology, 25*(1), 53-65.
Gleichgerrcht, E., Torralva, T., Rattazzi, A., Marenco, V., Roca, M., & Manes, F. (2013). Selective impairment of cognitive empathy for moral judgment in adults with high functioning autism. *Social cognitive and affective neuroscience, 8*(7), 780-788.
Gleichgerrcht, E., Torralva, T., Roca, M., Pose, M., & Manes, F. (2011). The role of social cognition in moral judgment in frontotemporal dementia. *Social neuroscience, 6*(2), 113-122.
Golan, O., Baron-Cohen, S., Hill, J. J., & Golan, Y. (2006). The "reading the mind in films" task: complex emotion recognition in adults with and without autism spectrum conditions. *Social neuroscience, 1*(2), 111-123.
Grant, B. F., Hasin, D. S., Blanco, C., Stinson, F. S., Chou, S. P., Goldstein, R. B., . . . Huang, B. (2005). The epidemiology of social anxiety disorder in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. *The Journal of clinical psychiatry, 66*(11), 1351-1361.
Green, M. F., Horan, W. P., & Lee, J. (2015). Social cognition in schizophrenia. *Nature Reviews. Neuroscience, 16*(10), 620.
Gregory, C., Lough, S., Stone, V., Erzinclioglu, S., Martin, L., Baron-Cohen, S., & Hodges, J. R. (2002). Theory of mind in patients with frontal variant frontotemporal dementia and Alzheimer's disease: theoretical and practical implications. *Brain, 125*(4), 752-764.
Grove, R., Baillie, A., Allison, C., Baron-Cohen, S., & Hoekstra, R. A. (2013). Empathizing, systemizing, and autistic traits: latent structure in individuals with autism, their parents, and general population controls. *Journal of abnormal psychology, 122*(2), 600.
Grühn, D., Smith, J., & Baltes, P. B. (2005). No aging bias favoring memory for positive material: evidence from a heterogeneity-homogeneity list paradigm using emotionally toned words. *Psychology and Aging, 20*(4), 579.
Halberstadt, J., Ruffman, T., Murray, J., Taumoepeau, M., & Ryan, M. (2011). Emotion perception explains age-related differences in the perception of social gaffes. *Psychology and Aging, 26*(1), 133.
Hall, J. A. (1978). Gender effects in decoding nonverbal cues. *Psychological bulletin, 85*(4), 845.
Han, S., Fan, Y., & Mao, L. (2008). Gender difference in empathy for pain: an electrophysiological investigation. *Brain research, 1196*, 85-93.
Haney, J. L. (2016). Autism, females, and the DSM-5: Gender bias in autism diagnosis. *Social Work in Mental Health, 14*(4), 396-407.
Hanley, M., Riby, D. M., Carty, C., Melaugh McAteer, A., Kennedy, A., & McPhillips, M. (2015). The use of eye-tracking to explore social difficulties in cognitively able students with autism spectrum disorder: A pilot investigation. *Autism, 19*(7), 868-873.

Happé, F., & Conway, J. R. (2016). Recent progress in understanding skills and impairments in social cognition. *Current opinion in pediatrics, 28*(6), 736-742.

Happé, F. G. (1994). An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. *Journal of autism and developmental disorders, 24*(2), 129-154.

Happé, F. G., Winner, E., & Brownell, H. (1998). The getting of wisdom: Theory of mind in old age. *Developmental psychology, 34*(2), 358.

Heavey, L., Phillips, W., Baron-Cohen, S., & Rutter, M. (2000). The Awkward Moments Test: A naturalistic measure of social understanding in autism. *Journal of autism and developmental disorders, 30*(3), 225-236.

Hedden, T., & Gabrieli, J. D. (2004). Insights into the ageing mind: a view from cognitive neuroscience. *Nature reviews neuroscience, 5*(2), 87-96.

Henry, J. D., Cowan, D. G., Lee, T., & Sachdev, P. S. (2015). Recent trends in testing social cognition. *Current opinion in psychiatry, 28*(2), 133-140.

Henry, J. D., Phillips, L. H., Ruffman, T., & Bailey, P. E. (2013). A meta-analytic review of age differences in theory of mind. *Psychology and Aging, 28*(3), 826.

Henry, J. D., Phillips, L. H., & Von Hippel, C. (2014). A meta-analytic review of theory of mind difficulties in behavioural-variant frontotemporal dementia. *Neuropsychologia, 56*, 53-62.

Henry, J. D., Von Hippel, W., Molenberghs, P., Lee, T., & Sachdev, P. S. (2016). Clinical assessment of social cognitive function in neurological disorders. *Nature Reviews Neurology, 12*(1), 28-39.

Hess, T. M. (2005). Memory and aging in context. *Psychological bulletin, 131*(3), 383.

Hezel, D. M., & McNally, R. J. (2014). Theory of mind impairments in social anxiety disorder. *Behavior therapy, 45*(4), 530-540.

Hoekstra, R. A., Bartels, M., Verweij, C. J., & Boomsma, D. I. (2007). Heritability of autistic traits in the general population. *Archives of Pediatrics & Adolescent Medicine, 161*(4), 372-377.

Hoffman, M. L. (1977). Sex differences in empathy and related behaviors. *Psychological bulletin, 84*(4), 712.

Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative health research, 15*(9), 1277-1288.

Hurst, R., Mitchell, J., Kimbrel, N. A., Kwapil, T., & Nelson-Gray, R. (2007). Examination of the reliability and factor structure of the Autism Spectrum Quotient (AQ) in a non-clinical sample. *Personality and Individual Differences, 43*(7), 1938-1949.

Hutchins, T. L., Prelock, P. A., & Bonazinga, L. (2012). Psychometric evaluation of the Theory of Mind Inventory (ToMI): A study of typically developing children and children with autism spectrum disorder. *Journal of autism and developmental disorders, 42*(3), 327.

Hutchins, T. L., Prelock, P. A., Morris, H., Benner, J., LaVigne, T., & Hoza, B. (2016). Explicit vs. applied theory of mind competence: A comparison of typically developing males, males with ASD, and males with ADHD. *Research in Autism Spectrum Disorders, 21*, 94-108.

Hyde, J. S. (2016). Sex and cognition: gender and cognitive functions. *Current opinion in neurobiology, 38*, 53-56.

Hynes, C. A., Baird, A. A., & Grafton, S. T. (2006). Differential role of the orbital frontal lobe in emotional versus cognitive perspective-taking. *Neuropsychologia, 44*(3), 374-383.

Isaacowitz, D. M., Allard, E. S., Murphy, N. A., & Schlangel, M. (2009). The time course of age-related preferences toward positive and negative stimuli. *Journals of Gerontology: Series B, 64*(2), 188-192.
Isaacowitz, D. M., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2006a). Is there an age-related positivity effect in visual attention? A comparison of two methodologies. *Emotion, 6*(3), 511.
Isaacowitz, D. M., Wadlinger, H. A., Goren, D., & Wilson, H. R. (2006b). Selective preference in visual fixation away from negative images in old age? An eye-tracking study. *Psychology and Aging, 21*(1), 40.
Izuma, K., Matsumoto, K., Camerer, C. F., & Adolphs, R. (2011). Insensitivity to social reputation in autism. *Proceedings of the National Academy of Sciences, 108*(42), 17302-17307.
Jarrold, C., Butler, D. W., Cottington, E. M., & Jimenez, F. (2000). Linking theory of mind and central coherence bias in autism and in the general population. *Developmental psychology, 36*(1), 126.
Jobe, L. E., & White, S. W. (2007). Loneliness, social relationships, and a broader autism phenotype in college students. *Personality and Individual Differences, 42*(8), 1479-1489.
Jolliffe, T., & Baron-Cohen, S. (1999). A test of central coherence theory: linguistic processing in high-functioning adults with autism or Asperger syndrome: is local coherence impaired? *Cognition, 71*(2), 149-185.
Kaland, N., Møller-Nielsen, A., Callesen, K., Mortensen, E. L., Gottlieb, D., & Smith, L. (2002). A newadvanced'test of theory of mind: evidence from children and adolescents with Asperger syndrome. *Journal of child psychology and psychiatry, 43*(4), 517-528.
Kalbe, E., Schlegel, M., Sack, A. T., Nowak, D. A., Dafotakis, M., Bangard, C., . . . Kessler, J. (2010). Dissociating cognitive from affective theory of mind: a TMS study. *Cortex, 46*(6), 769-780.
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.
Keltner, D., & Gross, J. J. (1999). Functional accounts of emotions. *Cognition & Emotion, 13*(5), 467-480.
Keltner, D., & Haidt, J. (1999). Social functions of emotions at four levels of analysis. *Cognition & Emotion, 13*(5), 505-521.
Kemp, J., Després, O., Sellal, F., & Dufour, A. (2012). Theory of Mind in normal ageing and neurodegenerative pathologies. *Ageing research reviews, 11*(2), 199-219.
Kennedy, D. P., & Adolphs, R. (2012). The social brain in psychiatric and neurological disorders. *Trends in cognitive sciences, 16*(11), 559-572.
Kensinger, E. A. (2004). Remembering emotional experiences: The contribution of valence and arousal. *Reviews in the Neurosciences, 15*(4), 241-252.
Kertesz, A., Davidson, W., & Fox, H. (1997). Frontal Behavioral Inventory: Diagnostic Criteria for Frontal Lobe Dementi. *Canadian Journal of Neurological Sciences, 24*(1), 29-36.
Kessler, R. C., Berglund, P., Demler, O., Jin, R., Merikangas, K. R., & Walters, E. E. (2005). Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey Replication. *Archives of General Psychiatry, 62*(6), 593-602.
Kessler, R. C., McGonagle, K. A., Zhao, S., Nelson, C. B., Hughes, M., Eshleman, S., . . . Kendler, K. S. (1994). Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States: results from the National Comorbidity Survey. *Archives of General Psychiatry, 51*(1), 8-19.

Kipps, C. M., & Hodges, J. R. (2006). Theory of mind in frontotemporal dementia. *Social neuroscience, 1*(3-4), 235-244. doi:10.1080/17470910600989847
Kirkland, R. A., Peterson, E., Baker, C. A., Miller, S., & Pulos, S. (2013). Meta-analysis Reveals Adult Female Superiority in" Reading the Mind in the Eyes Test". *North American Journal of Psychology, 15*(1), 121.
Klenberg, L., Korkman, M., & Lahti-Nuuttila, P. (2001). Differential development of attention and executive functions in 3-to 12-year-old Finnish children. *Developmental Neuropsychology, 20*(1), 407-428.
Klin, A. (2000). Attributing social meaning to ambiguous visual stimuli in higher-functioning autism and Asperger syndrome: the social attribution task. *Journal of child psychology and psychiatry, 41*(7), 831-846.
Klin, A., Jones, W., Schultz, R., Volkmar, F., & Cohen, D. (2002). Visual fixation patterns during viewing of naturalistic social situations as predictors of social competence in individuals with autism. *Archives of General Psychiatry, 59*(9), 809-816.
Koff, E., Brownell, H., Winner, E., Albert, M., & Zaitchik, D. (2004). Inference of mental states in patients with Alzheimer's disease. *Cognitive neuropsychiatry, 9*(4), 301-313.
Korkman, M., Kemp, S. L., & Kirk, U. (2001). Effects of age on neurocognitive measures of children ages 5 to 12: A cross-sectional study on 800 children from the United States. *Developmental Neuropsychology, 20*(1), 331-354.
Krych-Appelbaum, M., Law, J. B., Jones, D., Barnacz, A., Johnson, A., & Keenan, J. P. (2007). "I think I know what you mean": The role of theory of mind in collaborative communication. *Interaction Studies, 8*(2), 267-280.
Kumfor, F., Irish, M., Hodges, J. R., & Piguet, O. (2014). Frontal and temporal lobe contributions to emotional enhancement of memory in behavioral-variant frontotemporal dementia and Alzheimer's disease. *Frontiers in behavioral neuroscience, 8*.
Kunihira, Y., Senju, A., Dairoku, H., Wakabayashi, A., & Hasegawa, T. (2006). 'Autistic'traits in non-autistic Japanese populations: relationships with personality traits and cognitive ability. *Journal of autism and developmental disorders, 36*(4), 553-566.
Kwon, Y., Scheibe, S., Samanez-Larkin, G. R., Tsai, J. L., & Carstensen, L. L. (2009). Replicating the positivity effect in picture memory in Koreans: evidence for cross-cultural generalizability. *Psychology and Aging, 24*(3), 748.
Laisney, M., Bon, L., Guiziou, C., Daluzeau, N., Eustache, F., & Desgranges, B. (2013). Cognitive and affective theory of mind in mild to moderate Alzheimer's disease. *Journal of neuropsychology, 7*(1), 107-120.
Lang, P. J. (2005). International affective picture system (IAPS): Affective ratings of pictures and instruction manual. *Technical report*.
Langton, S. R., Law, A. S., Burton, A. M., & Schweinberger, S. R. (2008). Attention capture by faces. *Cognition, 107*(1), 330-342.
Lawrence, E. J., Shaw, P., Baker, D., Baron-Cohen, S., & David, A. S. (2004). Measuring empathy: reliability and validity of the Empathy Quotient. *Psychological medicine, 34*(05), 911-920.
Lee, P. H. (2014). Should we adjust for a confounder if empirical and theoretical criteria yield contradictory results? A simulation study. *Scientific Reports, 4*, 6085.
Lehnhardt, F., Gawronski, A., Volpert, K., Schilbach, L., Tepest, R., Huff, W., & Vogeley, K. (2011). Autism spectrum disorders in adulthood: clinical and neuropsychological findings of Aspergers syndrome diagnosed late in life. *Fortschritte der Neurologie-Psychiatrie, 79*(5), 290-297.
Leigland, L. A., Schulz, L. E., & Janowsky, J. S. (2004). Age related changes in emotional memory. *Neurobiology of aging, 25*(8), 1117-1124.

Li, X., Wang, K., Wang, F., Tao, Q., Xie, Y., & Cheng, Q. (2013). Aging of theory of mind: The influence of educational level and cognitive processing. *International Journal of Psychology, 48*(4), 715-727.
Liebowitz, M. R. (1987). *Social phobia*: Karger Publishers.
Lipsitz, J. D., & Schneier, F. R. (2000). Social phobia. *Pharmacoeconomics, 18*(1), 23-32.
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.
Löckenhoff, C. E., & Carstensen, L. L. (2007). Aging, emotion, and health-related decision strategies: motivational manipulations can reduce age differences. *Psychology and Aging, 22*(1), 134.
Losh, M., Adolphs, R., Poe, M. D., Couture, S., Penn, D., Baranek, G. T., & Piven, J. (2009). Neuropsychological profile of autism and the broad autism phenotype. *Archives of General Psychiatry, 66*(5), 518-526.
Losh, M., & Piven, J. (2007). Social-cognition and the broad autism phenotype: identifying genetically meaningful phenotypes. *Journal of child psychology and psychiatry, 48*(1), 105-112.
Lough, S., Gregory, C., & Hodges, J. R. (2001). Dissociation of social cognition and executive function in frontal variant frontotemporal dementia. *Neurocase, 7*(2), 123-130.
Lough, S., & Hodges, J. R. (2002). Measuring and modifying abnormal social cognition in frontal variant frontotemporal dementia. *Journal of psychosomatic research, 53*(2), 639-646.
Lough, S., Kipps, C. M., Treise, C., Watson, P., Blair, J. R., & Hodges, J. R. (2006). Social reasoning, emotion and empathy in frontotemporal dementia. *Neuropsychologia, 44*(6), 950-958. doi:10.1016/j.neuropsychologia.2005.08.009
Love, M. C. N., Ruff, G., & Geldmacher, D. S. (2015). Social sognition in older adults: A review of reuropsychology, neurobiology, and functional connectivity. *Medical & Clinical Reviews*.
Lugnegård, T., Hallerbäck, M. U., Hjärthag, F., & Gillberg, C. (2013). Social cognition impairments in Asperger syndrome and schizophrenia. *Schizophrenia research, 143*(2), 277-284.
Luong, G., Charles, S. T., & Fingerman, K. L. (2010). Better with age: Social relationships across adulthood. *Journal of social and personal relationships, 28*(1), 9-23.
MacPherson, S. E., Phillips, L. H., & Della Sala, S. (2002). Age, executive function and social decision making: a dorsolateral prefrontal theory of cognitive aging. *Psychology and Aging, 17*(4), 598.
Magee, W. J., Eaton, W. W., Wittchen, H.-U., McGonagle, K. A., & Kessler, R. C. (1996). Agoraphobia, simple phobia, and social phobia in the National Comorbidity Survey. *Archives of General Psychiatry, 53*(2), 159-168.
Majerus, S., & D'Argembeau, A. (2011). Verbal short-term memory reflects the organization of long-term memory: Further evidence from short-term memory for emotional words. *Journal of Memory and Language, 64*(2), 181-197.
Maner, J. K., DeWall, C. N., & Gailliot, M. T. (2008). Selective attention to signs of success: Social dominance and early stage interpersonal perception. *Personality and Social Psychology Bulletin, 34*(4), 488-501.
Mar, R. A., Oatley, K., Hirsh, J., dela Paz, J., & Peterson, J. B. (2006). Bookworms versus nerds: Exposure to fiction versus non-fiction, divergent associations with social ability, and the simulation of fictional social worlds. *Journal of Research in Personality, 40*(5), 694-712.

Maren, S., Phan, K. L., & Liberzon, I. (2013). The contextual brain: implications for fear conditioning, extinction and psychopathology. *Nature Reviews. Neuroscience, 14*(6), 417.
Martory, M.-D., Pegna, A. J., Sheybani, L., Métral, M., Pertusio, F. B., & Annoni, J.-M. (2015). Assessment of Social Cognition and Theory of Mind: Initial Validation of the Geneva Social Cognition Scale. *European neurology, 74*(5-6), 288-295.
Mather, M., & Carstensen, L. L. (2003). Aging and attentional biases for emotional faces. *Psychological science, 14*(5), 409-415.
Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in cognitive sciences, 9*(10), 496-502.
Mather, M., & Johnson, M. K. (2000). Choice-supportive source monitoring: Do our decisions seem better to us as we age? *Psychology and Aging, 15*(4), 596.
Mather, M., & Knight, M. (2005). Goal-directed memory: the role of cognitive control in older adults' emotional memory. *Psychology and Aging, 20*(4), 554.
Mather, M., Knight, M., & McCaffrey, M. (2005). The allure of the alignable: younger and older adults' false memories of choice features. *Journal of Experimental Psychology: General, 134*(1), 38.
Mathersul, D., McDonald, S., & Rushby, J. A. (2013). Understanding advanced theory of mind and empathy in high-functioning adults with autism spectrum disorder. *Journal of clinical and experimental neuropsychology, 35*(6), 655-668.
Matson, J. L., & Kozlowski, A. M. (2011). The increasing prevalence of autism spectrum disorders. *Research in Autism Spectrum Disorders, 5*(1), 418-425.
Mauri, M., Sinforiani, E., Zucchella, C., Cuzzoni, M. G., & Bono, G. (2012). Progression to dementia in a population with amnestic mild cognitive impairment: clinical variables associated with conversion. *Functional neurology, 27*(1), 49.
Maylor, E. A., Moulson, J. M., Muncer, A. M., & Taylor, L. A. (2002). Does performance on theory of mind tasks decline in old age? *British Journal of Psychology, 93*(Pt 4), 465-485.
McCrimmon, A. W., & Smith, A. D. (2013). Test Review: Review of the Wechsler Abbreviated Scale of Intelligence, Second Edition (WASI-II). *Journal of Psychoeducational Assessment, 31*(3), 337-341.
McDonald, S. (2012). New frontiers in neuropsychological assessment: Assessing social perception using a standardised instrument, The Awareness of Social Inference Test. *Australian Psychologist, 47*(1), 39-48.
McDonald, S., Flanagan, S., Martin, I., & Saunders, C. (2004). The ecological validity of TASIT: A test of social perception. *Neuropsychological rehabilitation, 14*(3), 285-302.
McDonald, S., Flanagan, S., Rollins, J., & Kinch, J. (2003). TASIT: A new clinical tool for assessing social perception after traumatic brain injury. *The Journal of head trauma rehabilitation, 18*(3), 219-238.
McKenna, P., & Warrington, E. (1983). *The Graded Naming Test.* Windsor: NFER-Nelson.
McKinnon, M. C., & Moscovitch, M. (2007). Domain-general contributions to social reasoning: theory of mind and deontic reasoning re-explored. *Cognition, 102*(2), 179-218.
McLean, C. P., Asnaani, A., Litz, B. T., & Hofmann, S. G. (2011). Gender differences in anxiety disorders: Prevalence, course of illness, comorbidity and burden

of illness. *Journal of Psychiatric Research, 45*(8), 1027-1035. doi:10.1016/j.jpsychires.2011.03.006
Meguro, K., Shimada, M., Yamaguchi, S., Ishizaki, J., Ishii, H., Shimada, Y., . . . Sekita, Y. (2001). Cognitive function and frontal lobe atrophy in normal elderly adults: implications for dementia not as aging-related disorders and the reserve hypothesis. *Psychiatry and Clinical Neurosciences, 55*(6), 565-572.
Mehrabian, A. (1996). Pleasure-arousal-dominance: A general framework for describing and measuring individual differences in temperament. *Current Psychology, 14*(4), 261-292.
Melloni, M., Lopez, V., & Ibanez, A. (2014). Empathy and contextual social cognition. *Cognitive, Affective, & Behavioral Neuroscience, 14*(1), 407-425.
Mikels, J. A., Larkin, G. R., Reuter-Lorenz, P. A., & Carstensen, L. L. (2005). Divergent trajectories in the aging mind: changes in working memory for affective versus visual information with age. *Psychology and Aging, 20*(4), 542.
Mitchell, J. P., Macrae, C. N., & Banaji, M. R. (2006). Dissociable medial prefrontal contributions to judgments of similar and dissimilar others. *Neuron, 50*(4), 655-663.
Modinos, G., Obiols, J. E., Pousa, E., & Vicens, J. (2009). Theory of Mind in different dementia profiles. *The Journal of neuropsychiatry and clinical neurosciences, 21*(1), 100-101.
Moran, J. M. (2013). Lifespan development: The effects of typical aging on theory of mind. *Behavioural brain research, 237*, 32-40.
Moran, J. M., Jolly, E., & Mitchell, J. P. (2012). Social-cognitive deficits in normal aging. *The Journal of Neuroscience, 32*(16), 5553-5561.
Müller, E., Schuler, A., & Yates, G. B. (2008). Social challenges and supports from the perspective of individuals with Asperger syndrome and other autism spectrum disabilities. *Autism, 12*(2), 173-190.
Murphy, N. A., & Isaacowitz, D. M. (2008). Preferences for emotional information in older and younger adults: A meta-analysis of memory and attention tasks. *Psychology and Aging, 23*(2), 263-286. doi:10.1037/0882-7974.23.2.263
Murray, K., Johnston, K., Cunane, H., Kerr, C., Spain, D., Gillan, N., . . . Happé, F. (2017). A new test of advanced theory of mind: The “Strange Stories Film Task” captures social processing differences in adults with autism spectrum disorders. *Autism Research*.
Nettle, D., & Liddle, B. (2008). Agreeableness is related to social-cognitive, but not social-perceptual, theory of mind. *European Journal of Personality, 22*(4), 323-335.
Niven, E., Newton, J., Foley, J., Colville, S., Swingler, R., Chandran, S., . . . Abrahams, S. (2015). Validation of the Edinburgh Cognitive and Behavioural Amyotrophic Lateral Sclerosis Screen (ECAS): a cognitive tool for motor disorders. *Amyotrophic Lateral Sclerosis and Frontotemporal Degeneration, 16*(3-4), 172-179.
Nunnally, J. (1978). *Psychometric Theory* (2 ed.). New York: McGraw-Hill Book Company.
O'Callaghan, C., Bertoux, M., Irish, M., Shine, J. M., Wong, S., Spiliopoulos, L., . . . Hornberger, M. (2016). Fair play: social norm compliance failures in behavioural variant frontotemporal dementia. *Brain, 139*, 204-216. doi:10.1093/brain/awv315

Oakley, B. F., Brewer, R., Bird, G., & Catmur, C. (2016). Theory of mind is not theory of emotion: A cautionary note on the Reading the Mind in the Eyes Test. *Journal of abnormal psychology, 125*(6), 818.
Offord, D. R., Boyle, M. H., Campbell, D., & Goering, P. (1996). One-year prevalence of psychiatric disorder in Ontarians 15 to 64 years of age. *The Canadian Journal of Psychiatry/La Revue canadienne de psychiatrie*.
Orsmond, G. I., Krauss, M. W., & Seltzer, M. M. (2004). Peer relationships and social and recreational activities among adolescents and adults with autism. *Journal of autism and developmental disorders, 34*(3), 245-256.
Orsmond, G. I., Shattuck, P. T., Cooper, B. P., Sterzing, P. R., & Anderson, K. A. (2013). Social participation among young adults with an autism spectrum disorder. *Journal of autism and developmental disorders, 43*(11), 2710-2719.
Palmen, A., Didden, R., & Lang, R. (2012). A systematic review of behavioral intervention research on adaptive skill building in high-functioning young adults with autism spectrum disorder. *Research in Autism Spectrum Disorders, 6*(2), 602-617.
Pardini, M., Emberti, G. L., Mascolo, M., Benassi, F., Abate, L., Guida, S., . . . Krueger, F. (2012). Isolated theory of mind deficits and risk for frontotemporal dementia: a longitudinal pilot study. *J Neurol Neurosurg Psychiatry*, jnnp-2012-303684.
Pardini, M., & Nichelli, P. F. (2009). Age-related decline in mentalizing skills across adult life span. *Experimental aging research, 35*(1), 98-106.
Park, D. C., Lautenschlager, G., Hedden, T., Davidson, N. S., Smith, A. D., & Smith, P. K. (2002). Models of visuospatial and verbal memory across the adult life span. *Psychology and Aging, 17*(2), 299.
Patin, A., & Hurlemann, R. (2015). Social cognition *Cognitive Enhancement* (pp. 271-303): Springer.
Perner, J., & Wimmer, H. (1985). "John thinks that Mary thinks that…" attribution of second-order beliefs by 5-to 10-year-old children. *Journal of experimental child psychology, 39*(3), 437-471.
Peterson, E., & Miller, S. (2012). The eyes test as a measure of individual differences: how much of the variance reflects verbal IQ? *Frontiers in psychology, 3*, 220.
Phillips, L. H., Bull, R., Allen, R., Insch, P., Burr, K., & Ogg, W. (2011). Lifespan aging and belief reasoning: Influences of executive function and social cue decoding. *Cognition, 120*(2), 236-247.
Phillips, L. H., MacLean, R. D., & Allen, R. (2002). Age and the understanding of emotions neuropsychological and sociocognitive perspectives. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences, 57*(6), P526-P530.
Piguet, O., Connally, E., Krendl, A. C., Huot, J. R., & Corkin, S. (2008). False memory in aging: effects of emotional valence on word recognition accuracy. *Psychology and Aging, 23*(2), 307.
Piven, J., Palmer, P., Jacobi, D., Childress, D., & Arndt, S. (1997). Broader autism phenotype: evidence from a family history study of multiple-incidence autism families. *American Journal of Psychiatry, 154*(2), 185-190.
Poletti, M., Enrici, I., & Adenzato, M. (2012). Cognitive and affective Theory of Mind in neurodegenerative diseases: Neuropsychological, neuroanatomical and neurochemical levels. *Neuroscience and Biobehavioral Reviews, 36*(9), 2147-2164. doi:10.1016/j.neubiorev.2012.07.004
Porter, M. A., Coltheart, M., & Langdon, R. (2008). Theory of mind in Williams syndrome assessed using a nonverbal task. *Journal of autism and developmental disorders, 38*(5), 806-814.

Possin, K. L., Feigenbaum, D., Rankin, K. P., Smith, G. E., Boxer, A. L., Wood, K., . . . Kramer, J. H. (2013). Dissociable executive functions in behavioral variant frontotemporal and Alzheimer dementias. *Neurology, 80*(24), 2180-2185.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and brain sciences, 1*(4), 515-526.

Prinzmetal, W., McCool, C., & Park, S. (2005). Attention: reaction time and accuracy reveal different mechanisms. *Journal of Experimental Psychology: General, 134*(1), 73.

Rakoczy, H., Harder-Kasten, A., & Sturm, L. (2012). The decline of theory of mind in old age is (partly) mediated by developmental changes in domain-general abilities. *British Journal of Psychology, 103*(1), 58-72.

Rankin, K. P. (2008). *Social Norms Questionaire NINDS Domain Specific Tasks of Executive Function.*

Rascovsky, K., Hodges, J. R., Knopman, D., Mendez, M. F., Kramer, J. H., Neuhaus, J., . . . Onyike, C. U. (2011). Sensitivity of revised diagnostic criteria for the behavioural variant of frontotemporal dementia. *Brain, 134*(9), 2456-2477.

Raz, N., Lindenberger, U., Rodrigue, K. M., Kennedy, K. M., Head, D., Williamson, A., . . . Acker, J. D. (2005). Regional brain changes in aging healthy adults: general trends, individual differences and modifiers. *Cerebral cortex, 15*(11), 1676-1689.

Reed, A. E., & Carstensen, L. L. (2012). The theory behind the age-related positivity effect. *Frontiers in psychology, 3.*

Reed, A. E., Chan, L., & Mikels, J. A. (2014). Meta-analysis of the age-related positivity effect: age differences in preferences for positive over negative information: American Psychological Association.

Reitan, R. M. (1955). The relation of the trail making test to organic brain damage. *Journal of consulting psychology, 19*(5), 393-394.

Reitan, R. M., & Wolfson, D. (1993). *The Halstead–Reitan neuropsychological test battery: Theory and clinical interpretation* (2nd ed.). Tucson, AZ: Neuropsychology Press.

Reniers, R. L., Völlm, B. A., Elliott, R., & Corcoran, R. (2014). Empathy, ToM, and self–other differentiation: An fMRI study of internal states. *Social neuroscience, 9*(1), 50-62.

Roeyers, H., Buysse, A., Ponnet, K., & Pichal, B. (2001). Advancing advanced mind-reading tests: empathic accuracy in adults with a pervasive developmental disorder. *Journal of child psychology and psychiatry, 42*(2), 271-278.

Roeyers, H., & Demurie, E. (2010). How impaired is mind-reading in high-functioning adolescents and adults with autism? *European Journal of Developmental Psychology, 7*(1), 123-134.

Rogers, K., Dziobek, I., Hassenstab, J., Wolf, O. T., & Convit, A. (2007). Who cares? Revisiting empathy in Asperger syndrome. *Journal of autism and developmental disorders, 37*(4), 709-715.

Romine, C. B., & Reynolds, C. R. (2005). A model of the development of frontal lobe functioning: Findings from a meta-analysis. *Applied neuropsychology, 12*(4), 190-201.

Rosbrook, A., & Whittingham, K. (2010). Autistic traits in the general population: What mediates the link with depressive and anxious symptomatology? *Research in Autism Spectrum Disorders, 4*(3), 415-424.

Rueckert, L., & Naybar, N. (2008). Gender differences in empathy: The role of the right hemisphere. *Brain and cognition, 67*(2), 162-167.

Russell, T. A., Tchanturia, K., Rahman, Q., & Schmidt, U. (2007). Sex differences in theory of mind: a male advantage on Happé's "cartoon" task. *Cognition and Emotion, 21*(7), 1554-1564.

Rutter, M. (2000). Genetic studies of autism: from the 1970s into the millennium. *Journal of Abnormal Child Psychology, 28*(1), 3-14.
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.
Salthouse, T. A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological review, 103*(3), 403.
Saltzman, J., Strauss, E., Hunter, M., & Archibald, S. (2000). Theory of mind and executive functions in normal human aging and Parkinson's disease. *Journal of the International Neuropsychological Society, 6*(07), 781-788.
Samson, A. C., Lackner, H. K., Weiss, E. M., & Papousek, I. (2012). Perception of other people's mental states affects humor in social anxiety. *Journal of behavior therapy and experimental psychiatry, 43*(1), 625-631.
Sasson, N. J., Nowlin, R. B., & Pinkham, A. E. (2013). Social cognition, social skill, and the broad autism phenotype. *Autism, 17*(6), 655-667.
Saxe, R., & Powell, L. J. (2006). It's the thought that counts: specific brain regions for one component of theory of mind. *Psychological science, 17*(8), 692-699.
Scheeren, A. M., de Rosnay, M., Koot, H. M., & Begeer, S. (2013). Rethinking theory of mind in high-functioning autism spectrum disorder. *Journal of child psychology and psychiatry, 54*(6), 628-635.
Scheibe, S., & Carstensen, L. L. (2010). Emotional aging: Recent findings and future trends. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 135-144.
Schiffer, B., Pawliczek, C., Müller, B. W., Gizewski, E. R., & Walter, H. (2013). Why don't men understand women? Altered neural networks for reading the language of male and female eyes. *PLoS One, 8*(4), e60278.
Schilbach, L., Eickhoff, S. B., Cieslik, E. C., Kuzmanovic, B., & Vogeley, K. (2012). Shall we do this together? Social gaze influences action control in a comparison group, but not in individuals with high-functioning autism. *Autism, 16*(2), 151-162.
Schneier, F. R., Johnson, J., Hornig, C. D., Liebowitz, M. R., & Weissman, M. M. (1992). Social phobia: comorbidity and morbidity in an epidemiologic sample. *Archives of General Psychiatry, 49*(4), 282-288.
Sebastian, C. L., Fontaine, N. M., Bird, G., Blakemore, S.-J., De Brito, S. A., McCrory, E. J., & Viding, E. (2011). Neural processing associated with cognitive and affective Theory of Mind in adolescents and adults. *Social cognitive and affective neuroscience*, 1-11.
Senju, A., Southgate, V., White, S., & Frith, U. (2009). Mindblind eyes: an absence of spontaneous theory of mind in Asperger syndrome. *Science, 325*(5942), 883-885.
Shamaskin, A. M., Mikels, J. A., & Reed, A. E. (2010). Getting the message across: age differences in the positive and negative framing of health care messages. *Psychology and Aging, 25*(3), 746.
Shamay-Tsoory, S., Tomer, R., Goldsher, D., Berger, B., & Aharon-Peretz, J. (2004). Impairment in cognitive and affective empathy in patients with brain lesions: anatomical and cognitive correlates. *Journal of clinical and experimental neuropsychology, 26*(8), 1113-1127.
Shamay-Tsoory, S. G., & Aharon-Peretz, J. (2007). Dissociable prefrontal networks for cognitive and affective theory of mind: a lesion study. *Neuropsychologia, 45*(13), 3054-3067.

Shamay-Tsoory, S. G., Harari, H., Aharon-Peretz, J., & Levkovitz, Y. (2010). The role of the orbitofrontal cortex in affective theory of mind deficits in criminal offenders with psychopathic tendencies. *Cortex, 46*(5), 668-677.
Shamay-Tsoory, S. G., Shur, S., Barcai-Goodman, L., Medlovich, S., Harari, H., & Levkovitz, Y. (2007). Dissociation of cognitive from affective components of theory of mind in schizophrenia. *Psychiatry research, 149*(1), 11-23.
Shamay-Tsoory, S. G., Tibi-Elhanany, Y., & Aharon-Peretz, J. (2006). The ventromedial prefrontal cortex is involved in understanding affective but not cognitive theory of mind stories. *Social neuroscience, 1*(3-4), 149-166.
Shamay-Tsoory, S. G., Tomer, R., Berger, B., & Aharon-Peretz, J. (2003). Characterization of empathy deficits following prefrontal brain damage: the role of the right ventromedial prefrontal cortex. *Journal of cognitive neuroscience, 15*(3), 324-337.
Shamay-Tsoory, S. G., Tomer, R., Berger, B. D., Goldsher, D., & Aharon-Peretz, J. (2005). Impaired "affective theory of mind" is associated with right ventromedial prefrontal damage. *Cognitive and Behavioral Neurology, 18*(1), 55-67.
Shany-Ur, T., Poorzand, P., Grossman, S. N., Growdon, M. E., Jang, J. Y., Ketelle, R. S., . . . Rankin, K. P. (2012). Comprehension of insincere communication in neurodegenerative disease: lies, sarcasm, and theory of mind. *Cortex, 48*(10), 1329-1341.
Shaw, P., Kabani, N. J., Lerch, J. P., Eckstrand, K., Lenroot, R., Gogtay, N., . . . Rapoport, J. L. (2008). Neurodevelopmental trajectories of the human cerebral cortex. *Journal of Neuroscience, 28*(14), 3586-3594.
Sijtsma, K. (2009). On the use, the misuse, and the very limited usefulness of Cronbach's alpha. *Psychometrika, 74*(1), 107.
Silk, J. B., Alberts, S. C., & Altmann, J. (2003). Social bonds of female baboons enhance infant survival. *Science, 302*(5648), 1231-1234.
Slessor, G., Phillips, L. H., & Bull, R. (2007). Exploring the specificity of age-related differences in theory of mind tasks. *Psychology and Aging, 22*(3), 639-643.
Snowden, J., Bathgate, D., Varma, A., Blackshaw, A., Gibbons, Z., & Neary, D. (2001). Distinct behavioural profiles in frontotemporal dementia and semantic dementia. *Journal of Neurology, Neurosurgery & Psychiatry, 70*(3), 323-332.
Snowden, J., Gibbons, Z., Blackshaw, A., Doubleday, E., Thompson, J., Craufurd, D., . . . Neary, D. (2003). Social cognition in frontotemporal dementia and Huntington's disease. *Neuropsychologia, 41*(6), 688-701.
Sodian, B., Thoermer, C., & Metz, U. (2007). Now I see it but you don't: 14-month-olds can represent another person's visual perspective. *Developmental science, 10*(2), 199-204.
Solé-Padullés, C., Bartrés-Faz, D., Junqué, C., Vendrell, P., Rami, L., Clemente, I. C., . . . Jurado, M. A. (2009). Brain structure and function related to cognitive reserve variables in normal aging, mild cognitive impairment and Alzheimer's disease. *Neurobiology of aging, 30*(7), 1114-1124.
Sommer, M., Döhnel, K., Sodian, B., Meinhardt, J., Thoermer, C., & Hajak, G. (2007). Neural correlates of true and false belief reasoning. *Neuroimage, 35*(3), 1378-1384.
Spek, A. A., Scholte, E. M., & Van Berckelaer-Onnes, I. A. (2010). Theory of mind in adults with HFA and Asperger syndrome. *Journal of autism and developmental disorders, 40*(3), 280-289.
Stein, M. B., & Stein, D. J. (2008). Social anxiety disorder. *The Lancet, 371*(9618), 1115-1125.

Steinmetz, K. R. M., Addis, D. R., & Kensinger, E. A. (2010). The effect of arousal on the emotional memory network depends on valence. *Neuroimage, 53*(1), 318-324.

Stewart, M. E., & Austin, E. J. (2009). The structure of the Autism-Spectrum Quotient (AQ): Evidence from a student sample in Scotland. *Personality and Individual Differences, 47*(3), 224-228.

Stiller, J., & Dunbar, R. I. (2007). Perspective-taking and memory capacity predict social network size. *Social Networks, 29*(1), 93-104.

Stone, V. E., Baron-Cohen, S., & Knight, R. T. (1998). Frontal lobe contributions to theory of mind. *Journal of cognitive neuroscience, 10*(5), 640-656.

Stuss, D. T., Gallup Jr, G. G., & Alexander, M. P. (2001). The frontal lobes are necessary fortheory of mind'. *Brain, 124*(2), 279-286.

Sucksmith, E., Allison, C., Baron-Cohen, S., Chakrabarti, B., & Hoekstra, R. (2013). Empathy and emotion recognition in people with autism, first-degree relatives, and controls. *Neuropsychologia, 51*(1), 98-105.

Sucksmith, E., Roth, I., & Hoekstra, R. (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). Social understanding: How does it fare with advancing years? *British Journal of Psychology, 95*(Pt 1), 1-18.

Taniai, H., Nishiyama, T., Miyachi, T., Imaeda, M., & Sumi, S. (2008). Genetic influences on the broad spectrum of autism: Study of proband-ascertained twins. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics, 147*(6), 844-849.

Thiébaut, F. I., White, S. J., Walsh, A., Klargaard, S. K., Wu, H.-C., Rees, G., & Burgess, P. W. (2016). Does Faux Pas Detection in Adult Autism Reflect Differences in Social Cognition or Decision-Making Abilities? *Journal of autism and developmental disorders, 46*(1), 103-112.

Tibi-Elhanany, Y., & Shamay-Tsoory, S. G. (2011). Social Cognition in Social Anxiety: First Evidence for Increased Empathic Abilities. *Israel Journal of Psychiatry and Related Sciences, 48*(2), 98-106.

Torralva, T., Kipps, C. M., Hodges, J. R., Clark, L., Bekinschtein, T., Roca, M., . . . Manes, F. (2007). The relationship between affective decision-making and theory of mind in the frontal variant of fronto-temporal dementia. *Neuropsychologia, 45*(2), 342-349.

Toussaint, L., & Webb, J. R. (2005). Gender differences in the relationship between empathy and forgiveness. *The Journal of social psychology, 145*(6), 673-685.

Trevisan, D., & Birmingham, E. (2016). Examining the relationship between autistic traits and college adjustment. *Autism, 20*(6), 719-729.

Valenzuela, M. J., & Sachdev, P. (2006). Brain reserve and dementia: a systematic review. *Psychological medicine, 36*(4), 441-454.

van der Hulst, E.-J., Bak, T. H., & Abrahams, S. (2014). Impaired affective and cognitive theory of mind and behavioural change in amyotrophic lateral sclerosis. *J Neurol Neurosurg Psychiatry*, jnnp-2014-309290.

van Ede, F., de Lange, F. P., & Maris, E. (2012). Attentional cues affect accuracy and reaction time via different cognitive and neural processes. *Journal of Neuroscience, 32*(30), 10408-10412.

Van Overwalle, F. (2009). Social cognition and the brain: A meta-analysis. *Human brain mapping, 30*(3), 829-858.

Vellante, M., Baron-Cohen, S., Melis, M., Marrone, M., Petretto, D. R., Masala, C., & Preti, A. (2013). The "Reading the Mind in the Eyes" test: systematic review of psychometric properties and a validation study in Italy. *Cognitive neuropsychiatry, 18*(4), 326-354.

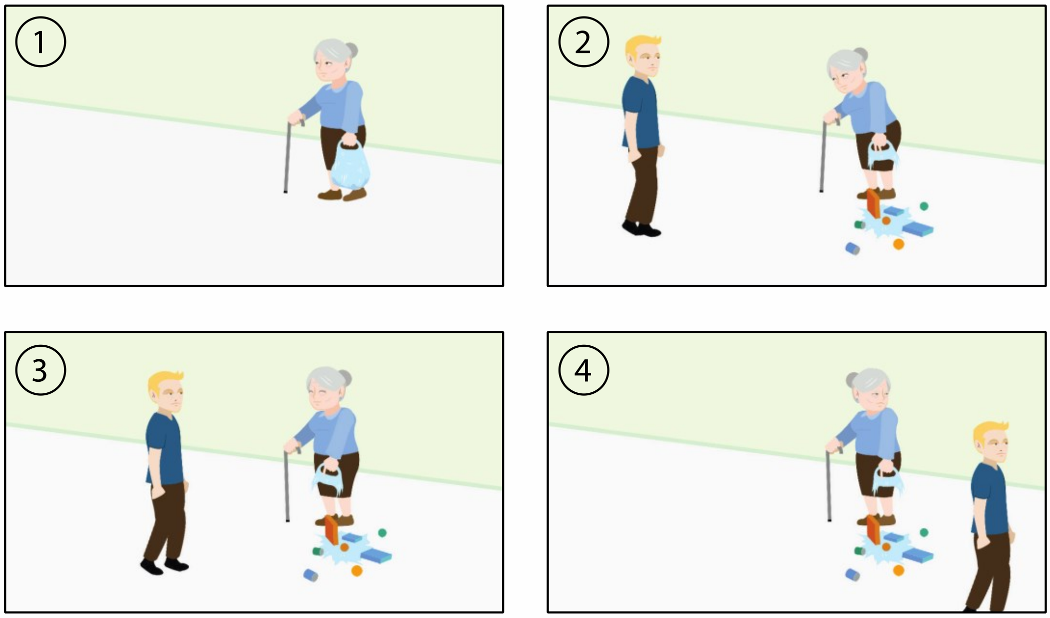
Vermeulen, P. (2015). Context blindness in autism spectrum disorder: Not using the forest to see the trees as trees. *Focus on autism and other developmental disabilities, 30*(3), 182-192.
Völlm, B. A., Taylor, A. N., Richardson, P., Corcoran, R., Stirling, J., McKie, S., . . . Elliott, R. (2006). Neuronal correlates of theory of mind and empathy: a functional magnetic resonance imaging study in a nonverbal task. *Neuroimage, 29*(1), 90-98.
Voracek, M., & Dressler, S. G. (2006). Lack of correlation between digit ratio (2D: 4D) and Baron-Cohen's "Reading the Mind in the Eyes" test, empathy, systemising, and autism-spectrum quotients in a general population sample. *Personality and Individual Differences, 41*(8), 1481-1491.
Wainer, A. L., Block, N., Donnellan, M. B., & Ingersoll, B. (2013). The broader autism phenotype and friendships in non-clinical dyads. *Journal of autism and developmental disorders, 43*(10), 2418-2425.
Wainer, A. L., Ingersoll, B. R., & Hopwood, C. J. (2011). The structure and nature of the broader autism phenotype in a non-clinical sample. *Journal of Psychopathology and Behavioral Assessment, 33*(4), 459.
Wallace, G. L., Budgett, J., & Charlton, R. A. (2016). Aging and autism spectrum disorder: Evidence from the broad autism phenotype. *Autism Research, 9*(12), 1294-1303. doi:10.1002/aur.1620
Wang, Y., & Su, Y. (2006). Theory of mind in old adults: The performance on Happé's stories and faux pas stories. *Psychologia, 49*(4), 228-237.
Wang, Z., & Su, Y. (2013). Age-related differences in the performance of theory of mind in older adults: A dissociation of cognitive and affective components. *Psychology and Aging, 28*(1), 284.
Warrington, E., & James, M. (1991). *The visual object and space perception battery*. Bury St. Edmunds: Thames Valley Test Co.
Washburn, D., Wilson, G., Roes, M., Rnic, K., & Harkness, K. L. (2016). Theory of mind in social anxiety disorder, depression, and comorbid conditions. *Journal of Anxiety Disorders, 37*, 71-77.
Wechsler, D. (1997). *Wechsler Adult Intelligence Scale: Technical and interpretive manual* (3rd ed.). San Antonio, TX: The Psychological Corporation.
Wechsler, D. (2011a). *Test of Premorbid Functioning - UK Edition*. London: Pearson Assessment.
Wechsler, D. (2011b). *Wechsler Abbreviated Scale of Intelligence–Second Edition (WASI-II)*. San Antonio, TX: NCS Pearson.
Wellman, H. M., Cross, D., & Watson, J. (2001). Meta-analysis of theory-of-mind development: the truth about false belief. *Child Development, 72*(3), 655-684.
Welsh, M. C., Pennington, B. F., & Groisser, D. B. (1991). A normative-developmental study of executive function: A window on prefrontal function in children. *Developmental Neuropsychology, 7*(2), 131-149.
Werling, D. M., & Geschwind, D. H. (2013). Sex differences in autism spectrum disorders. *Current opinion in neurology, 26*(2), 146-153.
Wheelwright, S., Auyeung, B., Allison, C., & Baron-Cohen, S. (2010). Defining the broader, medium and narrow autism phenotype among parents using the Autism Spectrum Quotient (AQ). *Molecular autism, 1*(1), 10.
Wheelwright, S., Baron-Cohen, S., Goldenfeld, N., Delaney, J., Fine, D., Smith, R., . . . Wakabayashi, A. (2006). Predicting autism spectrum quotient (AQ) from the systemizing quotient-revised (SQ-R) and empathy quotient (EQ). *Brain research, 1079*(1), 47-56.
White, S., Hill, E., Happé, F., & Frith, U. (2009). Revisiting the strange stories: revealing mentalizing impairments in autism. *Child Development, 80*(4), 1097-1117.

White, S. W., Ollendick, T. H., & Bray, B. C. (2011). College students on the autism spectrum: Prevalence and associated problems. *Autism, 15*(6), 683-701.
Williams, K., Mellis, C., & Peat, J. (2005). Incidence and prevalence of autism. *Advances in Speech Language Pathology, 7*(1), 31-40.
Williams, L. M., Brown, K. J., Palmer, D., Liddell, B. J., Kemp, A. H., Olivieri, G., . . . Gordon, E. (2006). The mellow years?: neural basis of improving emotional stability over age. *Journal of Neuroscience, 26*(24), 6422-6430.
Williams, P., & Drolet, A. (2005). Age-related differences in responses to emotional advertisements. *Journal of consumer research, 32*(3), 343-354.
Wimmer, H., & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition, 13*(1), 103-128.
Wolkenstein, L., Schönenberg, M., Schirm, E., & Hautzinger, M. (2011). I can see what you feel, but I can't deal with it: impaired theory of mind in depression. *Journal of affective disorders, 132*(1), 104-111.
Woolley, A. W., Chabris, C. F., Pentland, A., Hashmi, N., & Malone, T. W. (2010). Evidence for a collective intelligence factor in the performance of human groups. *Science, 330*(6004), 686-688.
Youmans, G., & Bourgeois, M. (2010). Theory of mind in individuals with Alzheimer-type dementia. *Aphasiology, 24*(4), 515-534.
Zalla, T., Sav, A.-M., Stopin, A., Ahade, S., & Leboyer, M. (2009). Faux pas detection and intentional action in Asperger Syndrome. A replication on a French sample. *Journal of autism and developmental disorders, 39*(2), 373-382.

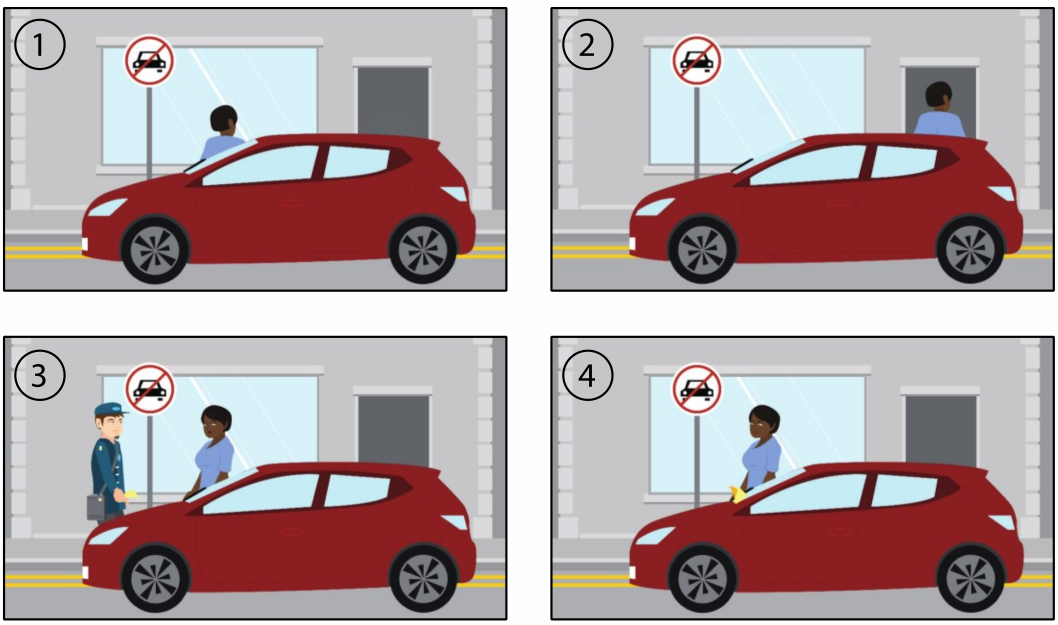
Appendix

Appendix 1.1. Summary storyboards for each animation

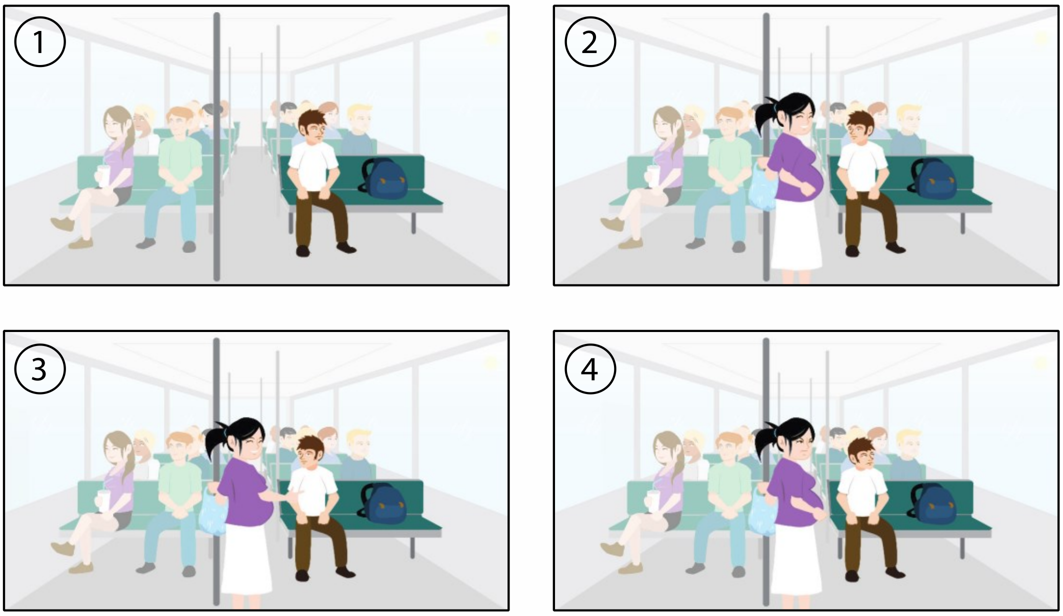
Scenario 1: Helping the elderly (social norm violation)



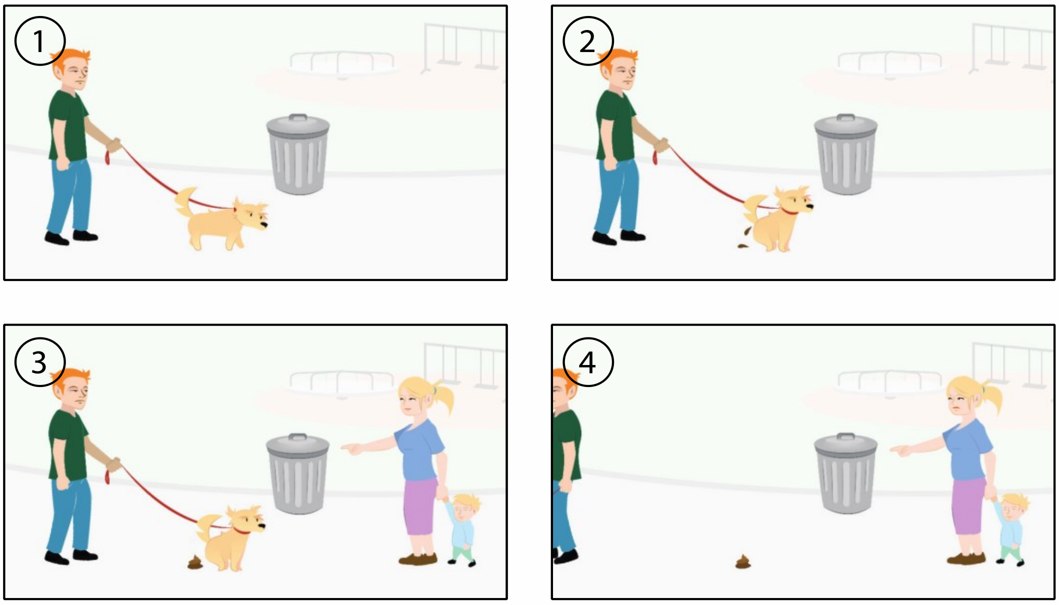
Scenario 2: Disobeying parking regulation (non-social norm violation)



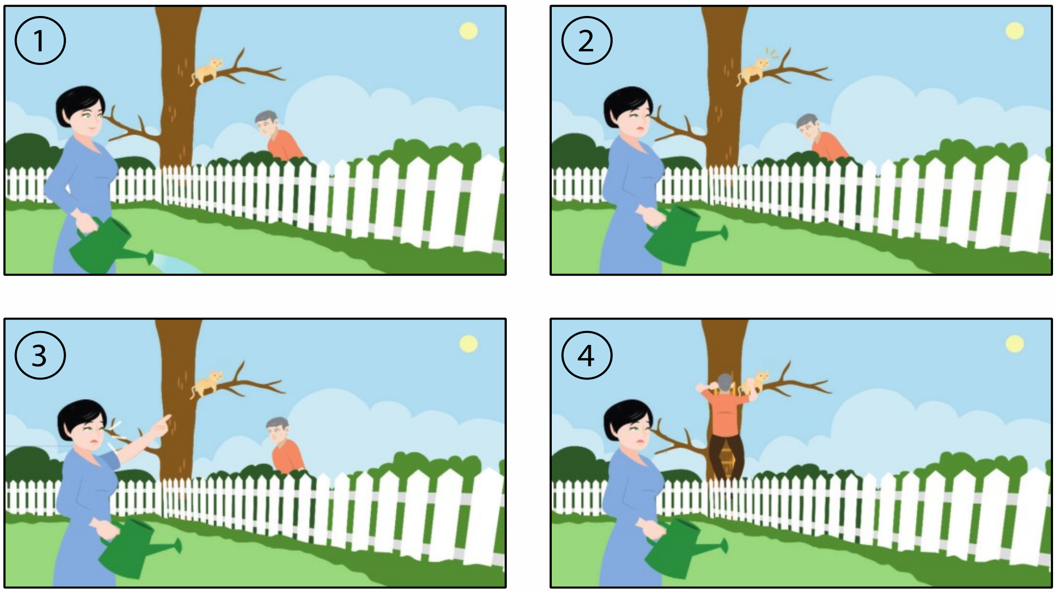
Scenario 3: Being considerate on the bus (social norm violation)



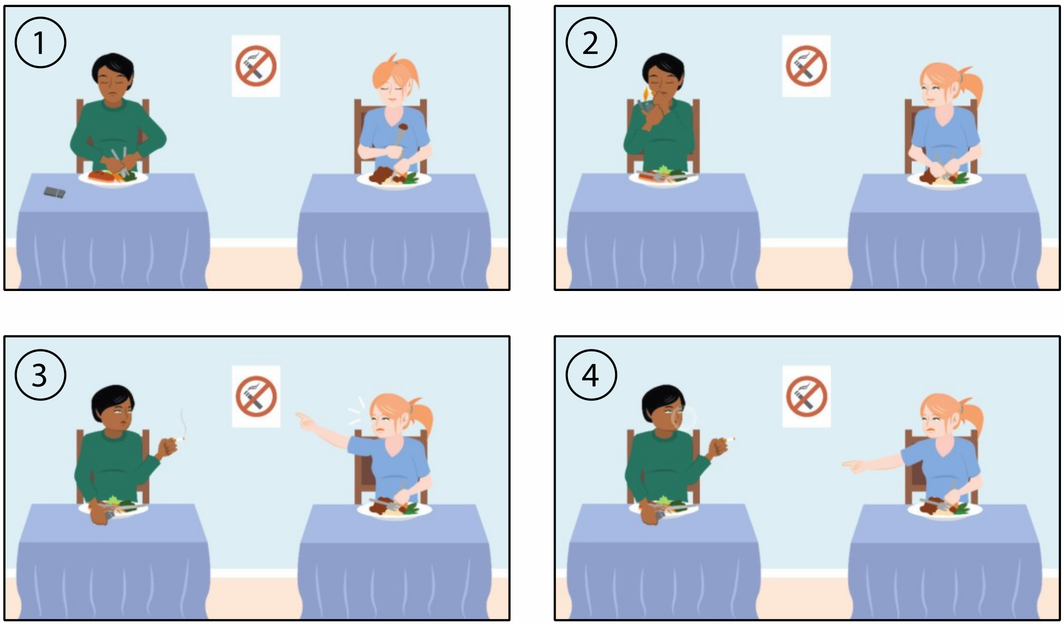
Scenario 4: Cleaning up after your pet (social norm violation)



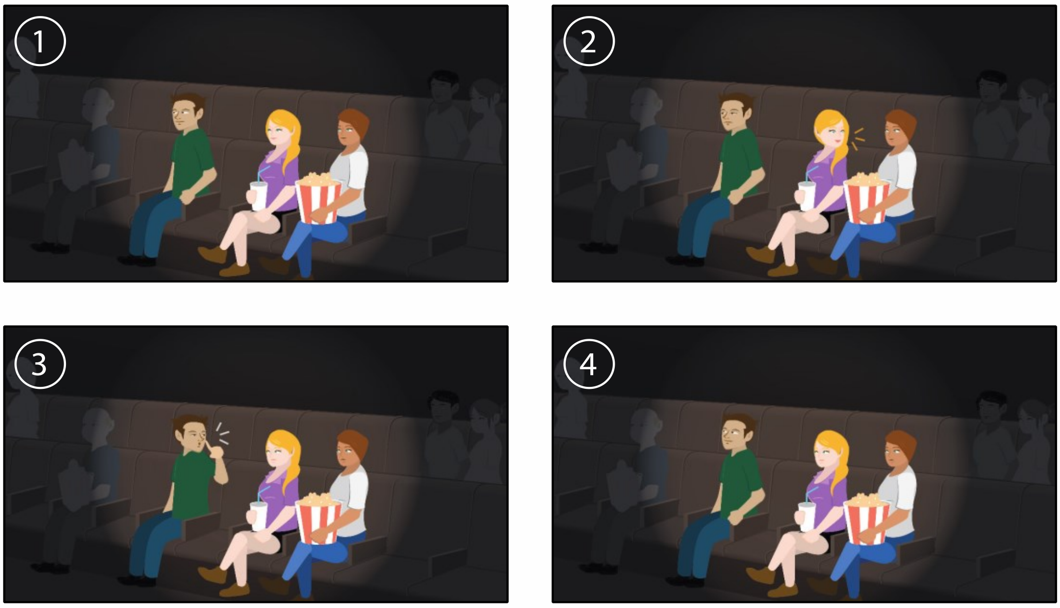
Scenario 5: Assisting a neighbour (non-social norm violation)



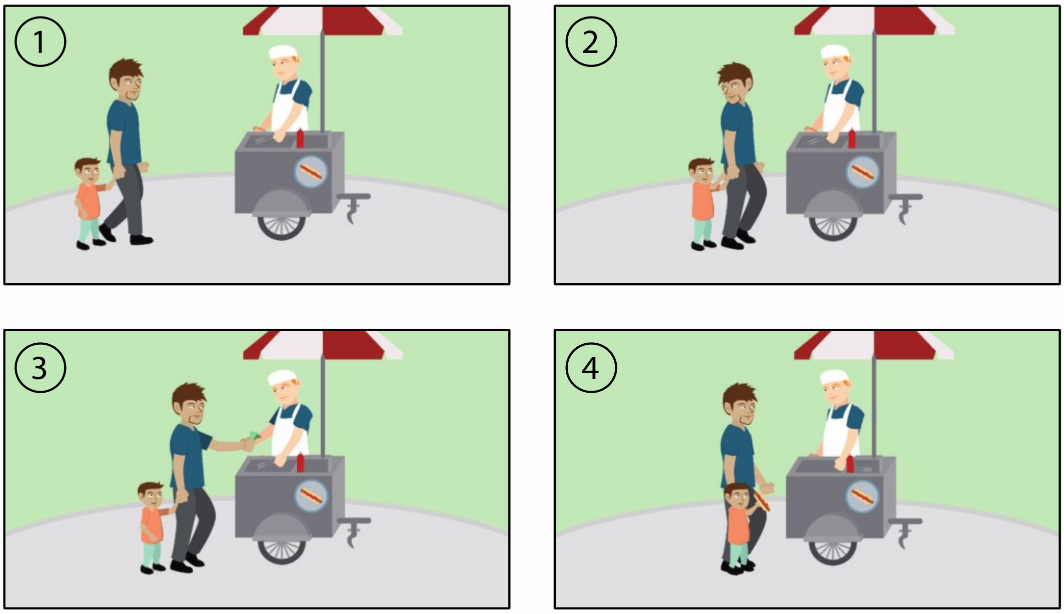
Scenario 6: Smoking in a prohibited area (social norm violation)



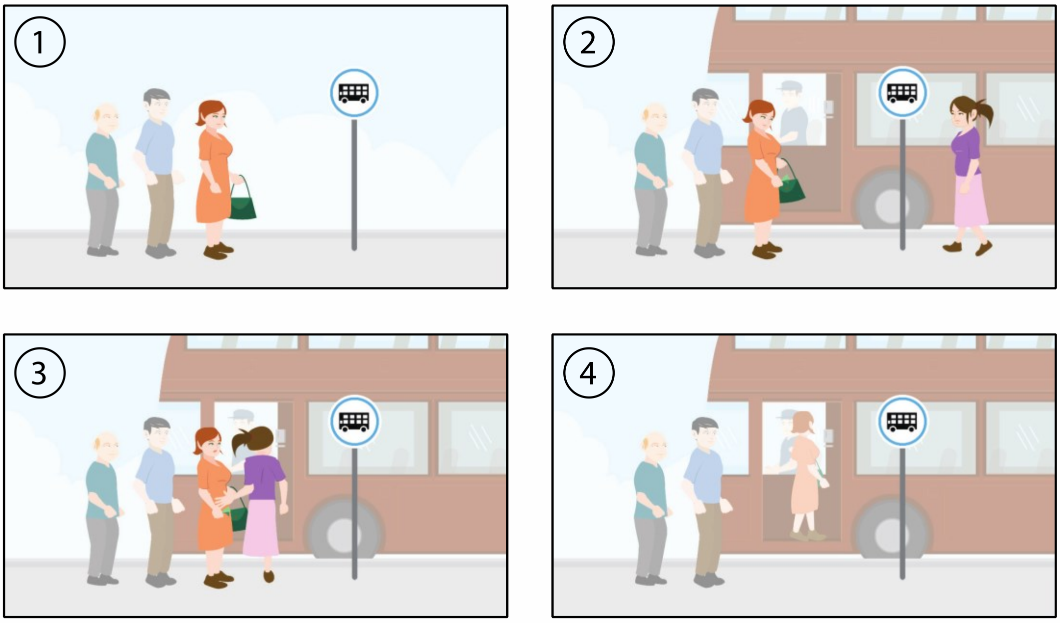
Scenario 7: Talking in the cinema (non-social norm violation)



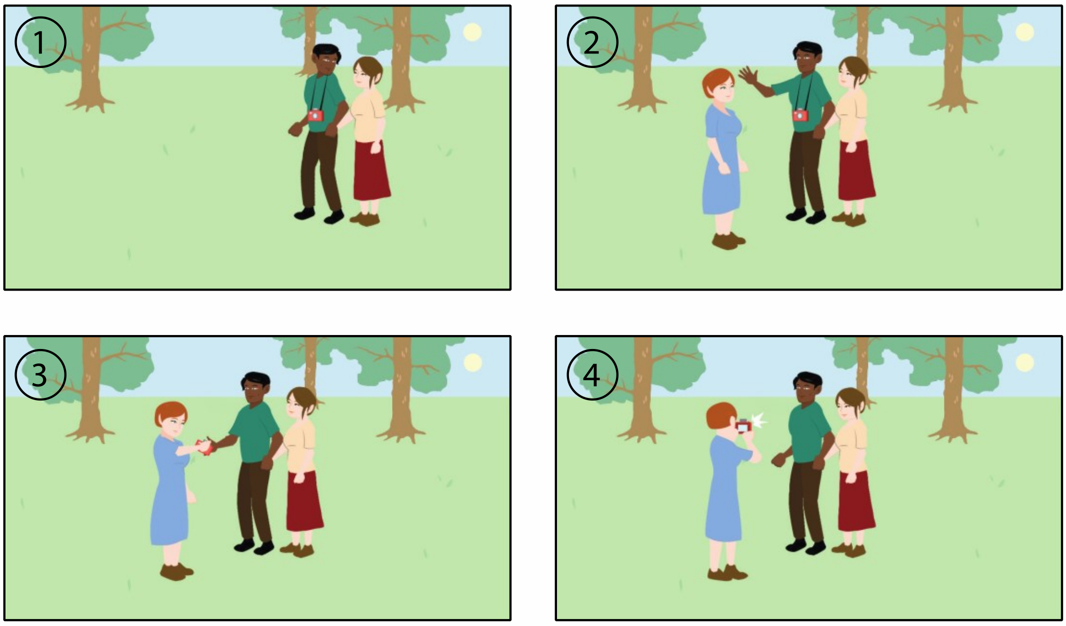
Scenario 8: Serving a customer (non-social norm violation)



Scenario 9: Skipping a bus queue (social rule violation)



Scenario 10: Assisting a stranger (non-social norm violation)



Appendix 1.2. Scoring 1 of the ESCoT

Tell the participant*: I'm going to show you a short animation that tells a story, and ask you a couple of questions about it. Let's begin.*

Scenario 1: Helping the elderly (social norm violation)

General Question: **Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?**

Prompt ONCE if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Old lady with bag		
2. Shopping bag bursts		
3. Points to spilled shopping as man is present		
4. Man walks on		
Other		

Question 1: Cognitive Theory of Mind: **What did the man think that the elderly woman wanted?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the elderly woman needs help with a specific activity and a contextual reason why she needs assistance. For example *help with her shopping because she looks like she is unable to pick it up herself/she has a walking stick so obviously has mobility issues*	3		
An answer that recognises that the elderly woman needs help with a specific activity. For example, *help with her shopping/her shopping to be picked.* No more than two points can be gained if the consequences of her age or situation is not explained **(prompt)**	2		
An answer that recognises that the elderly woman needs help. For example *his assistance/help* **(prompt)**	1		
An answer that does not recognise that the elderly woman needs help. For example *him to avoid stepping on her shopping* **OR** *don't know*	0		

Question 2: Affective Theory of Mind: **How did the elderly woman feel at the end of the animation?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that provides a specific negative emotion with a contextual reason. For example *angry/disappointed/sad/frustrated because the man walked straight pass her without offering to help pick up her spilled shopping when it is evident that she needs help*	3		
An answer that gives a specific negative emotion. For example *angry/disappointed/sad/frustrated* **(prompt)**	2		
An answer that provides a generic negative emotion. For example *not happy* **(prompt)**	1		
An answer that provides a neutral emotion. For example *tired/unconcerned* **OR** provides a positive emotion for example, *happy* **OR** *don't know*	0		

Question 3: Understanding of Social Norms: **Did the man in the animation behave as other people should behave?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the man acted in a socially unacceptable way and a contextual reason why she needed help. For example, *no - should have helped the elderly woman pick up her shopping as she obviously needed help/is frail/is old/has a stick*	3		
An answer that recognises that the man acted in a socially unacceptable manner. For example *no - should have helped her* **(prompt)**	2		
An answer that does not recognise that the man acted in a socially unacceptable manner but provides a reasonable justification. For example *yes - may have been in a rush and couldn't help/he didn't do anything wrong/he avoided her shopping as she requested/might not have noticed her pointing*	1		
Don't know/irrelevant explanation	0		

Question 4: Understanding of Social Norms (Section 2): **Would you have acted the same as the man in the animation?**

Prompt ONCE if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context	Personal attributes
YES				
NO				

C-ToM =	A-ToM =	UNS =	UNS2 =

Scenario 2: Disobeying parking regulation (non-social norm violation)

General Question: **Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?**

Prompt ONCE if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Woman arrives outside a shop in her car		
2. Woman goes into the shop leaving her car outside a no parking sign		
3. Parking attendant arrives and sees she is not allowed to park there		
4. Parking attendant gives the woman a ticket for parking in a no parking area		
Other		

Question 1: Cognitive Theory of Mind: **What did the woman think that the parking attendant wanted?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the parking attendant performed a specific action and a contextual reason why he performed the action. For example, t*o give her a parking ticket for parking outside a shop that clearly shows that parking is not allowed/because the sign shows that she should not be parking there*	3		
An answer that recognises that the parking attendant performed a specific action. For example, *to give her a parking ticket.* No more than two points can be gained if the reason for the action is not explained **(prompt)**	2		
An answer that recognises that the parking attendant performed an action. For example *to give her something* **(prompt)**	1		
An answer that does not recognise that the parking attendant performed an action. For example *to say hello to her* **OR** *don't know*	0		

Question 2: Affective Theory of Mind: **How did the woman feel at the end of the animation?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that provides a specific negative emotion with a contextual reason. For example *annoyed/ angry/irritated/frustrated because she was given a parking ticket which she now has to pay*	3		
An answer that gives a specific negative emotion. For example *annoyed/ angry/irritated/frustrated* **(prompt)**	2		
An answer that provides a generic negative emotion. For example *not happy* **(prompt)**	1		
An answer that provides a neutral emotion. For example *unconcerned/fine* **OR** provides a positive emotion for example, *happy* **OR** *don't know*	0		

Question 3: Understanding of Social Norms: **Did the parking attendant in the animation behave as other people should behave?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the parking attendant acted in a socially acceptable manner and contextual reason why he did. For example, *yes - he did his job and gave the woman a parking ticket because she was not allowed to parked where she did but she did it anyways*	3		
An answer that recognises that the parking attendant acted in a socially acceptable manner. For example *yes - he did his job* **(prompt)**	2		
An answer that does not recognise that the man acted in a socially acceptable manner but provides a reasonable justification. For example *no - he did not need to give her a parking ticket, he could just have asked her to move her car*	1		
Don't know/irrelevant explanation	0		

Question 4: Understanding of Social Norms (Section 2): **Would you have acted the same as the parking attendant in the animation?**

Prompt ONCE if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context	Personal attributes
YES				
NO				

C-ToM =	A-ToM =	UNS =	UNS2 =

Scenario 3: Being considerate on the bus (social norm violation)

<u>General Question:</u> **Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?**

Prompt ONCE if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Bus is full, seat next to man with bag on it		
2. Pregnant woman gets on bus carrying bags		
3. Pregnant woman points at seat		
4. Man does not move bags		
Other		

<u>Question 1: Cognitive Theory of Mind</u>: **What did the man think that the woman wanted?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the pregnant woman would have liked the man to be considerate and perform a specific action, and a contextual reason why he should have been considerate. For example, *to sit down in the seat his bags are on/him to move his bags so that she can sit down because she is heavily pregnant and would probably appreciate a seat*	3		
An answer that recognises that the pregnant woman would have liked the man to be considerate and perform a specific action. For example, *to sit down in the seat his bags are on/him to move his bags so that she can sit down.* No more than two points can be gained if the current condition of the woman is not considered **(prompt)**	2		
An answer that recognises that the pregnant woman had a contextually specific desire. For example, *to sit down/assistance* **(prompt)**	1		
An answer that recognises that the pregnant woman had a request. For example *to put her bags on the seat* **OR** *don't know*	0		

Question 2: Affective Theory of Mind: **How does the woman feel at the end of the animation?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that provides a specific negative emotion with a contextual reason. For example *angry/disappointed/disgusted/surprised because she is heavily pregnant and seats are reserved for people not bags*	3		
An answer that gives a specific negative emotion. For example *angry/disappointed/disgusted/surprised* **(prompt)**	2		
An answer that provides a generic negative emotion. For example, *not happy* **(prompt)**	1		
An answer that provides a neutral emotion. For example *unconcerned* **OR** provides a positive emotion for example, *happy* **OR** *don't know*	0		

Question 3: Understanding of Social Norms: **Did the man in the animation behave as other people should behave?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the man acted in a socially unacceptable way and what he should have done. For example, *no - he should have moved his bags so that she could sit down*	3		
An answer that recognises that the man acted in a socially unacceptable manner. For example *no - he should have helped her* **(prompt)**	2		
An answer that does not recognise that the man acted in a socially unacceptable manner but provides a reasonable justification. For example *yes - he was sitting down first/needs a place to put his own bags/he thinks she is overweight and does not realise she is pregnant*	1		
Don't know/irrelevant explanation	0		

Question 4: Understanding of Social Norms (Section 2): **Would you have acted the same as the man in the animation?**

Prompt ONCE if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context	Personal attributes
YES				
NO				

C-ToM =	A-ToM =	UNS =	UNS2 =

Scenario 4: Cleaning up after your pet (social norm violation)

General Question: **Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?**

Prompt ONCE if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Man walking dog near children's park/playground		
2. Dog defecates on ground near bin		
3. Woman and child approach, woman points at bin		
4. Man does not clean up after his dog		
Other		

Question 1: Cognitive Theory of Mind: **What does the man think that the woman wants?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the man should have performed a specific action, and a contextual reason why he should have done it. For example, *him to clean up after his dog/him to put his dog's droppings into the bin because the dog droppings are a health hazard and it is near a children's playground. It is illegal not to clean up after your dog, you can be fined*	3		
An answer that recognises that the man should have performed a specific action. For example, *him to clean up after his dog/him to put his dog's droppings into the bin.* No more than two points can be gained if there is no mention of why he should have done it **(prompt)**	2		
An answer that recognises that the man should have performed an action. For example, *him to use the bin* **(prompt)**	1		
An answer that does not recognise that the man should have performed a contextually specific action. For example, *her child to use the bin* **OR** *don't know*	0		

Question 2: Affective Theory of Mind: **How does the woman feel at the end of the animation?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that provides a specific negative emotion with a contextual reason. For example *disgusted/outraged/angry because it the man's responsibility to clean up after this pet. They are near a children's playground and the dog droppings are a health hazard*	3		
An answer that gives a specific negative emotion. For example *disgusted/outraged/angry* **(prompt)**	2		
An answer that provides a generic negative emotion. For example, *not happy* **(prompt)**	1		
An answer that provides a neutral emotion. For example *unconcerned* **OR** provides a positive emotion for example, *happy* **OR** *don't know*	0		

Question 3: Understanding of Social Norms: **Did the man in the animation behave as other people should behave?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the man acted in a socially unacceptable manner and should have performed a specific action in regards to his dog. For example, *no - he should have cleaned up after his dog/put the dog's droppings in the bin*	3		
An answer that recognises that the man acted in a socially unacceptable manner and should have performed a specific action. For example *no - he should have used the bin/followed the woman's request* **(prompt)**	2		
An answer that does not recognise that the man acted in a socially unacceptable manner but provides a reasonable justification. For example *yes - he had nothing to use to put the droppings in the bin so had to leave them/it's not his fault that his dog needed to defecate*	1		
Don't know/irrelevant explanation	0		

Question 4: Understanding of Social Norms (Section 2): **Would you have acted the same as the man in the animation?**

Prompt ONCE if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context	Personal attributes
YES				
NO				

C-ToM =	A-ToM =	UNS =	UNS2 =

Scenario 5: Assisting a neighbour (non-social norm violation)

General Question: **Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?**

Prompt ONCE if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Woman in garden watering plants		
2. Neighbour next door in his own garden		
3. Woman points to cat in her tree		
4. Cat seems to be stuck as neighbour fetches ladder to get it down		
Other		

Question 1: Cognitive Theory of Mind: **What did the man think that the woman wanted?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the woman needs help with a specific activity and a contextual reason why she needs assistance. For example, *help getting the cat down from the tree/him to get the cat down from the tree because the cat looks stuck and the woman looks distressed*	3		
An answer that recognises that the woman needs help with a specific activity. For example, *help getting the cat down from the tree/him to get the cat down from the tree.* No more than two points can be gained if there is no mention of why the man needs to perform the action **(prompt)**	2		
An answer that recognises that the woman needs help. For example *his assistance/help* **(prompt)**	1		
An answer that does not recognise that the woman needs help. For example *him to say hello* **OR** *don't know*	0		

Question 2: Affective Theory of Mind: **How does the woman feel at the end of the animation?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that provides a specific positive emotion with a contextual reason. For example *relieved/happy/grateful/thankful because the man was kind enough to get the cat down from the tree, she looked distressed and he offered his help*	3		
An answer that gives a specific positive emotion. For example *relieved/happy/grateful/thankful* **(prompt)**	2		
An answer that provides a generic positive emotion. For example, *ok/fine* **(prompt)**	1		
An answer that provides a neutral emotion. For example, *unconcerned* **OR** negative emotion. For example, *annoyed/sad/angry* **OR** *don't know*	0		

Question 3: Understanding of Social Norms: **Did the man in the animation behave as other people should behave?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the man acted in a socially acceptable manner and offered his help to perform a contextually specific action. For example, *yes - he got the cat down from the tree for the lady as she requested*	3		
An answer that recognises that the man acted in a socially acceptable manner and offered his help. For example *yes - he did what the lady wanted/he was helpful* **(prompt)**	2		
An answer that does not recognise that the man acted in a socially acceptable manner but provides a reasonable justification. For example *no - he shouldn't have gone up the ladder, it's not safe. He shouldn't have risked his life for a cat. The cat will not be as stuck as it seems*	1		
Don't know/irrelevant explanation	0		

Question 4: Understanding of Social Norms (Section 2): **Would you have acted the same as the man in the animation?**

Prompt ONCE if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context	Personal attributes
YES				
NO				

C-ToM =	A-ToM =	UNS =	UNS2 =

Scenario 6: Smoking in a prohibited area (social norm violation)

General Question: **Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?**

Prompt ONCE if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Two women eating in restaurant		
2. Anti-smoking sign visible		
3. Woman in green lights up cigarette, woman in blue points to anti-smoking sign		
4. Woman in green blows smoke rings towards the woman in blue		
Other		

Question 1: Cognitive Theory of Mind: **What does the woman in green think that the woman in blue wants?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the woman in blue wants her to pay attention to the sign and perform a specific action, and a contextual reason why she needs to perform the action. For example, *her to extinguish her cigarette/stop smoking because she is disobeying the sign which is clearly visible and says smoking is prohibited*	3		
An answer that recognises that the woman in blue wants her to pay attention to the sign and perform a specific action. For example, *her to extinguish her cigarette/stop smoking.* No more than two points can be gained if there is no mention of why she needs to extinguish her cigarette **(prompt)**	2		
An answer that recognises that the woman in blue wants her to pay attention to the sign. For example, *her to pay attention to what the sign says* **(prompt)**	1		
An answer that does not recognise that the woman in blue wants the woman in green to pay attention to the sign or perform an action. For example *wants her to share her cigarette* **OR** *don't know*	0		

Question 2: Affective Theory of Mind: **How does the woman in blue feel at the end of the animation?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that provides a specific negative emotion with a contextual reason. For example *irritated/disgusted/angry/furious because the woman in green was rude, she not only ignored her request and the sign but blew smoke rings at her which is very disrespectful*	3		
An answer that gives a specific negative emotion. For example *irritated/disgusted/angry/furious* **(prompt)**	2		
An answer that provides a generic negative emotion. For example, *not happy* **(prompt)**	1		
An answer that provides a neutral emotion. For example, *unconcerned* **OR** provides an irrelevant negative emotion, for example *angry she didn't share* **OR** *don't know*	0		

Question 3: Understanding of Social Norms: **Did the woman in green in the animation behave as other people should behave?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the woman in green acted in a socially unacceptable way and a contextual reason why she shouldn't be smoking. For example, *no - the woman in green shouldn't be smoking in an indoor public setting/where it is prohibited*	3		
An answer that recognises that the woman in green acted in a socially unacceptable manner. For example *no - the woman should have followed the woman in blue's request/shouldn't be smoking next to people who are trying to eat* **(prompt)**	2		
An answer that does not recognise that the woman in green acted in a socially unacceptable manner but provides a reasonable justification. For example *yes - she can smoke wherever she wants because she has a right to do what she wants, it's only a sign*	1		
Don't know/irrelevant explanation	0		

Question 4: Understanding of Social Norms (Section 2): **Would you have acted the same as the woman in green?**

Prompt ONCE if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context	Personal attributes
YES				
NO				

C-ToM =	A-ToM =	UNS =	UNS2 =

Scenario 7: Talking in the cinema (non-social norm violation)

General Question: *Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?*

Prompt ONCE if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. People in cinema watching film		
2. Two women start talking to one another		
3. One man says 'shh'/puts his finger to his mouth/tells them to be quiet		
4. Women cease talking and watch film		
Other		

Question 1: Cognitive Theory of Mind: **What did the women think that the man wanted?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the man wants the women to perform a specific action and a contextual reason why they should. For example, *them to be quiet/stop talking because they are disturbing him and other people watching the film*	3		
An answer that recognises that the man wants the women to perform a specific action. For example, *them to be quiet/stop talking.* No more than two points can be gained if there is no mention of why the women need to stop talking **(prompt)**	2		
An answer that recognises that the man has a request. For example *them to watch the film/pay attention to his action* **(prompt)**	1		
An answer that does not recognise that the man has a request. For example *them to say hello* **OR** *don't know*	0		

Question 2: Affective Theory of Mind: **How does the man feel at the end of the animation?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that provides a specific positive emotion with a contextual reason. For example *relieved/grateful/thankful that they stopped talking and he can go back to watching/enjoying the film in peace and quiet*	3		
An answer that gives a specific positive emotion. For example *relieved/grateful/thankful* **(prompt)**	2		
An answer that provides a generic positive emotion. For example, *fine/ok* **(prompt)**	1		
An answer that provides a neutral emotion. For example, *unconcerned* **OR** provides a negative emotion, for example *annoyed/sad* **OR** *don't know*	0		

Question 3: Understanding of Social Norms: **Did the women in the animation behave as other people should behave?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the women acted in a social acceptable manner by obliging to the man's request and performed a specific action. For example, *yes - they stopped talking when they were asked to*	3		
An answer that recognises that the women acted in a socially acceptable manner by accommodating the man's request. For *yes - they did what the man wanted* **(prompt)**	2		
An answer that does not recognise that the women acted in a socially unacceptable manner to begin with but provide a reasonable justification. For example *no - they are entitled to talk during the cinema as long as they are whispering and should have told the man this*	1		
Don't know/irrelevant explanation	0		

Question 4: Understanding of Social Norms (Section 2): **Would you have acted the same as the women in the animation?**

Prompt ONCE if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context	Personal attributes
YES				
NO				

C-ToM =	A-ToM =	UNS =	UNS2 =

Scenario 8: Serving a customer (non-social norm violation)

General Question: **Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?**

Prompt ONCE if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Man and child at hot-dog stand		
2. Child points to hot-dog sign/gestures towards employee at hot-dog stand		
3. Father hands man at hot-dog stand money		
4. Child gets hot-dog		
Other		

Question 1: Cognitive Theory of Mind: **What did the man behind the stand think that the father wanted?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the father required a specific service from the hotdog vendor and a contextual reason why he would have required the service. For example, *to buy his son a hotdog because his son might have been hungry and clearly wanted one*	3		
An answer that recognises that the father required a specific service from the hotdog vendor. For example, *to buy his son a hotdog.* No more than two points can be gained if there is no mention of why the man required the service **(prompt)**	2		
An answer that recognises that the father required a service from the hotdog vendor. For example *to buy his son something* **(prompt)**	1		
An answer that does not recognise that the father required a service. For example *for his son to say hello to him* **OR** *don't know*	0		

Question 2: Affective Theory of Mind: **How does the father feel at the end of the animation?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that provides a specific positive emotion with a contextual reason. For example *happy/thankful because his son got a hotdog/the man gave him the hotdog/took his money*	3		
An answer that gives a specific positive emotion. For example *happy/thankful* **(prompt)**	2		
An answer that provides a generic positive emotion. For example, *fine/ok* **(prompt)**	1		
An answer that provides a neutral emotion. For example, *unconcerned* **OR** provides a negative emotion, for example *annoyed/sad/angry* **OR** *don't know*	0		

Question 3: Understanding of Social Norms: **Did the man behind the stand in the animation behave as other people should behave?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the hotdog vendor acted in a social acceptable manner by obliging to the man's request and performed a specific action. For example, *yes - he gave the hot-dog to the father/gave them what they asked for*	3		
An answer that recognises that the hotdog acted in a socially acceptable manner by accommodating the man's request. For *yes - he did his job* **(prompt)**	2		
An answer that does not recognise that the hotdog vendor acted in a socially acceptable manner but provides a reasonable justification. For example *no – he shouldn't be selling hotdogs to children, because they're not very healthy*	1		
Don't know/irrelevant explanation	0		

Question 4: Understanding of Social Norms (Section 2): **Would you have acted the same as the man behind the stand in the animation?**

Prompt ONCE if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context	Personal attributes
YES				
NO				

C-ToM =	A-ToM =	UNS =	UNS2 =

Scenario 9: Skipping a bus queue (social rule violation)

General Question: **Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?**

Prompt ONCE if needed: Anything else?

		Notes/Partial Responses/Misconstruction/Omissions
1. People waiting in queue for bus		
2. Bus turns up, woman in purple approaches		
3. Woman in purple pushes past woman in orange at front of queue/skips queue		
4. Woman in purple is on bus first while others who were queuing are now paying		
Other		

Question 1: Cognitive Theory of Mind: **What does the woman in purple think that the woman in orange wants?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the woman in orange wanted the woman in purple to let her/the people waiting go before her and a contextual reason why she should have. For example, *to get on the bus before her/her to go to the back of the queue because people, including the woman in purple were waiting there longer than her*	3		
An answer that recognises that the woman in orange wanted the woman in purple to let her/the people waiting go before her. For example, *to get on the bus before her/her to go to the back of the queue.* No more than two points can be gained if there is no mention of why the woman in purple should have joined the queue **(prompt)**	2		
An answer that recognises that the woman in orange had a contextual desire. For example, *to go somewhere* **(prompt)**	1		
An answer that does not recognise that the woman in orange wanted the woman in purple to let her/the people waiting go before her. For example *thinks she's waiting for someone* **OR** *don't know*	0		

Question 2: Affective Theory of Mind: **How does the woman in orange feel at the end of the animation?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that provides a specific negative emotion with a contextual reason. For example *outraged/disgusted/angry/upset because the woman push her out of the way and skipped the queue of people waiting*	3		
An answer that gives a specific negative emotion. For example *outraged/disgusted/angry/upset* **(prompt)**	2		
An answer that provides a generic negative emotion. For example *not happy* **(prompt)**	1		
An answer that provides a neutral emotion. For example *unconcerned* **OR** provides a positive emotion, for example *happy* **OR** *don't know*	0		

Question 3: Understanding of Social Norms: **Did the woman in purple in the animation behave as other people should behave?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the woman in purple acted in a socially unacceptable way and a contextual suggest of what she should have done. For example, *no - she should have waited her turn/gone to the back of the queue/let the woman go in front of her*	3		
An answer that recognises that the woman in purple acted in a socially unacceptable manner. For example *no - she was too impatient/didn't like the idea of having to wait* **(prompt)**	2		
An answer that does not recognise that the woman in purple acted in a socially unacceptable manner but provides a reasonable justification. For example *yes – she shouldn't have to wait if she doesn't want to or maybe she didn't think they were getting on the same bus as her*	1		
Don't know/irrelevant explanation	0		

Question 4: Understanding of Social Norms (Section 2): **Would you have acted the same as the woman in purple in the animation?**

Prompt ONCE if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context	Personal attributes
YES				
NO				

C-ToM =	A-ToM =	UNS =	UNS2 =

Scenario 10: Assisting a stranger (non-social norm violation)

General Question: **Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?**

Prompt ONCE if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Man and partner walking through park		
2. Man signals to other lady		
3. Man hands other lady his camera		
4. Other lady takes photo of man and his partner		
Other		

Question 1: Cognitive Theory of Mind: **What did the woman think that the couple wanted?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the couple requires assistance with a specific activity and a contextual reason why they need help. For example, *her to take a photograph of them because they want a photo of them together and they can't take it themselves*	3		
An answer that recognises that the couple requires assistance with a specific activity. For example, *her to take a photograph of them.* No more than two points can be gained if there is no mention of why the couple needs assistance **(prompt)**	2		
An answer that recognises that the couple needs help. For example *her assistance/her to use their camera* **(prompt)**	1		
An answer that does not recognise that the couple needs help. For example *to give her a free camera* **OR** *don't know*	0		

Question 2: Affective Theory of Mind: **How does the couple feel at the end of the animation?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that provides a specific positive emotion with a contextual reason. For example *grateful/thankful/happy because the woman was kind enough to help them take a photo*	3		
An answer that gives a specific positive emotion. For example *grateful/thankful/happy* **(prompt)**	2		
An answer that provides a generic positive emotion. For example, *fine/ok* **(prompt)**	1		
An answer that provides a neutral emotion. For example *unconcerned* **OR** negative emotion. For example, *annoyed* **OR** *don't know*	0		

Question 3: Understanding of Social Norms: **Did this woman (*point to woman taking photo*) in the animation behave as other people should behave?**

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that recognises that the woman acted in a socially acceptable manner and offered her help to perform a contextual specific action. For example, *yes - she did as the man requested and took the photo*	3		
An answer that recognises that the woman acted in a socially acceptable manner and offered her help. For example *yes - she did what the man wanted* **(prompt)**	2		
An answer that does not recognise that the woman acted in a socially acceptable manner but provides a reasonable justification. For example *no- she shouldn't have said yes, she doesn't know them. They are complete strangers*	1		
Don't know/irrelevant explanation	0		

Question 4: Understanding of Social Norms (Section 2): **Would you have acted the same as the woman in the animation?**

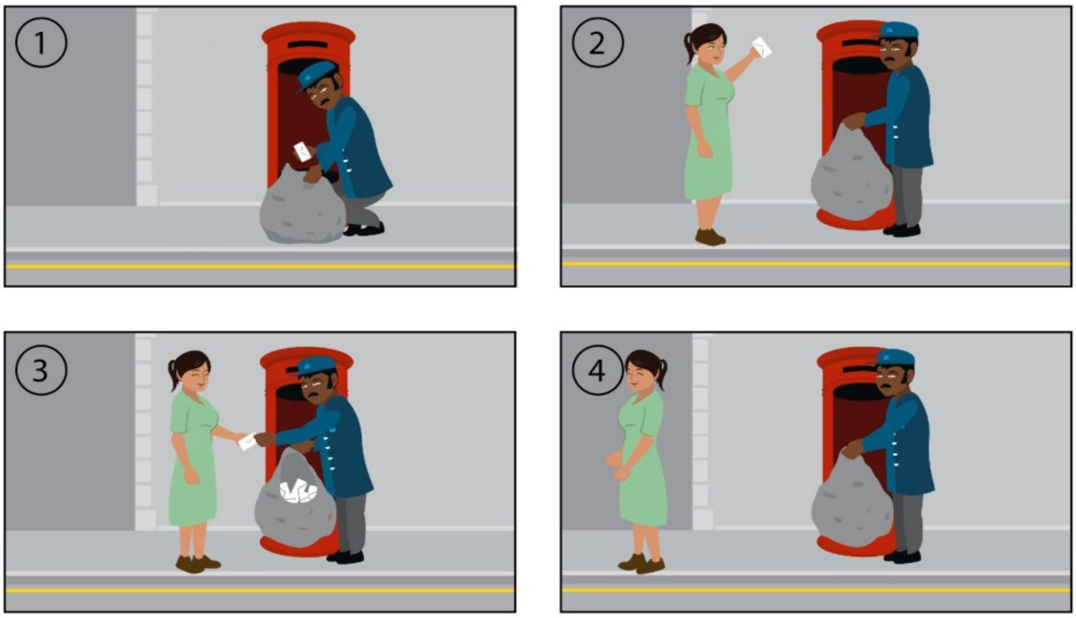
Prompt ONCE if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context	Personal attributes
YES				
NO				

C-ToM =	A-ToM =	UNS =	UNS2 =

Appendix 1.3. New practice scenario

Practice Scenario: Assisting a stranger



Appendix 1.4. Final scoring scheme for the ESCoT

Tell the participant: *I'm going to show you a short animation that tells a story, and ask you a couple of questions about it.*

The first animation is a practice, to get you used to the sort of questions I'm going to be asking. Let's begin.

Practice Scenario: Assisting a stranger

General Comprehension: ***Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?***

Prompt **ONCE** if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. A postman is empting a post box and filling up his bag		
2. Woman approaching with letter, looks to be in a rush		
3. Woman hands the postman the letter, and he takes the letter		
4. Postman puts the letter that the woman gave him his bag		
Other		

Question 1
Cognitive Theory of Mind: ***What is the woman with the letter thinking?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that recognises that the woman wanted to perform a specific action and a **contextual reason why** she performed the action. For example, *she is thinking that* ***she wants him/the postman*** *to post her letter/put the letter with the others* ***because*** *she was late and missed the mail collection.* Mention of **affective state** limits mark to 2 points	3		
A **social answer** that recognises that the woman wanted to perform a specific action. No more than 2 points can be gained if a contextual reason is not given. For example, *she is thinking that* ***she wants him/the postman*** *to post her letter/put the letter with the others* **(prompt)**	2		
A **non-social answer** that recognises that the woman wanted to perform a specific action. No more than 1 point can be gained if there is no mention of the other person from the interaction in the response, even with a contextual reason. For example, she *wants to post the letter she has/ she is thinking she wants to post her letter/put the letter in the bag* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 2
<u>Affective Theory of Mind</u>: ***How does the woman with the letter feel at the end of the animation?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that demonstrates a **higher order emotional understanding**, with a contextual reason. For example, *she feels content/pleased/thankful* ***because*** *she was able to post her letter* **(prompt)**	3		
An answer that demonstrates a **lower order emotional understanding**, with a contextual reason. For example, *she feels happy/ok/fine* ***because*** *she was able to post her letter* **(prompt)**	2		
An answer that demonstrates a **lower order emotional understanding**. For example, *she feels happy/ok/fine* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 3
<u>Interpersonal Understanding of Social Norms</u>: ***Did the postman in the animation behave as other people should behave?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the postman acted in a socially acceptable manner, and provides a contextual reason for his actions. For example, *yes - he took the letter that* ***she/the woman*** *wanted to be posted/that the woman handed to him, it was the nice thing to do* ***because*** *she was late, he did not have to take the letter from her*	3		
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the postman acted in a socially acceptable manner. No more than 2 points can be gained if a contextual reason is not given. For example, *yes - he took the letter that* ***she/the woman*** *wanted to be posted/that the woman handed to him, it was the nice thing to do* **(prompt)**	2		
A **non-social answer** that exhibits an understanding of the relevant social norm highlighting that the postman acted in a socially acceptable manner. For example, *yes – he took the letter/he did his job/he was helpful* **(prompt) OR** *no - he should have made her put it in the box and wait for the next collection because she was late/it is illegal to take it*	1		
Don't know/irrelevant answer	0		

Question 4
<u>Intrapersonal Understanding of Social Norms (Part 2):</u> ***Would you have acted the same as the postman in the animation?***

Prompt **ONCE** if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context **(2)**	Personal attributes **(1)**
YES (1)				
NO (0)				

cToM = /3	aToM = /3	UNS = /3	UNS2 = /3

Scenario 1: Helping the elderly (social norm violation)

General Comprehension: ***Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?***

Prompt ONCE if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Old lady with bag		
2. Shopping bag bursts and all of her shopping is on the ground		
3. Points to spilled shopping as man is present		
4. Man walks on		
Other		

Question 1
Affective Theory of Mind: ***How does the elderly lady feel at the end of the animation?***

Prompt ONCE if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that demonstrates a **higher order emotional understanding**, with a contextual reason. For example, *she feels abandoned/vulnerable/helpless* ***because*** *the man just ignored her and she is going to have to pick up her shopping on her own, which will be difficult as she has mobility issues* **(prompt)**	3		
An answer that demonstrates a **lower order emotional understanding**, with a contextual reason. For example, *she feels angry/she is upset/not happy* ***because*** *the man just ignored her and she is going to have to pick up her shopping on her own, which will be difficult as she has mobility issues* **(prompt)**	2		
An answer that demonstrates a **lower order emotional understanding**. For example, *she feels angry/she is upset/not happy* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 2
<u>Cognitive Theory of Mind</u>: ***What is the elderly lady thinking?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that recognises that the elderly lady required assistance, and provides a contextual reason of why she needed assistance. For example, *she is thinking* ***she wants him/the young man*** *to help her pick up the shopping/she wants his help* ***because*** *her bag has split/she has a stick so she cannot do it herself.* Mention of **affective state** limits mark to 2 points	3		
A **social answer** that recognises that the elderly lady required assistance. No more than 2 points can be gained if a contextual reason is not given. For example, *she is thinking* ***she wants him/the young man*** *to help her pick up the shopping/she wants his help* **(prompt)**	2		
A **non-social answer** that recognises that the elderly lady required assistance. No more than 1 point can be gained if there is no mention of the other person from the interaction in the response, even with a contextual reason. For example, *she wants assistance/she is thinking she wants help/help to pick up her shopping* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 3
<u>Interpersonal Understanding of Social Norms</u>: ***Did the man in the animation behave as other people should behave?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner, and provides a contextual explanation of why she needed help. For example, *no - he should have helped* ***her/the elderly woman*** *pick up her shopping* ***because*** *she obviously needed help/is frail/is old/has a stick*	3		
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner. No more than 2 points can be gained if a contextual explanation is not given. For example, *no - he should have helped* ***her/the elderly woman*** *pick up her shopping* **(prompt)**	2		
A **non-social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner. For example, *no - he should have helped/picked up the shopping* **(prompt) OR** *yes – he may have been in a rush and could not help/he did not do anything wrong/he avoided her shopping as she requested/might not have noticed her pointing*	1		
Don't know/irrelevant answer	0		

Question 4
<u>Intrapersonal Understanding of Social Norms (Part 2):</u> ***Would you have acted the same as the man in the animation?***

Prompt **ONCE** if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context **(2)**	Personal attributes **(1)**
YES **(0)**				
NO **(1)**				

cToM = /3	aToM = /3	UNS = /3	UNS2 = /3

Scenario 2: Disobeying parking regulation (non-social norm violation)

<u>General Comprehension</u>: ***Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?***

Prompt **ONCE** if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Woman arrives outside a shop in her car		
2. Woman goes into the shop leaving her car outside a no parking sign		
3. Parking attendant arrives and sees she is not allowed to park there		
4. Parking attendant gives the woman a ticket for parking in a no parking area		
Other		

Question 1
<u>Cognitive Theory of Mind</u>: ***What is the woman thinking?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that recognises the woman's decision to park her car where she did had a consequence, and provides a contextual reason for this consequence. For example, *she is thinking that she should not have parked there because* ***he/the parking attendant*** *is going to give her a ticket* **since** *she parked illegally/ she is thinking that* ***he/the parking attendant*** *wants to give her a parking ticket/she is going to receive a fine* ***from him/the parking attendant because*** *the sign says it is a no parking zone/she parked illegally/broke the rules.* Mention of **affective state** limits mark to 2 points	**3**		
A **social answer** that recognises the woman's decision to park her car where she did had a consequence. No more than 2 points can be gained if a contextual reason is not given. For example, *she is thinking that she should not have parked there because* ***he/the parking attendant*** *is going*	**2**		

*to give her a ticket/**he/the parking attendant** wants to give her a parking ticket/she is going to receive a fine **from him/the parking attendant*** **(prompt)**			
A **non-social answer** that recognises the woman's decision to park her car where she did had a consequence. No more than 1 point can be gained if there is no mention of the other person from the interaction in the response, even with a contextual reason. For example, *she is going to have to pay a fine/she is thinking that she is going to get a ticket/she is going to receive a fine* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 2

<u>Affective Theory of Mind</u>: ***How does the woman feel at the end of the animation?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that demonstrates a **higher order emotional understanding**, with a contextual reason. For example, *she feels irritated/unlucky/annoyed **because** she received a parking ticket and probably feels like it was underserved* **(prompt)**	3		
An answer that demonstrates a **lower order emotional understanding**, with a contextual reason. For example, *she feels angry/she is upset/not happy **because** she received a parking ticket and probably feels like it was underserved* **(prompt)**	2		
An answer that demonstrates a **lower order emotional understanding**. For example, *she feels angry/she is upset/not happy* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 3

<u>Interpersonal Understanding of Social Norms</u>: ***Did the parking attendant in the animation behave as other people should behave?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the parking attendant acted in a socially acceptable manner, and provides a contextual reason for his actions. For example, *yes - he did his job and gave **her/the woman** a parking ticket **because** she disobeyed the sign/was not allowed to parked where she did but she did it anyway*	3		
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the parking attendant acted in a socially acceptable manner. No more than 2 points can be gained if a contextual reason is not given. For example, *yes - he did his job and gave **her/the woman** a parking ticket* **(prompt)**	2		
A **non-social answer** that exhibits an understanding of the relevant social norm highlighting that the parking attendant acted in a socially acceptable manner. For example, *yes – he did his job/acted the way his job required him to* **(prompt) OR** *no - he did not need to give her a parking ticket, he could just have asked her to move her car*	1		
Don't know/irrelevant answer	0		

Question 4
<u>Intrapersonal Understanding of Social Norms (Part 2):</u> ***Would you have acted the same as the parking attendant in the animation?***

Prompt **ONCE** if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context **(2)**	Personal attributes **(1)**
YES (1)				
NO (0)				

cToM = /3	aToM = /3	UNS = /3	UNS2 = /3

Scenario 3: Being considerate on the bus (social norm violation)

<u>General Comprehension</u>: ***Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?***

Prompt **ONCE** if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Bus is full, seat next to man with bag on it		
2. Pregnant woman gets on bus		
3. Pregnant woman points at seat		
4. Man does not move bags		
Other		

Question 1
<u>Affective Theory of Mind</u>: ***How does the pregnant woman feel at the end of the animation?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that demonstrates a **higher order emotional understanding**, with a contextual reason. For example, *she feels annoyed/infuriated/frustrated* ***because*** *he did not move his bag and she will have to stand on the bus* **(prompt)**	3		
An answer that demonstrates a **lower order emotional understanding**, with a contextual reason. For example, *she feels angry/surprised/she is upset/not happy* ***because*** *he did not move his bag and she will have to stand on the bus* **(prompt)**	2		
An answer that demonstrates a **lower order emotional understanding**. For example, *she feels angry/surprised/she is upset/not happy* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 2
<u>Cognitive Theory of Mind</u>: ***What is the pregnant woman thinking?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that recognises that the pregnant woman had a contextual desire after getting on the bus, and provides a contextual reason for this desire. For example, *she is thinking that she wants **him/the man** to move his bag so that she can sit down in the seat his bag is on/sit down next to him **because** she is heavily pregnant and would probably appreciate a seat/seats are reserved for people not bags.* Mention of **affective state** limits mark to 2 points	3		
A **social answer** that recognises that the pregnant woman had a contextual desire after getting on the bus. No more than 2 points can be gained if a contextual reason is not given. For example, *she is thinking that she wants **him/the man** to move his bag so that she can sit down in the seat his bag is on/sit down next to him* **(prompt)**	2		
A **non-social answer** that recognises that the pregnant woman had a contextual desire after getting on the bus. No more than 1 point can be gained if there is no mention of the other person from the interaction in the response, even with a contextual reason. For example, *she wants to sit down/ she is thinking that she wants a seat/wants to sit down* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 3
<u>Interpersonal Understanding of Social Norms</u>: ***Did the man in the animation behave as other people should behave?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner, and provides a contextual explanation of why she needed a seat. For example, *no - he should have moved his bags so that **she/the pregnant woman** could sit down **because** she looks heavily pregnant and his bag could have gone on the ground*	3		
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner. No more than 2 points can be gained if a contextual reason is not given. For example, *no - he should have moved his bags so that **she/the pregnant** woman could sit down* **(prompt)**	2		
A **non-social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner. For example, *no - he should have moved his bag* **(prompt) OR** *yes - he was sitting down first/needs a place to put his own bags/he thinks she is overweight and does not realise she is pregnant*	1		
Don't know/irrelevant answer	0		

Question 4
<u>Intrapersonal Understanding of Social Norms (Part 2):</u> ***Would you have acted the same as the man in the animation?***

Prompt **ONCE** if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context **(2)**	Personal attributes **(1)**
YES **(0)**				
NO **(1)**				

cToM = /3	aToM = /3	UNS = /3	UNS2 = /3

Scenario 4: Cleaning up after your pet (social norm violation)

<u>General Comprehension</u>: ***Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?***

Prompt **ONCE** if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Man walking dog near children's park/playground		
2. Dog defecates on ground near bin		
3. Woman and child approach, woman points at bin		
4. Man does not clean up after his dog		
Other		

Question 1
<u>Cognitive Theory of Mind</u>: ***What is the woman with the child thinking?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that recognises that the woman with the child wanted a specific action performed, and provides a contextual reason for this action to be performed. For example, *she is thinking that she wants* ***him/the man*** *to clean up after his dog/put the dog's droppings in the bin* ***because*** *it is the man's responsibility to clean up after his pet/it is a health hazard and they are near a children's playground/it is illegal not to clean up after your dog.* Mention of **affective state** limits mark to 2 points	**3**		
A **social answer** that recognises that the woman with the child wanted a specific action performed. No more than 2 points can be gained if a contextual reason is not given. For example, *she is thinking that she wants* ***him/the man*** *to clean up after his dog/put the dog's droppings in the bin* **(prompt)**	**2**		
A **non-social answer** that recognises that the woman with the child	**1**		

wanted a specific action performed. No more than 1 point can be gained if there is no mention of the other person from the interaction in the response, even with a contextual reason. For example, *she does not want dog droppings near her child/ she is thinking that she wants the mess cleaned up/the dog's droppings to be put into the bin* **(prompt)**			
Don't know/irrelevant answer	0		

Question 2
<u>Affective Theory of Mind</u>: ***How does the woman with the child feel at the end of the animation?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that demonstrates a **higher order emotional understanding**, with a contextual reason. For example, *she feels annoyed/revolted/appalled* ***because*** *the man did not clean up after his dog and just left the mess on the ground* **(prompt)**	3		
An answer that demonstrates a **lower order emotional understanding**, with a contextual reason. For example, *she feels angry/surprised/disgusted/ she is upset/not happy* ***because*** *the man did not clean up after his dog and just left the mess on the ground* **(prompt)**	2		
An answer that demonstrates a **lower order emotional understanding**. For example, *she is upset/not happy/ she feels angry/surprised/disgusted* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 3
<u>Interpersonal Understanding of Social Norms</u>: ***Did the man in the animation behave as other people should behave?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner, and provides a contextual explanation of why the dog mess needed to be cleaned up. For example, *no - he should have listened to* ***her/the woman*** *and cleaned up after his dog/put the dog's droppings in the bin* ***because*** *it is illegal to leave it/it is hazardous waste*	3		
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner. No more than 2 points can be gained if a contextual reason is not given. For example, *no - he should have listened to* ***her/the woman*** *and cleaned up after his dog/put the dog's droppings in the bin* **(prompt)**	2		
A **non-social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially unacceptable manner. For example, *no - he should have cleaned up after his dog/put the dog's droppings in the bin* **(prompt) OR** *yes – it is not his fault that his dog needed to defecate*	1		
Don't know/irrelevant answer	0		

Question 4
<u>Intrapersonal Understanding of Social Norms (Part 2):</u> ***Would you have acted the same as the man in the animation?***

Prompt **ONCE** if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context **(2)**	Personal attributes **(1)**
YES **(0)**				
NO **(1)**				

cToM = /3	aToM = /3	UNS = /3	UNS2 = /3

Scenario 5: Assisting a neighbour (non-social norm violation)

<u>General Comprehension</u>: ***Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?***

Prompt **ONCE** if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Woman in garden watering plants		
2. Neighbour next door in his own garden		
3. Woman points to cat in her tree		
4. Cat seems to be stuck as neighbour fetches ladder to get it down		
Other		

Question 1
<u>Affective Theory of Mind</u>: ***How does the woman feel at the end of the animation?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that demonstrates a **higher order emotional understanding**, with a contextual reason. For example, *she feels thankful/relieved/appreciative* ***because*** *the man rescued the cat/went out of his way to make sure the cat was safe* **(prompt)**	3		
An answer that demonstrates a **lower order emotional understanding**, with a contextual reason. For example, *she feels happy/ok/fine* ***because*** *the man rescued the cat/went out of his way to make sure the cat was safe* **(prompt)**	2		
An answer that demonstrates a **lower order emotional understanding**. For example, *she feels happy/ok/fine* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 2
<u>Cognitive Theory of Mind</u>: ***What is the woman thinking?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that recognises that the woman had a contextual request, and provides a contextual reason for this request. For example, *she is thinking that she wants* ***him/the man*** *to get the cat down from the tree/to help in getting the cat down from the tree* ***because*** *the cat looks stuck/the woman indicated that she wanted him to do something about the cat.* Mention of **affective state** limits mark to 2 points	3		
A **social answer** that recognises that the woman had a contextual request. No more than 2 points can be gained if a contextual reason is not given. For example, *she is thinking that she wants* ***him/the man*** *to get the cat down from the tree/to help in getting the cat down from the tree* **(prompt)**	2		
A **non-social answer** that recognises that the woman had a contextual request. No more than 1 point can be gained if there is no mention of the other person from the interaction in the response, even with a contextual reason. For example, *she wants help/ she is thinking that she wants the cat recused/help to get the cat down from the tree* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 3
<u>Interpersonal Understanding of Social Norms</u>: ***Did the man in the animation behave as other people should behave?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially acceptable manner, and provides a contextual explanation of the need for help. For example, *yes - he got the cat down from the tree for* ***her/the lady*** *as* ***she/the lady*** *requested* ***because*** *it was evident that the cat needed assistance and it is nice to assist your neighbour*	3		
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially acceptable manner. No more than 2 points can be gained if a contextual reason is not given. For example, *yes - he got the cat down from the tree for* ***her/the lady*** *as* ***she/the lady*** *requested* **(prompt)**	2		
A **non-social answer** that exhibits an understanding of the relevant social norm highlighting that the man acted in a socially acceptable manner. For example, *yes - he was helpful* **(prompt) OR** *no - he should not have gone up the ladder, it is not safe. He should not have risked his life for a cat. The cat will not be as stuck as it seems*	1		
Don't know/irrelevant answer	0		

Question 4
<u>Intrapersonal Understanding of Social Norms (Part 2):</u> ***Would you have acted the same as the man in the animation?***

Prompt **ONCE** if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context **(2)**	Personal attributes **(1)**
YES (1)				
NO (0)				

cToM = /3	aToM = /3	UNS = /3	UNS2 = /3

Scenario 6: Smoking in a prohibited area (social norm violation)

<u>General Comprehension:</u> ***Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?***

Prompt **ONCE** if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Two women eating in restaurant		
2. Anti-smoking sign visible		
3. Woman in green lights up cigarette, woman in blue points to anti-smoking sign		
4. Woman in green blows smoke rings towards the woman in blue		
Other		

Question 1
<u>Cognitive Theory of Mind</u>: ***What is the woman in blue thinking?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that recognises that the woman in blue wanted a specific action performed, and provides a contextual reason for this action to be performed. For example, *she is thinking that she wants* ***her/the woman/the woman in green*** *to extinguish her cigarette/stop smoking* ***because*** *she is disobeying the sign that is clearly visible/smoking is prohibited in the restaurant.* Mention of **affective state** limits mark to 2 points	**3**		
A **social answer** that recognises that the woman in blue wanted a specific action performed. No more than 2 points can be gained if a contextual reason is not given. For example, *she is thinking that she wants* ***her/the woman/the woman in green*** *to extinguish her cigarette/stop smoking* **(prompt)**	**2**		
A **non-social answer** that recognises that the woman in blue wanted a specific action performed. No more than 1 point can be gained if there is	**1**		

no mention of the other person from the interaction in the response, even with a contextual reason. For example, *she does not want to be near smoke when she is eating/ she is thinking that she does not want to be near smoke while she's eating her meal* **(prompt)**			
Don't know/irrelevant answer	0		

Question 2
<u>Affective Theory of Mind</u>: ***How does the woman in blue feel at the end of the animation?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that demonstrates a **higher order emotional understanding**, with a contextual reason. For example, *she feels irritated/disrespected/furious* ***because*** *the woman in green ignored her request and the sign* **(prompt)**	3		
An answer that demonstrates a **lower order emotional understanding**, with a contextual reason. For example, *she feels angry/surprised/disgusted/she is upset/not happy* ***because*** *the woman in green ignored her request and the sign* **(prompt)**	2		
An answer that demonstrates a **lower order emotional understanding**. For example, *she is upset/not happy/ she feels angry/surprised/disgusted* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 3
<u>Interpersonal Understanding of Social Norms</u>: ***Did the woman in green in the animation behave as other people should behave?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the woman in green acted in a socially unacceptable manner, and provides a contextual explanation of why she should have listened to the woman in blue. For example, *no - she should have listened to* ***her/the woman in blue*** *and stopped smoking* ***because*** *she should not be smoking in an indoor public setting/where it is prohibited*	3		
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the woman in green acted in a socially unacceptable manner. No more than 2 points can be gained if a contextual reason is not given. For example, *no - she should have listened to* ***her/the woman in blue*** *and stopped smoking/paid attention to the sign* **(prompt)**	2		
A **non-social answer** that exhibits an understanding of the relevant social norm highlighting that the woman in green acted in a socially unacceptable manner. For example, *no - she should have stopped smoking/paid attention to the sign* **(prompt) OR** *yes - she can smoke wherever she wants because she has a right to do what she wants*	1		
Don't know/irrelevant answer	0		

Question 4
<u>Intrapersonal Understanding of Social Norms (Part 2):</u> ***Would you have acted the same as the woman in green in the animation?***

Prompt **ONCE** if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context **(2)**	Personal attributes **(1)**
YES (0)				
NO (1)				

cToM = /3	aToM = /3	UNS = /3	UNS2 = /3

Scenario 7: Talking in the cinema (non-social norm violation)

<u>General Comprehension</u>: ***Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?***

Prompt **ONCE** if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. People in cinema watching film		
2. Two women start talking to one another		
3. One man says 'shh'/puts his finger to his mouth/tells them to be quiet		
4. Women cease talking and watch film		
Other		

Question 1
<u>Affective Theory of Mind</u>: ***How does the man feel at the end of the animation?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that demonstrates a **higher order emotional understanding**, with a contextual reason. For example, *he feels satisfied/relieved/pleased* ***because*** *they listened to him and stopped talking so he can go back to watching/enjoying the movie in peace and quiet* **(prompt)**	3		
An answer that demonstrates a **lower order emotional understanding**, with a contextual reason. For example, *he feels happy/ok/fine* ***because*** *they listened to him and stopped talking so he can go back to watching/enjoying the movie in peace and quiet* **(prompt)**	2		
An answer that demonstrates a **lower order emotional understanding**. For example, *he feels happy/ok/fine* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 2
<u>Cognitive Theory of Mind</u>: ***What is the man thinking?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that recognises that the man had a contextual request, and provides a contextual reason for the request. For example, *the man is thinking that he wants* ***them/the women*** *to be quiet/stop talking* ***because*** *they are being loud/distracting him from the movie/being rude.* Mention of **affective state** limits mark to 2 points	3		
A **social answer** that recognises that the man had a contextual request. No more than 2 points can be gained if a contextual reason is not given. For example, *the man is thinking that he wants* ***them/the women*** *to be quiet/stop talking* **(prompt)**	2		
A **non-social answer** that recognises that the man had a contextual request. No more than 1 point can be gained if there is no mention of the other person from the interaction in the response, even with a contextual reason. For example, *he wants to watch the movie in silence/the man is thinking that he wants to watch the movie in silence/in peace and quiet* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 3
<u>Interpersonal Understanding of Social Norms</u>: ***Did the women in the animation behave as other people should behave?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the women acted in a socially acceptable manner, and provides a contextual explanation of why they listened to the man. For example, *yes - they did what* ***he/the man wanted****/they listened to* ***him/the man*** *and stopped talking when they were asked to* ***because*** *they were disrupting people trying to watch the movie/it is rude to talk in the cinema*	3		
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the women acted in a socially acceptable manner. No more than 2 points can be gained if a contextual reason is not given. For example, *yes - they listened to* ***him/the man*** *and stopped talking when they were asked to* **(prompt)**	2		
A **non-social answer** that exhibits an understanding of the relevant social norm highlighting that the women acted in a socially acceptable manner. For example, *yes - they stopped talking* **(prompt) OR** *no - they are entitled to talk during the cinema as long as they are whispering and should have told the man this*	1		
Don't know/irrelevant answer	0		

Question 4
<u>Intrapersonal Understanding of Social Norms (Part 2):</u> ***Would you have acted the same as the women in the animation?***

Prompt **ONCE** if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context **(2)**	Personal attributes **(1)**
YES (1)				
NO (0)				

cToM = /3	aToM = /3	UNS = /3	UNS2 = /3

Scenario 8: Serving a customer (non-social norm violation)

<u>General Comprehension</u>: ***Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?***

Prompt **ONCE** if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Man and child at hot-dog stand		
2. Child points to hot-dog sign/gestures towards employee at hot-dog stand		
3. Father hands man at hot-dog stand money		
4. Child gets hot-dog		
Other		

Question 1
<u>Cognitive Theory of Mind</u>: ***What is the father thinking?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that recognises that the father required a service, and provides a contextual reason for this service to be performed. For example, *he is thinking that he wants to buy a hotdog from* ***him/the vendor*** *for his son/to feed his son* ***because*** *his son indicated that he wanted a hotdog/his son is hungry.* Mention of **affective state** limits mark to 2 points	**3**		
A **social answer** that recognises that the father required a service. No more than 2 points can be gained if a contextual reason is not given. For example, *he is thinking that he wants to buy a hotdog from* ***him/the vendor*** *for his son/to feed his son* **(prompt)**	**2**		
A **non-social answer** that recognises that the father required a service. No more than 1 point can be gained if there is no mention of the other person from the interaction in the response, even with a contextual	**1**		

reason. For example, *the father wants a hotdog/the father is thinking that he wants to buy a hotdog for his son/feed his son* **(prompt)**			
Don't know/irrelevant answer	0		

Question 2
<u>Affective Theory of Mind</u>: ***How does the father feel at the end of the animation?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that demonstrates a **higher order emotional understanding**, with a contextual reason. For example, *he feels satisfied/pleased/content* ***because*** *the man gave him the hotdog/took his money and now his son has a hotdog which is what he wanted* **(prompt)**	3		
An answer that demonstrates a **lower order emotional understanding**, with a contextual reason. For example, *he feels happy/ok/fine* ***because*** *the man gave him the hotdog/took his money and now his son has a hotdog which is what he wanted* **(prompt)**	2		
An answer that demonstrates a **lower order emotional understanding**. For example, *he feels happy/ok/fine* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 3
<u>Interpersonal Understanding of Social Norms</u>: ***Did the man behind the stand in the animation behave as other people should behave?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the man behind the stand acted in a socially acceptable manner, and provides a contextual explanation for his actions. For example, *yes - he gave the hotdog to* ***him/the father****/gave them what they asked for* ***because*** *that is his job, to serve customers and make hotdogs*	3		
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the man behind the stand acted in a socially acceptable manner. No more than 2 points can be gained if a contextual reason is not given. For example, *yes - he gave the hotdog to* ***him/the father/gave them*** *what they asked for* **(prompt)**	2		
A **non-social answer** that exhibits an understanding of the relevant social norm highlighting that the man behind the stand acted in a socially acceptable manner. For example, *yes - he did his job* **(prompt)** **OR** *no - he should not be selling hotdogs to children, because they are not very healthy*	1		
Don't know/irrelevant answer	0		

Question 4
<u>Understanding of Social Norms (Part 2):</u> ***Would you have acted the same as the man behind the stand in the animation?***

Prompt **ONCE** if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context **(2)**	Personal attributes **(1)**
YES (1)				
NO (0)				

cToM = /3	aToM = /3	UNS = /3	UNS2 = /3

Scenario 9: Skipping a bus queue (social rule violation)

<u>General Comprehension</u>: ***Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?***

Prompt **ONCE** if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. People waiting in queue for bus		
2. Bus turns up, woman in purple approaches		
3. Woman in purple pushes past woman in orange at front of queue/skips queue		
4. Woman in purple is on bus first while others who were queuing are now paying		
Other		

Question 1
<u>Affective Theory of Mind</u>: ***How does the woman in orange feel at the end of the animation?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that demonstrates a **higher order emotional understanding**, with a contextual reason. For example, s*he feels outraged/annoyed/shocked **because** the woman in purple pushed her out of the way* **(prompt)**	3		
An answer that demonstrates a **lower order emotional understanding**, with a contextual reason. For example, *she feels angry/surprised/disgusted/she is upset/not happy **because** the woman in purple pushed her out of the way* **(prompt)**	2		
An answer that demonstrates a **lower order emotional understanding**. For example, *she is upset/not happy/ she feels angry/surprised/disgusted* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 2
<u>Cognitive Theory of Mind</u>: ***What is the woman in orange thinking?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that recognises that the woman in orange had a contextual desire, and provides a contextual reason for this desire. For example, *the woman in orange is thinking that she wants to get on the bus first/on the bus before* ***her/the woman in purple because*** *she is at the front at the queue.* Mention of **affective state** limits mark to 2 points	3		
A **social answer** that recognises that the woman in orange had a contextual desire. No more than 2 points can be gained if a contextual reason is not given. For example, *the woman in orange is thinking that she wants to get on the bus first/on the bus before* ***her/the woman in purple*** **(prompt)**	2		
A **non-social answer** that recognises that the woman in orange has a contextual desire. No more than 1 point can be gained if there is no mention of the other person from the interaction in the response, even with a contextual reason. For example, *she wants to get on the bus/the woman in orange is thinking that she wants to get on the bus first/get on the bus* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 3
<u>Interpersonal Understanding of Social Norms</u>: ***Did the woman in purple in the animation behave as other people should behave?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the woman in purple acted in a socially unacceptable manner, and provides a contextual explanation of why her actions were inappropriate. For example, *no - she should have waited her turn and let* ***her/the woman in orange*** *go first/gone to the back of the queue and waited for* ***everyone*** *else to get on first* ***because*** *they were waiting before her*	3		
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the woman in purple acted in a socially unacceptable manner. No more than 2 points can be gained if a contextual reason is not given. For example, *no - she should have waited her turn and let* ***her/the woman in orange*** *go first/gone to the back of the queue and waited for* ***everyone*** *else to get on first* **(prompt)**	2		
A **non-social answer** that exhibits an understanding of the relevant social norm highlighting that the woman in purple acted in a socially unacceptable manner. For example, *no - she should have waited her turn/gone to the back of the queue* **(prompt) OR** *yes - she should not have to wait if she does not want to or maybe she did not think they were getting on the same bus as her*	1		
Don't know/irrelevant answer	0		

Question 4
<u>Intrapersonal Understanding of Social Norms (Part 2):</u> ***Would you have acted the same as the woman in purple in the animation?***

Prompt **ONCE** if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context **(2)**	Personal attributes **(1)**
YES **(0)**				
NO **(1)**				

cToM = /3	aToM = /3	UNS = /3	UNS2 = /3

Scenario 10: Assisting a stranger (non-social norm violation)

<u>General Comprehension</u>: ***Can you tell me what's happening in this story, starting with the first picture and finishing with the last picture?***

Prompt **ONCE** if needed: *Anything else?*

		Notes/Partial Responses/Misconstruction/Omissions
1. Man and partner walking through park		
2. Man signals to other lady		
3. Man hands other lady his camera		
4. Other lady takes photo of man and his partner		
Other		

Question 1
<u>Cognitive Theory of Mind</u>: ***What is the couple thinking?***

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that recognises that the couple had a contextual request, and provides a contextual reason for this request. For example, *the couple are thinking that they want* ***her/the woman*** *to take a photo for them* ***because*** *they want a photo of them together to remember their walk/trip and they cannot take it themselves.* Mention of **affective state** limits mark to 2 points	**3**		
A **social answer** that recognises that the couple had a contextual request. No more than 2 points can be gained if a contextual reason is not given. For example, *the couple are thinking that they want* ***her/the woman*** *to take a photo for them* **(prompt)**	**2**		
A **non-social answer** that recognises that the couple had a contextual request. No more than 1 point can be gained if	**1**		

there is no mention of the other person from the interaction in the response, even with a contextual reason. For example, *they want a photo/the couple are thinking that they want a photo of themselves together* **(prompt)**			
Don't know/irrelevant answer	0		

Question 2
<u>Affective Theory of Mind</u>: *How does the couple feel at the end of the animation?*

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
An answer that demonstrates a **higher order emotional understanding**, with a contextual reason. For example, *they feel pleased/grateful/thankful* ***because*** *the woman stopped and took the photograph for them and now they have something to remember their walk/trip***(prompt)**	3		
An answer that demonstrates a **lower order emotional understanding**, with a contextual reason. For example, *they feel happy* ***because*** *the woman stopped and took the photograph for them and now they have something to remember their walk/trip* **(prompt)**	2		
An answer that demonstrates a **lower order emotional understanding**. For example, *they feel happy/ok/fine* **(prompt)**	1		
Don't know/irrelevant answer	0		

Question 3
<u>Interpersonal Understanding of Social Norms</u>: *Did the woman taking the photo in the animation behave as other people should behave?*

Prompt **ONCE** if needed: *Can you tell me more about what you mean by that? / Can you explain that in a little bit more detail?*

			Additional notes
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the woman acted in a socially acceptable manner, and provides a contextual explanation of why she did. For example, *yes - she did as* ***they/the man*** *requested and took the photo* ***because*** *they could not do it themselves and it did not take much time out of her day to oblige a kind request*	3		
A **social answer** that exhibits an understanding of the relevant social norm highlighting that the woman acted in a socially acceptable manner. No more than 2 points can be gained if a contextual reason is not given. For example, *yes - she did as* ***they/the man*** *requested and took the photo* **(prompt)**	2		
A **non-social answer** that exhibits an understanding of the relevant social norm highlighting that the woman acted in a socially acceptable manner. For example, *yes - she was helpful/took the photo* **(prompt) OR** *no - she should not have said yes, she does not know them and they are complete strangers*	1		
Don't know/irrelevant answer	0		

Question 4

<u>Intrapersonal Understanding of Social Norms (Part 2):</u> ***Would you have acted the same as the woman in the animation?***

Prompt **ONCE** if needed: *Can you tell me why?*

		Reason **(prompt if not provided)**	Social context **(2)**	Personal attributes **(1)**
YES (1)				
NO (0)				

cToM = /3	aToM = /3	UNS = /3	UNS2 = /3

Appendix 1.5. Formula and calculations for age-adjusted scores for subtests of the ESCoT

General formula:

$K = b_1 (\chi - \text{mean}(\chi))$

Cognitive Theory of Mind:

$1 = 0.037 (\chi - 50)$

Affective Theory of Mind

$1 = 0.043 (\chi - 50)$

Interpersonal Understanding of Social Norms:

$1 = 0.066 (\chi - 50)$

To calculate the age adjustments for individuals younger than 20 years old and 81 years old and older:

$2 = 0.066 (\chi - 50)$

Appendix 1.6. Supplementary information for Chapter 4

Age adjusted scores

Cognitive ToM. Raw cognitive ToM scores should be adjusted for age accordingly: 18–22 years old= –1 point, 23–77 years old= no change in raw score and 78 years and older= +1 point.

Affective ToM. Raw affective ToM scores should be adjusted for age: 18–26 years old= –1 point, 27–73 years old= no change in raw score and 74 years and older= +1 point.

Interpersonal Understanding of Social Norms. Raw scores should be adjusted as follows: 18–19 years old= –2 points, 20–34 years old= –1 point, 35–65 years old=no change, 66–80 years old= +1 point and 81 years and older= +2 points.

Appendix 1.7 Neuropsychological testing of patients

The table below shows the mean scores of the patient group on the neuropsychological tests that patients completed with Professor Abrahams.

Test	Mean (*SD*)
Memory	
BMIPB – story recall	
Immediate	11.88 (7.60)
Delay	8.84 (8.15)
% retained	63.48 (41.38)
BMIPB – figure recall	
Copy	73.17 (10.31)[a]
Immediate recall	36.80 (19.16)
Delayed recall	32.37 (20.83)[a]
% retained	77.92 (24.57)[a]
BMIPB – FSCRT	
Free recall	13.33 (7.67)[a]
Cued	38.42 (9.22)[a]
Sensitivity to cuing (%)	77.22 (19.63)[b]
Delay	4.05 (3.19)[c]
Cued	12.91 (3.49)[c]
Executive functions	
Trail Making Test (seconds)	
Part A	49.45 (22.35)[a]
Part B	116.58 (64.43)[d]
Letter fluency	
Total score	27.56 (16.72)

Animal fluency	13.78 (4.45)[b]
D-KEFS card sorting (scaled score)	7.92 (2.81)[a]
Language functions	
Graded naming test	16.12 (7.97)
Warrington spelling test	20.28 (8.23)[e]
TROG	36.73 (13.67)[d]
Visuospatial	
Number location	9.87 (0.35)[f]
Dot counting	7.13 (3.18)[f]
Behaviour change	
FBI	
Negative behaviours	12.61 (9.52)
Disinhibition	8.72 (7.71)
Total	21.33 (16.61)

[a]$n = 24$; [b]$n = 23$; [c]$n = 21$; [d]$n = 19$; [e]$n = 18$, [f]$n = 15$.